

# BOTANICAL ASSESSMENT OF THE PELLA HOUSING DEVELOPMENT SITE



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## EXECUTIVE SUMMARY

The aim of the study was to determine the possible impact of the proposed development of 118 stands on the diversity and ecological status of the vegetation at the Pella housing development site and surrounds.

Pella is situated in the Northern Cape province along the lower Orange River, northwest of Pofadder at approximately 29° 02' 24" South, and 19° 08' 59" East. The site covers approximately 11 ha. The topocadastral grid reference is 2919 AA. The agricultural activities in the region include vineyards and date palm production. The mean annual rainfall measured at the nearby Pofadder weather station is 117 mm. The geology of the sandy plains comprises Quaternary wind-blown sands and sheet-wash alluvial deposits, overlying yellow-brown to grey-weathering biotite-hornblende augen gneiss. The site occurs in the Ae84 Land Type indicating red-yellow apedal, freely drained soils with a red high base status and >300 mm deep (no dunes).

The proposed housing development site at Pella falls in the Eastern Gariep Plains Desert vegetation type that occurs on the plains south of the Orange River and south of the Pella Mountains. The site is characterised by deep sandy soils, but is severely degraded, overgrazed and trampled. The effect of the current drought has exacerbated the poor vegetation cover in the region. Only 18 plant species were recorded on the site of 11 ha.

The most prominent tree species on site are the protected *Vachellia erioloba* and the alien invasive *Prosopis cf. glandulosa*. The shrub layer is represented by *Sisyndite spartea*; with *Rhigozum trichotomum* and *Senna italica* representing the dwarf shrub layer; and *Tetraena simplex* dominating the herbaceous layer. The grass layer is basically non-existent with a few individuals of *Schmidtia kalahariensis* and *Stipagrostis* spp. present.

Twenty-five individuals of *Vachellia erioloba* were recorded in the footprint of the proposed development, while another 34 individuals were surveyed in the area to the west, south and east of the site (see Section 3.9 and Appendix C for details on each individual of *Vachellia erioloba* in the area).

The conservation status of the site is as follows:

- The Eastern Gariep Plains Desert is "**least threatened**". None of this vegetation type is conserved in statutory conservation areas.
- According to the Newposa plant species list for the immediate vicinity of the site (2919 AA quarter degree), 204 plant taxa were listed.
- No IUCN red listed species were recorded on site.
- No NCNCA specially protected plant species were recorded on site.
- One protected plant species was recorded on site, i.e. *Jamesbrittenia maxii*.
- No threatened or protected plant species (ToPS) according to NEM:BA (2011) were recorded on site.
- No CITES plant species were recorded on site.
- *Sisyndite spartea* is the only endemic species from the Gariep Centre of Endemism on site.

- No biogeographically important endemic taxa were listed by Mucina & Rutherford (2006) for the Eastern Gariep Plains Desert.
- *Vachellia erioloba*, a nationally protected tree species, occurs on site (National Forest Act, Act 84 of 1998) (NFA 2018). In the footprint of the proposed development, 25 individuals of *Vachellia erioloba* were recorded and another 34 individuals were found in the area to the west, south and east of the site.
- The site at Pella falls within a Critical Biodiversity Area 2 area (CBA 2)(Namakwa Biodiversity Sector Plan 2016). CBAs should be kept in a natural or near-natural state, with no further loss of habitat or land-use change permitted.
- *Prosopis cf. glandulosa* is the only alien invasive species recorded on site.

### *Sensitivity*

By using a number of criteria such as conservation status of the vegetation type, presence of rare or threatened species, protected trees and endemic plant species, species richness and degree of fragmentation of the habitat, the sensitivity rating of the habitat on site was Very Low (VL). A very low sensitivity means that a minimum score is allocated to almost all the sensitivity criteria used. It is usually applicable to habitats in poor condition or that have been transformed, especially by human activities.

### *Impacts*

The following impacts were identified:

- Loss of indigenous vegetation, including the protected tree *Vachellia erioloba* and concomitant loss of faunal habitat.
- Establishment of invasive alien vegetation.
- Increased erosion and water run-off by the clearing of the indigenous vegetation and paving of driveways and streets.
- Increased dust deposition during construction.
- Increased noise levels during construction.

Mitigation measures proposed:

- The removal of any individual of the protected tree *Vachellia erioloba* will require the necessary permits from DAFF.
- Vegetation clearance should be confined to the footprint of the proposed housing development.
- The position of each dwelling should be micro-sited to accommodate the trees where possible.
- The use of arboricides for the clearing of vegetation is not recommended
- A control program to combat declared alien invasive plant species should be employed.
- No invasive alien species should be used in rehabilitation projects or for gardening.
- Streets should be designed to reduce the risk of erosion.
- Planning for storm water drainage (pipes) should be part of the development.
- Excessive dust during construction, can be reduced by spraying water regularly to control dust generation. Other suitable dust control mitigation measures can also be considered.
- The SANS noise standards should be adhered to.

- Construction crew, in particular the drivers, should undergo environmental training to increase their awareness of environmental concerns.
- Existing speed limits should be adhered to.

*Significance of impacts:*

The significance of impacts for the various potential impacts identified (with mitigation) range from very low to low. Except for the protected *Vachellia erioloba*, the impacts of the proposed development on the indigenous vegetation in the sandy plains habitat is regarded as negligible. The disturbed nature of the site, the poor species richness and absence of red listed plant species on the site, leads to an assessment of very low impact. Therefore, the development will have almost no effect on the biodiversity of the region.

## TERMS OF REFERENCE

- Summarise available literature on the vegetation of the area as well as the physical environment, e.g. climate, geology, land types, soil, topography and drainage.
- Stratify the area into relatively homogeneous units or habitats based on physiography and vegetation cover, using aerial images and topocadastral maps.
- Do a site survey of the stratified units.
- Compile checklists of flora and identify rare plant species, protected species, endemic species as well as alien invaders. Investigate management of these plant species.
- Do a sensitivity analysis and produce a sensitivity map.
- Indicate the presence of unique habitats, ecologically sensitive areas and degraded areas that may need further investigation, protection or rehabilitation.
- Assess the possible impact of the development on the ecosystem, habitats, drainage and fauna and flora, and propose mitigation measures.

## GENERAL INFORMATION

**Study site:** Pella Mission 39  
**District Municipality:** Namakwa  
**Local Municipality:** Khäi-Ma

**Approximate size of property:** 11 ha

**Environmental Assessment Practitioner (EAP):**

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# REGULATIONS GOVERNING THIS REPORT

This report has been prepared in terms of the EIA Regulations under the National Environmental Management Act (Act No. 107 of 1998) (NEMA 2014, 2017).

## **Appointment of specialist**

Ekotrust cc was commissioned by EnviroAfrica cc (Somerset West) to provide a botanical assessment for a BA application for a housing development at Pella in the Northern Cape.

## **Company profile:**

Name of Company: Ekotrust cc  
(Registration number: CK90/05465/23)  
Sole Member: Dr Noel van Rooyen  
Founding date: 1990

Ekotrust cc specialises in habitat evaluation, vegetation classification and mapping, floristic diversity assessments, rare species assessments, alien plant assessments and management, wildlife management, wildlife production and economic assessments, veld condition assessment, bush encroachment, fire management, carrying capacity, wildlife numbers and ratios.

## **Declaration of independence**

I, Noel van Rooyen, declare that:

- I am a member of Ekotrust cc: (CK90/05465/23);
- I act as an independent specialist consultant in the fields of ecology and botany;
- I regard the information contained in the report to be objective, true and correct within the framework of assumptions and limitations;
- I undertake to disclose to the applicant and the competent authority all information in my possession that reasonably has or may have the potential of influencing any decision to be taken by the competent authority; and
- I do not have any business, financial, personal or other interest in the activity or application other than fair remuneration for work performed in connection with the activity or application.



### **Indemnity and conditions relating to this report**

The observations, findings, recommendations and conclusions provided in the current report are based on the compilers' best scientific and professional knowledge and other available information. If new information should become available Ekotrust cc reserves the right to modify aspects of the report. This report (hard copy and/or electronic) must not be amended or extended without the prior written consent of the author. Furthermore, any recommendations, statements or conclusions drawn from or based on this report must make reference to the report. If these recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety (as an Appendix).

Although Ekotrust cc has exercised due care in preparing this report, it accepts no liability, and by receiving this document, the client indemnifies Ekotrust cc against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

### **Scope and purpose of report**

The scope and purpose of the report are summarised in the "Terms of Reference" section of this report.



Dr Noel van Rooyen

Date: 8 April 2019

## LIMITATIONS, ASSUMPTIONS AND UNCERTAINTIES

The following assumptions, limitations or uncertainties are listed regarding the ecological assessment of the Pella site:

- The survey was conducted during very dry conditions in early April 2019. Additionally, the site is disturbed, degraded and overgrazed resulting in a very species poor composition of the site.
- Rare and threatened plant and animal species are generally uncommon and/or localised and the once-off survey may fail to locate such species, especially if the survey is outside the flowering season of such species.

# CHAPTER 1

## INTRODUCTION

A botanical assessment for a housing development at the missionary town of Pella in the Khâi-Ma Local Municipality in the Northern Cape was commissioned by EnviroAfrica cc as part of a Basic Assessment according to NEMA (2014, 2017). The site of approximately 11 ha is located next to the town and occurs on the sandy plains south of the Pella Mountains. Pella has two kinds of commonage: an Act 9 land comprising 60 000 ha and the new commonage acquired after 1994 covering 40 000 ha.

Loss of habitat is regarded as the foremost cause of loss of biodiversity. It is essential that the impact of development on biodiversity in sensitive and irreplaceable habitats is minimized. Much of the impact can be minimized through careful planning and avoidance of sensitive areas. Although the area has a relatively low biodiversity, a number of rare and endemic species are found in this region, especially in the mountainous regions, e.g. Pella Mountain.

The aim of the study is to determine the possible impact of the proposed development of 118 stands on the diversity and ecological status of the vegetation at the Pella housing development site and the surrounding area.

## CHAPTER 2

### METHODS

#### 2.1 Approach

The study commenced as a desktop study, followed by a field-based survey and verification in early April 2019. Hard copy and digital information from spatial databases, such as DAFFarcgis, topocadastral maps (2919 AA) and vegetation types (Mucina & Rutherford 2006), were sourced to provide information on topography, geology, land types and broad vegetation types of the study area. Information on the climate was sourced from the Weather Bureau (1988, 1998).

A Google Earth satellite image was used to select sampling sites during the site visit. Sampling consisted of systematically recording all identifiable woody species, grasses, forbs and alien (exotic) plant species. Physical habitat features, e.g. geology, topography and soil texture were noted at each sampling point. A checklist of the plant species recorded during the site visit was compiled. During the site visit, digital photographs of the site and some individual plant species were taken and included in the report.

#### 2.2 Data analyses

The terrain, soil type and vegetation on the relatively small site proved to be very homogeneous and a formal classification of the vegetation was not deemed necessary. The vegetation was described as part of a sandy plains habitat.

#### 2.3 Plant species checklists

All plant species recorded on site (18 species) are listed in the checklist (see Appendix A). An additional plant species checklist of the 2919 AA quarter degree grid was obtained from the NewPosa database of the South African National Biodiversity Institute (SANBI, April 2019) which lists 204 taxa (Appendix B).

#### 2.4 Red Data plant species

The site was systematically surveyed for rare, threatened and/or endemic plant species. The Red Data status, conservation and protected status of plant species recorded on site were determined from available literature and Acts.

#### 2.5 Sensitivity and impact assessment

A sensitivity assessment of the sandy plains habitat was done based on a number of criteria and a rating awarded. An assessment of the ecological impacts and their significance on the vegetation and flora is discussed and mitigation measures proposed.

## CHAPTER 3

# ENVIRONMENTAL DESCRIPTION

### 3.1 Location

Pella is situated in the Northern Cape province along the lower Orange River, northwest of Pofadder at approximately 29° 02' 24" South, and 19° 08' 59" East (Figures 1 & 2). The site covers approximately 11 ha. The topocadastral grid reference is 2919 AA. The agricultural activities in the region include vineyards and date palm production.

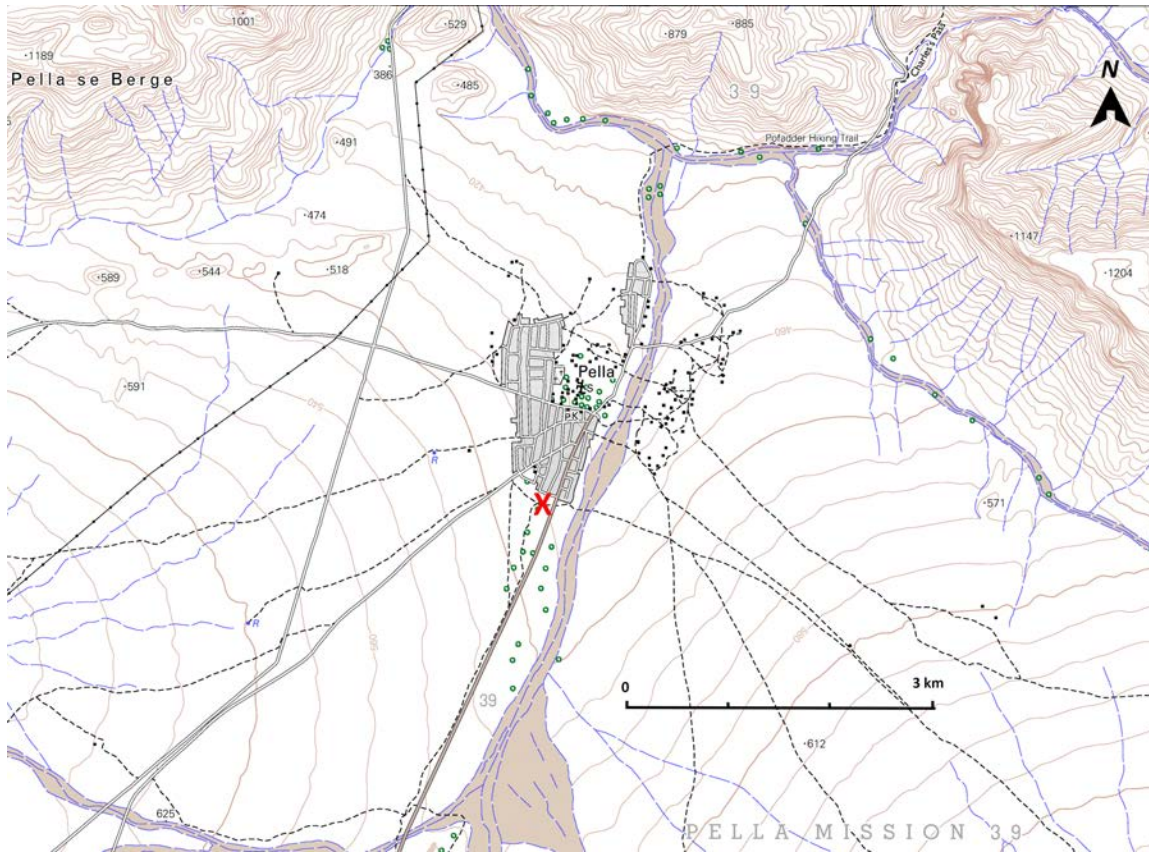


Figure 1: Topocadastral map of the Pella site (site is marked by X).



Figure 2: Satellite image of the immediate environs of the proposed Pella housing development site to the south of the town.

## 3.2 Climate

### *Regional climate*

A summary of the broad climate of the area is provided by Mucina & Rutherford (2006). The mean annual precipitation of the area covered by the Eastern Gariep Plains Desert is 57 mm with a rainfall peak in March. The mean annual temperature is 23.6°C. Mean monthly maxima and minima for Goodhouse are 44.9°C and 1.9°C for January and July, respectively. Frost is absent or very rare.

### *Rainfall and temperature*

The mean annual rainfall measured at the Pofadder weather station is 117 mm (Tables 1 & 2) (see also Figure 3). However, the total annual rainfall may vary from 38 mm to 277 mm during dry and wet years respectively, indicating an annual precipitation coefficient of variation of 69% and a rainfall scenario that is highly unpredictable. The rainy season is predominantly from December to April when about 68% of the annual rainfall occurs. The driest months are from July to November, when less than 7 mm of rain is recorded per month. The maximum rainfall measured over a 24 hour period at Pofadder was 77 mm in April. The highest monthly rainfall recorded was 146 mm, measured in February.

Table 1: Rainfall at some weather stations in the general area near Pella

Month	Uppington	Pofadder	Augrabies	Goodhouse
Jan	24	9	2	3
Feb	35	19	13	7
Mar	37	22	20	13
Apr	26	21	15	6
May	10	7	2	4
June	4	7	1	5
July	2	6	2	5
Aug	4	3	1	2
Sep	4	6	0	2
Oct	9	5	7	2
Nov	17	4	10	4
Dec	17	8	10	4
Year	189	117	83	57

Table 2: Rainfall statistics for Pofadder weather station (0247668A4; 29° 08' S; 19° 23' E; 989 m a.s.l.; Period 29 years)

Month	Mean monthly	24 h max	Max per month	Min per month
Jan	9	41	77	0
Feb	19	77	146	0
Mar	22	40	77	0
Apr	21	52	101	0
May	7	38	70	0
June	7	27	40	0
July	6	42	42	0
Aug	3	14	17	0
Sep	6	20	27	0
Oct	5	27	43	0
Nov	4	14	18	0
Dec	8	46	83	0
Year	117	77	277	38

The mean annual temperatures for Pofadder is 18.6°C (Table 3). The extreme maximum and minimum temperatures measured at Pofadder were 40.6°C and -3.0°C. The mean daily maximum at Pofadder for January is 33.0°C and for July it is 18.0°C (Table 3). The mean daily minimum for January is 16.6°C and for July it is 5.1°C. Frost may potentially occur from May to September, a period of approximately 150 days.

Table 3 Temperature data (°C) for Pofadder weather station 0247668A4; 29° 08' S; 19° 23' E; 989 m a.s.l.; Period 29 years

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Max	33.0	32.4	30.1	25.4	21.4	17.8	18.0	20.0	23.6	26.5	30.0	32.1	25.8
*Ext. Max	40.6	39.6	39.2	35.7	31.3	26.0	27.6	31.0	35.2	37.9	39.4	40.5	40.6
Min	16.6	17.2	16.0	12.4	8.6	5.7	5.1	6.0	8.6	10.9	14.0	15.5	11.4
*Ext. Min	6.4	5.6	4.4	0.5	-0.4	-2.7	-3.0	-2.7	-1.2	1.6	4.0	5.0	-3.0
Mean	24.8	24.8	23.0	18.9	15.0	11.8	11.6	13.0	16.1	18.7	22.0	23.8	18.6

Max = mean daily maximum temperature for the month

\*Ext. Max = extreme maximum temperature recorded per month

Min = mean daily minimum temperature for the month

\*Ext. Min = extreme minimum temperature recorded per month

Mean = mean monthly temperature for each month and for the year

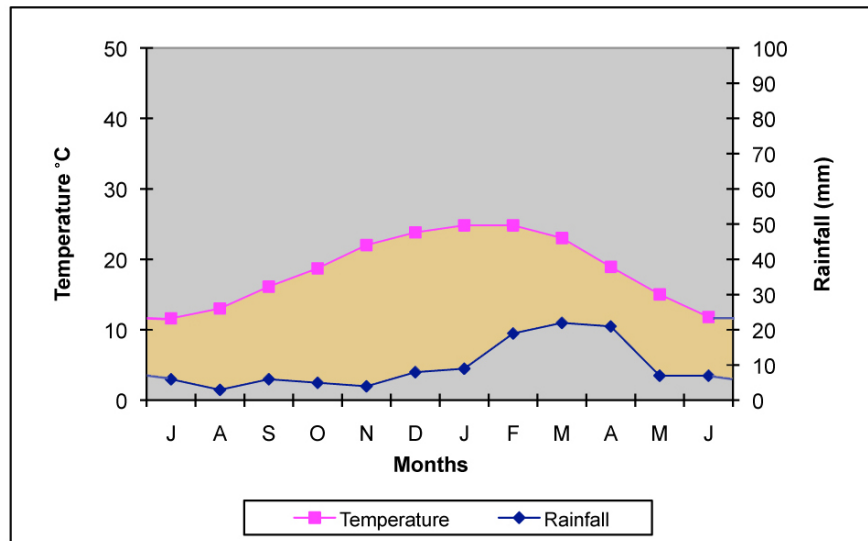


Figure 3: Climate diagram for Pofadder, about 25 km to the southeast of Pella.

*Cloud cover*

The cloud cover at Pofadder at 14:00 is highest from February to April when a mean cloud cover of more than 20% (1.9/8) or more occurs (Table 4). The mean percentage relative air humidity at 08:00 varies from 63% to 69 during the period April to July, to less than 52% from November to January. The humidity at 14:00 varies from 42% in June to 24% in December (Table 4).



Table 4: Cloud cover (in eights) at 14:00 and relative air humidity at 08:00 and 14:00 at the Pofadder weather station. Location: 29° 08' S; 19° 23' E; 989 m a.s.l. Period 29 years

	Cloud cover (0 - 8)	Relative air humidity (%)	
	14:00	08:00	14:00
Jan	1.6	52	26
Feb	1.7	56	29
Mar	1.9	60	33
Apr	2.1	65	37
May	1.9	63	37
June	1.7	69	42
July	1.4	65	38
Aug	1.5	62	32
Sept	1.7	59	29
Oct	2.1	54	26
Nov	1.7	50	25
Dec	1.3	48	24
Year	1.7	59	32

### 3.3 Terrain morphology and drainage

The site occurs on the plains between the hills and rocky outcrops near the Orange River at altitudes varying from about 480 m a.s.l. at the site to 1206 m a.s.l. in the mountains to the east of Pella (Figure 1). The area is drained towards the Orange River in the north by the T'Goob se Laagte and a number of other dry sandy water courses which flow only after significant amounts of rainfall have occurred.

### 3.4 Geology

The geology of the sandy plains consists of Quaternary wind-blown sands and sheet-wash alluvial deposits. The substrate of the site consists of yellow-brown to grey-weathering biotite-hornblende augen gneiss (Figure 4).

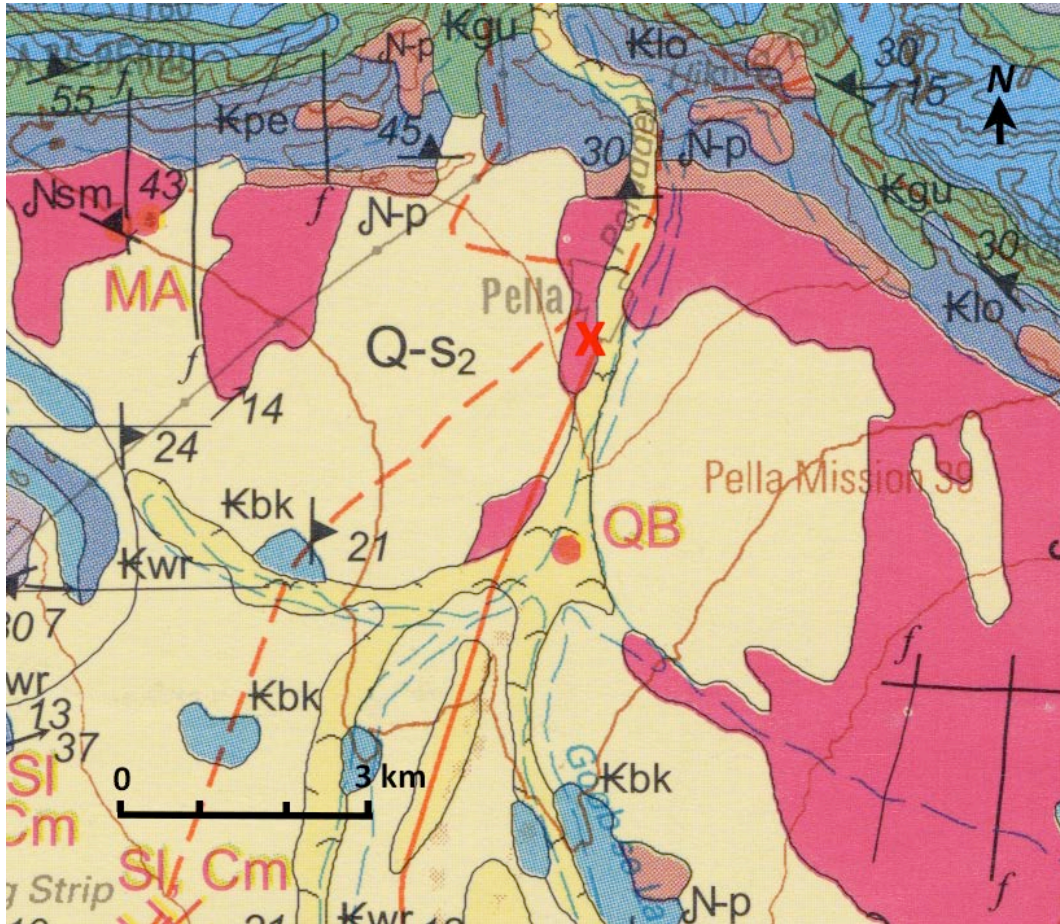


Figure 4: Geology of the Pella region. Location of the site is indicated with red X.

Legend to Figure 4:

Alluvium: Found along the drainage lines.

Q-S1: Red wind-blown sand and sand dunes - Quaternary

Q-S2: Sand, scree, rubble, sandy soil - Quaternary

Nsm: Yellow-brown to grey-weathering biotite-hornblende augen gneiss

N-p: Pegmatite

Kbk: Calc-silicate gneiss, amphibolite, biotite gneiss and marble of the Brulkolk Formation, Aggeneys Subgroup, Bushmanland Group

Klo: Calc-silicate gneiss, quartzitic calc-silicate gneiss, biotite gneiss and amphibolite of the Longsiekvlei Formation, Droëboom Group

Kpe: Quartzite and conglomerate of the Pella Subgroup, Droëboom Group.

### 3.5 Land Types

Land Types denote areas that display a marked degree of uniformity with respect to terrain form, soil pattern and climate. A terrain unit is any part of the land surface with homogeneous form and slope. Terrain unit 1 represents a crest, 2 = scarp, 3 = midslope, 4 = footslope and 5 = valley bottom.

The site occurs in the Ae84 Land Type (Figure 5). Land Type Ae84 indicates red-yellow apedal, freely drained soils with a red high base status and >300 mm deep (no dunes). The Ic136 Land Type occurs to the north of the site while the Ag36 and Ag63 Land Types cover the areas to the west, south and east of the site.

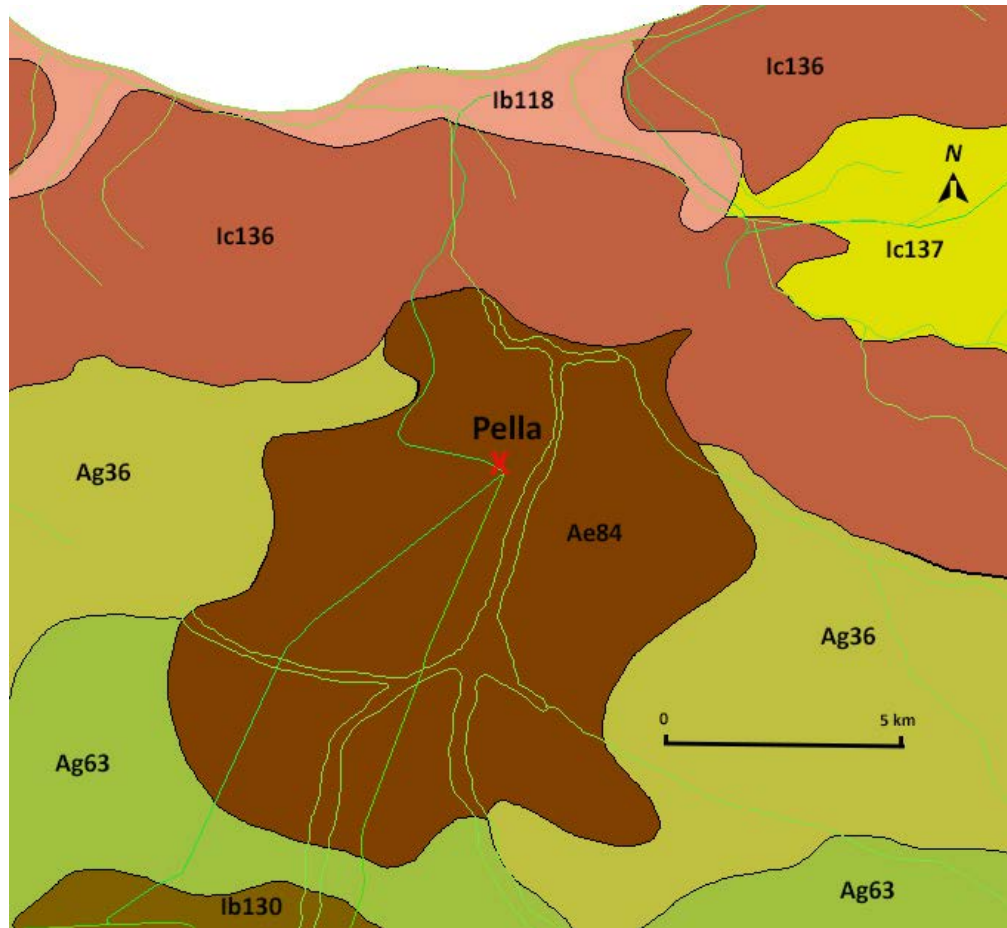


Figure 5: Land Types of the Pella region with the site occurring in the Ae84 Land Type (red cross).

## CHAPTER 4

# ENVIRONMENTAL LEGISLATION

### 4.1 Introduction

The White Paper on the conservation and sustainable use of South Africa's biodiversity and the National Environmental Management Act (Act No. 107 of 1998) specify that due care must be taken to conserve and avoid negative impacts on biodiversity and that the sustainable, equitable and efficient use of biological resources must be promoted. Various acts provide control over natural resources in terms of their conservation, the use of biological resources and avoidance of negative impacts on biodiversity. Some international conventions are also relevant to sustainable development.

### 4.2 National Environmental Management Act (Act No. 107 of 1998) (NEMA)

NEMA is the framework environmental management legislation, enacted as part of the government's mandate to ensure every person's constitutional right to an environment that is not harmful to his or her health or well-being. It is administered by DEA but several functions have been delegated to the provincial environment departments. One of the purposes of NEMA is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment. The Act further aims to provide for institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state and to provide for the administration and enforcement of other environmental management laws.

NEMA requires that measures are taken that "prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development." In addition: (1) NEMA requires that the disturbance of ecosystems and loss of biological diversity are avoided, or where they cannot be altogether avoided, are minimised and remedied, (2) a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions, and (3) sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

This report considers the Environmental Impact Assessment (EIA) Regulations 2014, with amendments in 2017, under the National Environmental Management Act, (Act No. 107 of 1998) (NEMA 1998, 2014, 2017). According to the Regulations (2017) under Listing Notice 1 (GRN No. 327), Listing Notice 2 (GRN No 325) and Listing Notice 3 (GRN No 324), the activities listed are identified as activities that may require

Environmental Authorisation prior to commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.

The following listed activities may be applicable to the housing project and may require Environmental Authorisation prior to commencement of that activity.

*Listing Notice 1 (GNR 327):*

*Activity 27: The clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation\*, except where such clearance of indigenous vegetation is required for -*

- (i) the undertaking of a linear activity; or*
- (ii) maintenance purposes undertaken in accordance with a maintenance management plan.*

*Listing Notice 3 (GRN 324):*

*Activity 12 - The clearance of an area of 300 m<sup>2</sup> or more of indigenous vegetation except where such clearance of indigenous vegetation\* is required for maintenance purposes undertaken in accordance with a maintenance management plan.*

**g. Northern Cape:**

- ii. Within critical biodiversity areas identified in bioregional plans;
- iv. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning.

\*“indigenous vegetation” refers to vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding 10 years (NEMA 1998).

### 4.3 National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEM:BA)

As the principal national act regulating biodiversity protection, NEM:BA, which is administered by DEA, is concerned with the management and conservation of biological diversity, as well as the use of indigenous biological resources in a sustainable manner. The term biodiversity according to the Convention on Biodiversity (CBD) refers to the variability among living organisms from all sources including, *inter alia* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity in genes, species and ecosystems.

#### 4.3.1 Threatened ecosystems

Section 53 of NEM:BA lists the threatened status of ecosystems, i.e. critically endangered ecosystems, endangered ecosystems, and vulnerable ecosystems. The list of threatened ecosystems was published in 2011 (NEM:BA, 2011).

#### 4.3.2 *Threatened or Protected Species (ToPS) Regulations*

Section 56 of NEM:BA makes provision for the declaration of species which are of such high conservation value, national importance or are considered threatened that they need protection, i.e. critically endangered species, endangered species and vulnerable species. Lists of species that are threatened or protected, and associated activities that are prohibited and/or exempted from restriction have been published in the Government Gazette Vol 574, No 36375 of 16 April 2013 (NEM:BA 2013). Any proposed removal of threatened or protected species and/or prohibited/restricted activities will require a permit in term of these Threatened or Protected Species (ToPS) Regulations of 2013, as read with NEM:BA.

#### 4.3.3 *Alien and Invasive Species (AIS) Regulations*

Chapter 5 of NEM:BA provides for the protection of biodiversity from alien and invasive species. The act defines alien species and contemplates the listing of invasive species in regulations. As for ToPS, the act defines certain activities that are restricted in connection with declared listed alien or invasive species which include, among others, importing, exporting, growing, breeding, transporting and selling those species, and would therefore require Environmental Authorisation.

The Alien and Invasive Species (AIS) Regulations, in terms of Section 97(1) of NEM:BA, was published in Government Notice R598 in Government Gazette 37885 dated 1 August 2014. The Alien and Invasive Species (AIS) lists in terms of sections 66(1), 67(1), 70(1)(a), 71(3) and 71A of NEM:BA was subsequently published in Government Notice R 864 of 29 July 2016.

In terms of the aforementioned legislation, the following categories of declared alien and invasive plants are recognised in South Africa:

**Exempted Alien Species** means an alien species that is not regulated in terms of this statutory framework - as defined in Notice 2 of the AIS List.

**Prohibited Alien Species** mean an alien species listed by notice by the Minister, in respect of which a permit may not be issued as contemplated in section 67(1) of the act. These species are contained in Notice 4 of the AIS List, which is referred to as the List of Prohibited Alien Species (with freshwater fish in List 7 of Notice 4).

**Category 1a Listed Invasive Species** mean a species listed as such by notice in terms of section 70(1)(a) of the act, as a species that must be combatted or eradicated. These species are contained in Notice 3 of the AIS List, which is referred to as the National Lists of Invasive Species. Landowners are obliged to take immediate steps to control Category 1a species.

**Category 1b Listed Invasive Species** mean species listed as such by notice in terms of section 70(1)(a) of the act, as species that must be controlled or 'contained'. These species are contained in Notice 3 of the AIS List, which is referred to as the National Lists of Invasive Species. However, where an Invasive Species Management Programme has been developed for a Category 1b species, then landowners are obliged to "control" the species in accordance with the requirements of that programme. Therefore, Category 1a triggers an immediate obligation to control, whereas that obligation only comes into effect for Category

1b species when an Invasive Species Management Programme is implemented for that species in the specific area.

**Category 2 Listed Invasive Species** mean species listed by notice in terms of section 70(1)(a) of the act, as species that require a permit to carry out a restricted activity e.g. cultivation within an area specified in the Notice or an area specified in the permit, as the case may be. Category 2 includes plant species that have economic, recreational, aesthetic or other valued properties, notwithstanding their invasiveness. It is important to note that a Category 2 species that falls outside the demarcated area specified in the permit, becomes a Category 1b invasive species. Permit-holders must take all the necessary steps to prevent the escape and spread of the species.

**Category 3 Listed Invasive Species** mean species listed by notice in terms of section 70(1)(a) of the act, as species that are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of act, as specified in the notice. Category 3 species are less-transforming invasive species which are regulated by activity. The principal focus with these species is to ensure that they are not introduced, sold or transported. However, Category 3 plant species are automatically Category 1b species within riparian and wetland areas.

#### 4.4 The National Environmental Management: Protected Areas Act (Act No. 57 of 2003) (NEM:PAA)

NEM:PAA provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; and for matters in connection therewith.

#### 4.5 National Forests Act (Act No. 84 of 1998)(NFA)

The National Forest Act makes provision for the declaration of for example specially protected areas, forest nature reserves, forest wilderness areas and protected woodlands. A list of tree species declared protected in terms of the NFA, was published in 2017. In terms of section 15(1) of this act, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any product derived from a protected tree, except under a license or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated. The competent authority responsible for considering and issuing the license will be the national Department of Agriculture, Forestry and Fisheries (DAFF).

#### 4.6 National Water Act (Act No. 36 of 1998)

The National Water Act places strong emphasis on sustainable use of water resources, and its purpose as per Subsection 2(g) of the NWA includes protecting aquatic and associated ecosystems and their biological diversity. Wetlands, riparian zones and watercourses are defined as water resources by the Water Act and any contemplated activities that could affect these areas require authorisation.

The key mechanism through which NEMA (2014, 2017) attempts to mitigate the impacts of development on streamflows and wetlands is by specifying a buffer zone of some 32 m from the edge of the watercourse and wetland areas NEMA (2014, 2017) that should not be developed without authorisation. It is therefore necessary to delineate all watercourses and wetlands and their associated buffer zones in areas to be developed.

#### 4.7 Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA)

The objectives of CARA (1983, 2001) are to provide for the conservation of the natural agricultural resources by the maintenance of the production potential of the land, by combating and preventing erosion and weakening or destruction of the water resources, and by protecting the vegetation and combating weeds and invader plants. In order to achieve the objectives, certain control measures are prescribed which shall be complied with by land users to whom they apply. The activities which are mentioned relate to (*inter alia*):

- the cultivation of virgin soil;
- the utilisation and protection of land which is cultivated;
- the irrigation of land;
- the prevention or control of waterlogging or salinization of land;
- the utilisation and protection of vleis, marshes, water sponges, watercourses and water sources;
- the regulation of the flow pattern of run-off water;
- the control of weeds and invader plants;
- the restoration or reclamation of eroded land or land which is otherwise disturbed or denuded;
- the protection of water sources against pollution on account of farming practices; and
- the construction, maintenance, alteration or removal of soil conservation works or other structures on land.

In addition, lists of alien invasive plant species are provided with associated categories indicating the appropriate management and mitigation of these declared alien invasive species.

#### 4.8 Northern Cape Nature Conservation Act (Act No. 9 of 2009) (NCNCA)

The Northern Cape Nature Conservation Act (Act No. 9 of 2009) restricts activities involving specially protected, protected and indigenous plant species.

Section 50 deals with the restricted activities involving protected plants and states that no person may, without a permit, pick, import, export, transport, cultivate or trade in a specimen of a protected plant.

Section 51 involves the picking, receipt, possession, acquisition or handling of indigenous plants and states that no person may, without a permit, pick an indigenous plant – (a) on a public road; (b) on land next to a public road within a distance of 100 meters measured from the centre of the road; or (c) within



an area bordering a natural water course, whether wet or dry, up to and within a distance of 100 meters from the middle of a river on either side of the natural water course.

The Act lists different categories of flora and fauna, i.e. Schedules 1, 2, 3 and 6 for flora and Schedules 1, 2, 3, 4, 5 and 6 for fauna. The lists of flora in the Act were consulted and compared with lists of plant species recorded during the vegetation surveys of the sites.

**Permit applications pertaining to selected plant species in terms of the Northern Cape Nature Conservation Act (Act No. 9 of 2009) (see Appendix C) for purposes of the proposed Pella housing development will have to be lodged with the Northern Cape Department of Environment and Nature Conservation.**

#### 4.9 Convention on Biodiversity (CBD)

South Africa became a signatory to the United Nations Convention on Biological Diversity (CBD) in 1993, which was ratified in 1995. The CBD requires signatory states to implement objectives of the Convention, which are the conservation of biodiversity; the sustainable use of biological resources; and the fair and equitable sharing of benefits arising from the use of genetic resources. According to Article 14 (a) of the CBD, each Contracting Party, as far as possible and as appropriate, must introduce appropriate procedures, such as environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biological diversity, to avoid or minimize these effects and, where appropriate, to allow for public participation in such procedures.

#### 4.10 Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES is an international agreement to which countries adhere voluntarily. The aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The species covered by CITES (2017) are listed in three appendices reflecting the degree of protection that the species needs. Appendix I includes species which are threatened with extinction and trade in these species is permitted only in exceptional circumstances. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. Appendix III lists species that are protected in at least one country that has asked other CITES parties for assistance in controlling the trade (Website: [www.cites.org](http://www.cites.org)).

# CHAPTER 5

## VEGETATION

### 5.1 Introduction

Floristically the site falls in the Karoo-Namib Zone of White (1983), an extensive region stretching from Namibia into the western interior of South Africa. Vegetation types such as the Eastern Gariep Plains Desert and Eastern Gariep Rocky Desert fall in the Gariep Desert Bioregion of the Desert Biome (Mucina & Rutherford 2006). Acocks (1953), Mostert *et al.* (1971) and Gubb (1980) described the area as the Orange River Broken Veld, while Low & Rebelo (1998) classified the area as part of the Orange River Nama Karoo.

The proposed housing development site at Pella falls in the Eastern Gariep Plains Desert (Mucina & Rutherford 2006). Other vegetation types in the region include the Eastern Gariep Rocky Desert (Dg10), the Bushmanland Arid Grassland (NKb3) and the Lower Gariep Alluvial Vegetation (Aza3) (Figure 6).

### 5.2 Vegetation types

#### 5.2.1. Eastern Gariep Plains Desert (Dg 9)

The site occurs on the plains south of the Orange River and south of the Pella Mountains (Figure 6). The Lower Gariep Plains Desert occurs from Onseepkans in the east to near Vioolsdrif in the west. The altitude of this vegetation type varies from 250 to 900 m. The plains contrast with the surrounding hills and mountains. Typical wash vegetation occurs in the breaks between the mountains with *Stipagrostis* species dominant.

The tree component includes *Parkinsonia africana* and *Vachellia erioloba*, while the shrub layer is represented by *Calicorema capitata*, *Sisyndite spartea*, *Euphorbia gregaria*, *Mesembryanthemum subnodosum* and *Justicia spartioides*. Dwarf shrubs and forbs include *Hermbstaedia glauca*, *Petalidium setosum*, *Codon royenii* and *Rogeria longiflora*. The grass layer is dominated by *Stipagrostis* spp., e.g. *Stipagrostis brevifolia*, *S. ciliata* and *S. obtusa*. *Schmidtia kalahariensis* is seasonally dominant.

This vegetation type is considered “least threatened”. Although few intact examples of this vegetation remain, none of this vegetation type is statutory conserved. Heavy grazing and the arid climate combined mean that pastoral activities in the past have significantly altered the structure and composition of the vegetation of this unit (Mucina & Rutherford 2006). *Prosopis* spp. have the potential of becoming a serious problem along water courses and around springs.

#### 5.2.2. Eastern Gariep Rocky Desert (Dg 10)

The site under evaluation in Pella does not occur in this vegetation type and this unit will therefore not be discussed in detail. This unit includes all the rocky desert areas along the Lower Orange River from Pella to

Violsdrif. The altitude varies from 250 m to 1 206 m at the highest peak of the Pella Mountain. The landscape consists of hills and mountains with bare outcrops and very sparse shrubby vegetation.

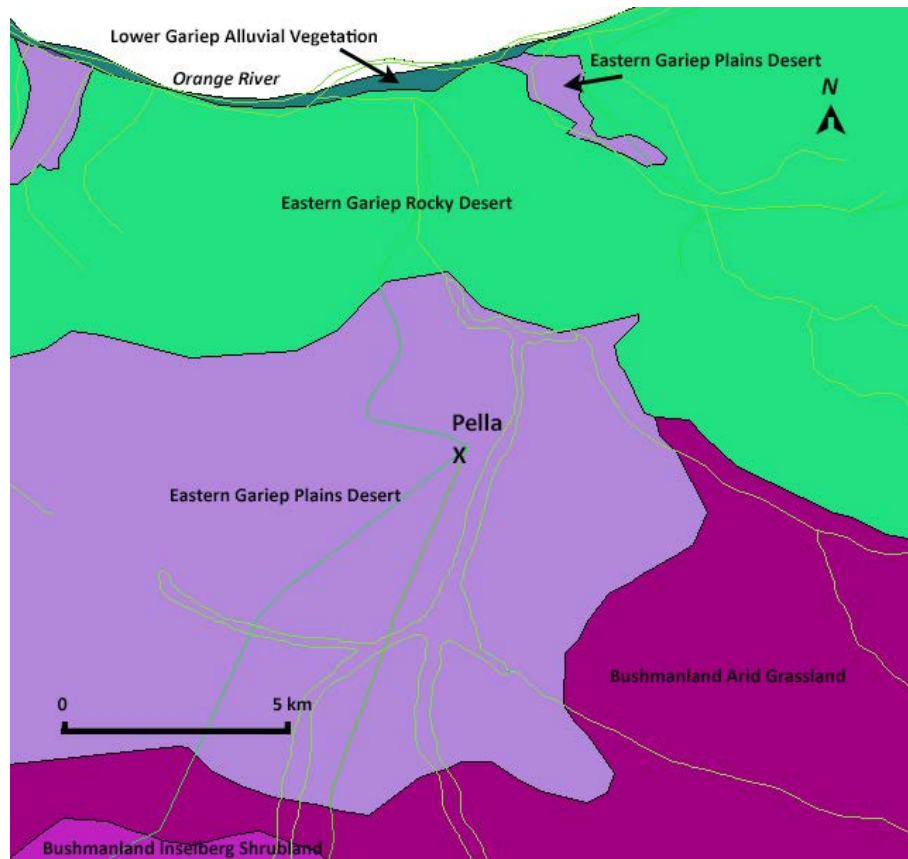


Figure 6. Vegetation types of the Pella region (site indicated with X) (Mucina & Rutherford 2006).

The tree layer is represented by species such as *Aloidendron dichotomum*, *Boscia foetida*, *Boscia albitrunca*, *Ehretia alba*, *Euclea pseudebenus*, *Ficus cordata* and *Pappaea capensis*. Succulent species include *Mesembryanthemum pseudoschlichtianum*, *Portulacaria namaquensis*, *Commiphora gracilifrons*, *Euphorbia avasmontana* and *Euphorbia gregaria*.

This vegetation type is considered “least threatened”. None of this vegetation type is conserved in South Africa in statutory conservation areas. This unit also occurs north of the Orange River in Namibia.

### 5.2.3. Lower Gariep Alluvial Vegetation (AZa 3)

The site under evaluation in Pella does not occur in this vegetation type and this unit will therefore not be discussed in detail. This vegetation type includes the broad alluvial plains and islands of the Orange River between Groblershoop and the mouth of the Atlantic Ocean at Alexander Bay. Conspicuous species are *Searsia pendulina*, *Ziziphus mucronata*, *Euclea pseudebenus*, *Schotia afra* var. *angustifolia*, *Salix mucronata* and *Tamarix usneoides*, with beds of *Phragmites australis* occurring locally.

This vegetation type is considered “Endangered” although 6% is conserved in the Richtersveld and Augrabies Falls National Parks. Some 50% is transformed for agricultural purposes or alluvial diamond mining.

### 5.3 Habitats on the site and surrounding area

#### 5.3.1 Sandy plains

This site occurs on the sandy plains of the Eastern Gariep Plains Desert (Figures 7, 8, 9 & 10) and is characterised by deep sandy soils. It is severely degraded, overgrazed and trampled and the effect of the current drought has exacerbated the poor vegetation cover of the area. Only 18 plant species were recorded on the site of 11 ha.

The most prominent tree species on site are the protected *Vachellia erioloba* and the alien invasive *Prosopis cf. glandulosa*. The shrub layer is represented by *Sisymbrium sparteum* (d), with *Rhigozum trichotomum* and *Senna italica* representing the dwarf shrub layer. The grass layer is basically non-existent with a few individuals of *Schmidtia kalahariensis* and *Stipagrostis* spp. present.

The forbs species are represented by *Acanthopsis hoffmannseggiana*, *Aptosimum procumbens*, *Indigostrum argyroides*, *Jamesbrittenia maxii*, *Sesamum triphyllum*, *Tetraena simplex* and *Tribulus zeyheri*. Other forbs include a *Lotononis* sp. and *Wahlenbergia* sp. Because of the drought, no bulbous plants were recorded in this habitat at the time of the survey. The plant parasite *Tapinanthus oleifolius* was observed in some of the trees on site.



Figure 7: View of site from the northwestern corner to the southeast.



Figure 7: View of site from the northeastern corner to the southwest.



Figure 8: View of site from the southern corner to the northwest.



Figure 9: View of site from the western corner to the east.



Figure 10: View from site across the Pella road towards the drainage line in the east.

### 5.3.2 Drainage lines

This site occurs to the west of T'Goop se Laagte, the main drainage channel east of Pella flowing northwards to the Orange River (Figure 10). Some mature individuals of *Vachellia erioloba* occur along the drainage line. However, no drainage lines occur on site.

## CHAPTER 6

# FLORA AND VEGETATION

### 6.1 Threats

Environmental sustainability is threatened by changes in land use, land degradation, clearing of indigenous vegetation, overgrazing, invasion of land by alien species, informal settlements, urban development, industrial and agricultural pollution, mining, impoundments, cultivation, water abstraction and climate change. Development (or change in land use) usually contributes to habitat loss and degradation in many biodiversity important areas. Much of the impact can be minimized through careful planning and avoidance of sensitive areas. Loss of habitat is regarded as the foremost cause of loss of biodiversity.

### 6.2 Vegetation types

The conservation status of the Eastern Gariep Plains Desert is "**least threatened**" (NEMA 2011). None of this vegetation type is conserved in statutory conservation areas.

### 6.3 Plant species richness

A total of 18 plant species (the term species is used here in a general sense to denote species, subspecies and varieties) was recorded on the site during the vegetation survey undertaken during April 2019.

Because of the dry conditions and degraded condition of the site during the vegetation survey in April 2019, the species list is an underestimate of the potential species richness of the site. However, the chances of finding rare plant species on site are limited.

### 6.4 Threatened, protected and endemic plant species

Red Data species are threatened with extinction and therefore require protection from threatening factors. Species threatened by habitat destruction need to be conserved through mechanisms that conserve the entire ecosystem, where possible.

To determine the status of the flora in the study area the following sources of information were consulted (see Table 5):

- Species lists of the quarter degree grids falling in the study area were drawn from the South African Biodiversity Institute (SANBI) website from the Newposa database;
- Red lists of southern African plants (SANBI: [www.redlist.sanbi.org](http://www.redlist.sanbi.org)) together with the Red List of South African plants (Raimondo *et al.* 2009);
- National Forests Act (Act No 84 of 1998)(revised list 2018);

- National Environmental Management: Biodiversity Act, (Act No 10 of 2004) (ToPS lists) (NEM:BA 2013);
- CITES lists (2018) (Appendices I, II & III) (<https://www.cites.org>); and
- Lists of protected species of the Northern Cape Nature Conservation Act (Act No 9 of 2009) (NCNCA).

In the Newposa plant species list (Appendix C) for the immediate region of the site (2919 AA quarter degree), 204 plant taxa were listed. The two IUCN threatened species are only found in the mountainous habitat of the region, i.e. *Anginon jaarsveldii* (EN) and *Lithops dinteri* (VU). The Near threatened species (NT) is *Ectadium virgatum*, while *Acanthopsis hoffmannseggiana* and *Wahlenbergia divergens* are Data Deficient species (DD).

Table 5: Threatened, protected and endemic plant species on the site

Species	Endemic*	NCNCA*			NFA*	CITES*	NEM:BA ToPS*	IUCN Red list*
		Sch 1*	Sch 2*	Sch 6*				
<i>Acanthopsis hoffmannseggiana</i>								DD
<i>Jamesbrittenia maxii</i>			x					LC
<i>Prosopis cf. glandulosa</i>				x				NE
<i>Sisyndite spartea</i>	x							LC
<i>Vachellia erioloba</i>					x			LC

\*Endemic: Gariep Centre of Endemism (Van Wyk & Smith 2001; Mucina & Rutherford 2006)

\*NCNCA: Northern Cape Nature Conservation Act 2009 (No. 9 of 2009)

\*Schedule 1: Specially protected species; \*Schedule 2: Protected species; \*Schedule 6: Alien invasive plant species

\*NFA (2017): Protected trees: National Forest Act, (Act 84 of 1998).

\*CITES: Convention on the Trade in Endangered Species of Wild Fauna and Flora (2017)

\*NEM:BA (2013)- ToPS Threatened or Protected Species list

\*IUCN Red List of South African plants (NEWPOSA, SANBI)

\*DD = Data Deficient; \*LC = least concern; \*NE = Not Evaluated

## 6.5 Northern Cape Nature Conservation Act 2009 (Act No 9 of 2009) (NCNCA 2009)

As shown in Table 5, the following NCNCA Schedules 1 – 6 species occur on site:

- Schedule 1 - Specially protected species: none recorded

- Schedule 2 - Protected species:

One protected species was recorded on site, i.e. *Jamesbrittenia maxii*

- Schedule 3: Common indigenous plant species:

These are all indigenous species, except those listed as Schedule 1 and 2 species.

- Schedule 6 - Invasive plant species:

*Prosopis cf. glandulosa* is a declared alien invasive plant species recorded near the site.



## 6.6 National Environmental Management: Biodiversity Act, (Act 10 of 2004) (ToPS lists)

No ToPS plant species were recorded.

## 6.7 CITES classification (2018 lists)

CITES comprises three Appendices. Appendix I lists species that are threatened with extinction. CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.

No CITES plant species were recorded.

## 6.8 Gariiep Centre of Endemism (Van Wyk & Smith 2001)

The term endemic refers to a taxon that is limited in its range to a specified geographical area. A Centre of Endemism is a localised area which has a high occurrence of endemics (Van Wyk & Smith 2001). The site at Pella is located in the Gariiep Centre of Endemism (Van Wyk & Smith 2001). A total of approximately 2700 species/infraspecific taxa are found in this region with about 560 endemic or near-endemic species/infraspecific taxa (20.7%). About 80% of the taxa are succulents.



Figure 11: *Sisyndite spartea*, an endemic species of the Gariiep Centre of Endemism.

*Sisyndite spartea* is a prominent Gariiep endemic species on site (Figure 11, Table 5). No biogeographically important endemic taxa were listed by Mucina & Rutherford (2006) for the Eastern Gariiep Plains Desert.

## 6.9 Protected trees (National Forest Act, Act 84 of 1998) (NFA 2018)

The criteria used to select tree species for inclusion in the protected tree list (NFA 2018) are:

- Red List Status (i.e. rare or threatened species);
- keystone species playing a dominant role in an ecosystem’s functioning;
- unsustainability of use;
- cultural or spiritual importance; and
- whether a species is already adequately protected by other legislation.

*Vachellia erioloba* is the nationally protected tree that occurs on site (National Forest Act, Act 84 of 1998) (NFA 2018) (Figure 12). According to Golding (2002), Golding & Geldenhuys (2003) and DAFF (undated b), the technical definition that is used for protected trees is as follows: “a woody plant, self-supporting, with a diameter at breast height greater than 10 mm and a height greater than 3 m (if single-stemmed), and if multi-stemmed, then a height greater than 5 m”. According to DAFF (undated a) documentation, the number of adult and subadult trees affected by a development should be indicated. These subadult and adult trees, which qualify as protected trees, are defined as individuals taller than 3 m. However, it should be noted that the definition indicated above, is not used in the National Forests Act (Act No 9 of 1998) (NFA 1998) or in later amendments. The legal definition of a “tree” according to the NFA (1998) is any tree seedling, sapling, transplant or coppice shoot of any age and any root, branch or other part of it.

The location (GPS) of each individual tree on the site and surrounding area is given in Appendix C. Twenty-five individuals of *Vachellia erioloba* were recorded in the footprint of the proposed development, while another 34 individuals were surveyed in the area to the west, south and east of the site (see Appendix C for details on each individual of *Vachellia erioloba* in the area) (Figure 13).

The main aim of biodiversity offsets is to compensate for environmental impacts of a development that cannot be avoided or mitigated (residual impacts). The challenge therefore lies in the determination of a cut-off point where offsets must be required, e.g. number of mature protected trees affected, and calculating the value of these offsets.

The guidelines provided by DAFF (undated a) to calculate an offset for protected trees of 3 m and higher are summarized below:

- Tree species listed as protected due to rarity or with a red list status of vulnerable or higher should be conserved. If exceptional circumstances do not allow avoidance, over and above the transplanting of trees as mitigation measure, an offset should be calculated based on certain tree values.
- When between 500 and 2000 trees per site are recorded, off-site mitigation can be requested for the trees. This could entail the provision of three trees for urban greening for each protected tree removed.
- If more than 2000 trees are recorded on site, an offset involving land for conservation or funds for conservation projects can be requested. A task team of stake-holders and specialists should determine the actual offset based on the number of trees and area affected.

Based on the number of *Vachellia erioloba* trees on site, an offset is therefore not required.

A license/permit is needed if an activity conducted in terms of Section 7 (1), 15 (1) and 23 (1) of the National Forest Act. Permits are required for the utilisation, e.g. harvesting for wood, and medicinal purposes of declared protected trees. The effect of the Act is that no person may cut, disturb, damage or destroy any indigenous, living protected tree in a natural forest; or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, or any forest product derived from a protected tree, except in terms of a license granted by the Minister (or a delegated authority) to an applicant and subject to a period and conditions as may be stipulated. Certain exemptions are also described in the Act. The listing of a tree species as protected does not mean it cannot be used, but the objective is to ensure sustainable use through licensing control measures.

*Vachellia erioloba* is considered as endangered in parts of its range because of over-use (firewood). It is a protected species because of its role as a keystone species in its natural environment, because of its spiritual value and because it is not adequately protected by legislation. It is slow-growing and is estimated to live to about 300 years of age. It increases habitat heterogeneity, increases species richness by providing habitats and services such as nesting for birds, lizards, rodents and other small mammals. It also provides shade, enriches the soil underneath it, and provides suitable microhabitat for shade-tolerant and fleshy-fruited plants. A diverse invertebrate community exists within these trees. Disturbances that fundamentally change the population or size structure of this species are likely to have detrimental effects on both biodiversity pattern and process.



Figure 12: Example of one of the mature *Vachellia erioloba* trees on site.

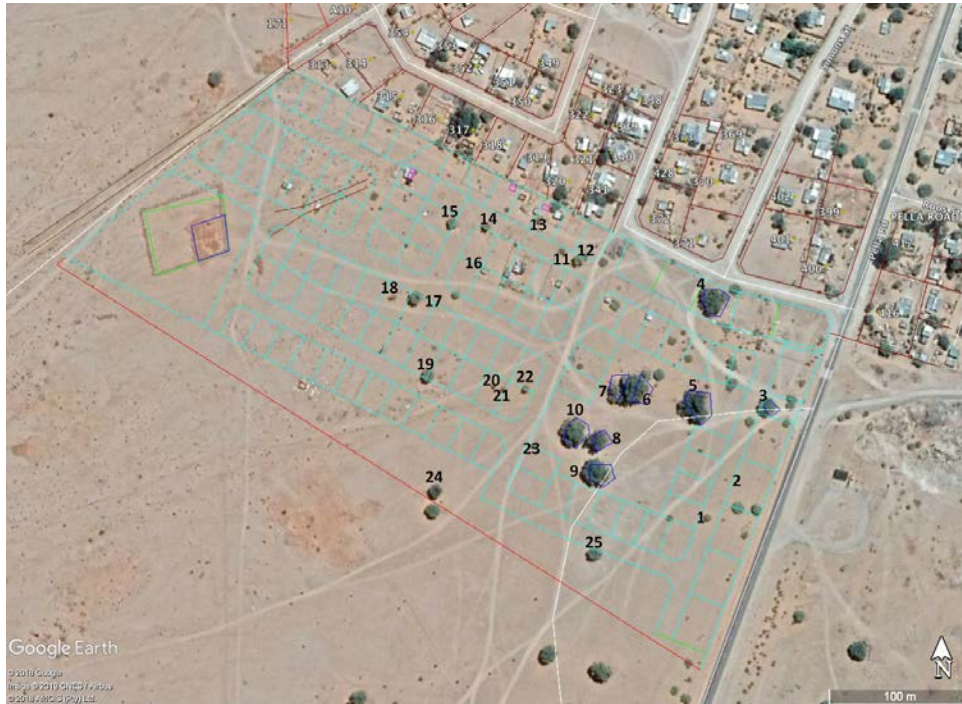


Figure 13: The 25 individuals of *Vachellia erioloba* within the boundaries of the proposed Pella housing development site (see Appendix C for more details).

The local human population should be made aware of the biodiversity status of protected species, their importance in the ecological function of the ecosystem, their commercial significance and legal status. It is important that the significance of ecosystem processes and biotic diversity be understood by human societies to allow them to make decisions necessary to ensure continued functioning of the biosphere to sustain future generations.

## 6.10 Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs)

The Orange River and the area southwards to Pella are classified as a CBA 1 area, while the proposed housing site at Pella falls within a CBA 2 area (Namakwa Biodiversity Sector Plan 2016, Figure 14). CBAs are areas required to meet biodiversity targets for ecosystems, species or ecological processes. CBAs should be kept in a natural or near-natural state, with no further loss of habitat or land-use change permitted. An ESA is not essential for meeting biodiversity targets but plays an important role in supporting the ecological functioning in a CBA.

Although the proposed housing development site technically falls within a CBA2, it is important to note that the site forms part of the town of Pella and is highly disturbed and degraded. Furthermore, the sensitivity analysis revealed that the sensitivity of the particular site was 'Very Low' (see Chapter 8).

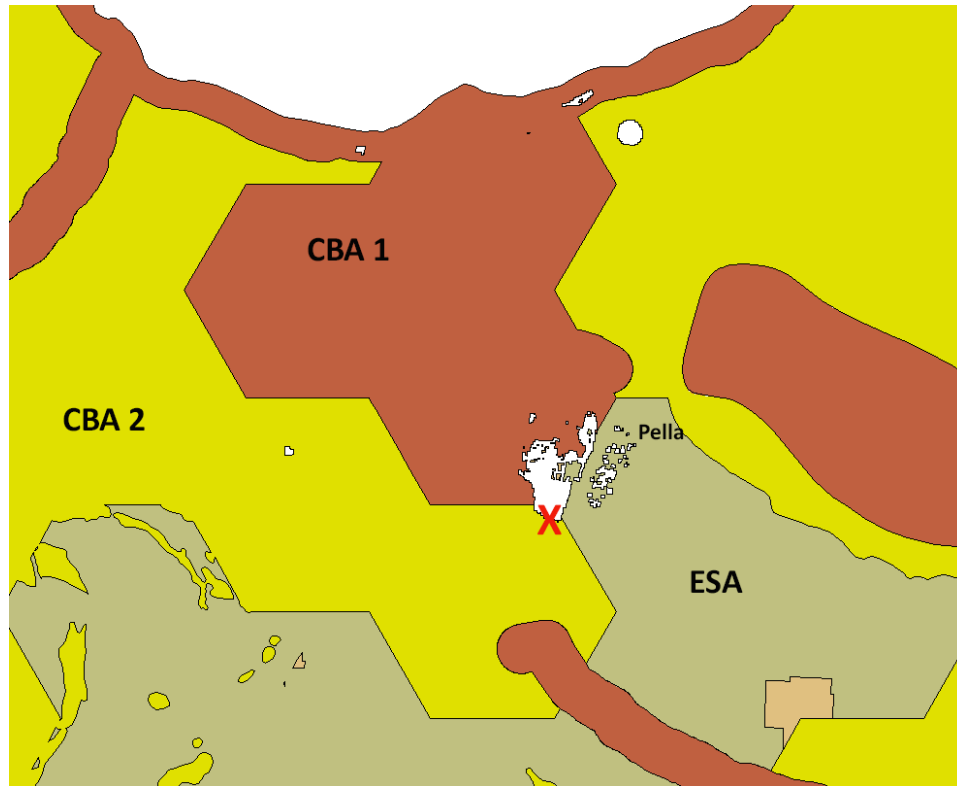


Figure 14: Critical Biodiversity Areas (CBA1 & CBA2), Ecological Support Areas (ESAs) and Other Natural Areas (ONAs) (Namakwa Biodiversity Sector Plan 2016; biodiversityadvisor.sanbi.org; accessed April 2019). Site boundary indicated in red)

### 6.11 Alien and invasive plant species

The following declared alien and invasive plant species was recorded on site (Figure 15):

*Prosopis cf. glandulosa* Category 3

Alien invaders should be controlled by mechanical and/or chemical means. Mechanical means include ringbarking (girdling), uprooting, chopping, slashing and felling. An axe or chain saw or brush cutter can be used. Stumps or ring-barked stems should be treated immediately with a chemical weedkiller. Follow-up treatment is usually needed.



Figure 15: *Prosopis* cf. *glandulosa*, a category 3 alien invasive species.

# CHAPTER 7

## ECOLOGICAL SENSITIVITY ANALYSIS

### 7.1 Introduction

Sensitivity is the vulnerability of a habitat to any impact, for example a dune, wetland or ridge system would be more vulnerable to development than would a sandy plain. Several features of a site can be identified and assessed to derive a sensitivity score, e.g.:

- threatened status of the regional vegetation type wherein the proposed site is situated;
- percentage of red list plant species per community or site;
- number of protected tree species per community or site;
- percentage of provincially protected plant species;
- percentage of endemic plant species per community or site (endemic to vegetation type);
- conservation value of community (habitat) or site;
- species richness per plant community or per sample plot (number of plant species);
- degree of connectivity and/or fragmentation of the habitat, i.e. high connectivity and low fragmentation infers a low rating;
- soil erosion potential; and
- resilience (this is a measure of the ability of a particular habitat/plant community to recover after an impact, i.e. high resilience infers low rating).

An **overall sensitivity model** (Table 6) is developed for each plant community on site. This is achieved by weighting each criterion and calculating the sum for the community, which reflects the sensitivity and sensitivity ranking

The parameters that were used to allocate the different categories of sensitivity (very low, low, moderate, high and very high) were the following:

1. Threatened status of the ecosystem (depends on the percentage area intact, or degree of transformation) (Driver *et al.* 2005, Mucina & Rutherford 2006, NEM:BA 2011).

The ecosystems are classified into the following categories:

Low sensitivity: If “Least Threatened”, the vegetation type has most of its habitat intact, i.e. more than 80%; or the vegetation type is adequately statutory or formally conserved in parks and reserves.

Moderate sensitivity: If “Vulnerable”, the vegetation type has from 60% to 80% of the ecosystem intact; less than 40% has been transformed which could result in some ecosystem functioning being altered, and/or the ecosystem is statutory poorly conserved. For example, the vegetation

type is rich in plant species but is not a pristine example of a vegetation type, therefore some transformation or disturbance occurred, such as human structures and degraded veld due to overgrazing and/or bush encroachment.

High sensitivity: If “Endangered”, the vegetation type has from 40% to 60% of the ecosystem intact; or 40% to 60% transformed due to disturbance, cultivation or alien species; or the ecosystem is statutory poorly conserved e.g. less than about 3% conserved.

Very high sensitivity: If “Critically Endangered”, the vegetation type has only 16% to 36% of the ecosystem intact. The richer the ecosystem is in terms of species, the higher the percentage threshold.

*Category rating:*

Low	(LT)	= 1
Moderate	(VU)	= 2
High	(EN)	= 3
Very high	(CE)	= 4

2. Percentage of IUCN red list plant species (listed higher than ‘least concern’, LC).

The sensitivity scale ranges from low, moderate to high and the rating is determined by the presence of rare flora in a plant community (calculated as percentage of the mean number of species per community).

*Category rating:*

None	(0%)	= 0
Low	(>0 – 2%)	= 1
Moderate	(>2 – 5%)	= 2
High	(>5%)	= 3

3. Presence of protected tree species (National Forests Act, Act No. 84 of 1998; NFA 2015)

The presence of protected tree species in a vegetation type is rated as low, moderate or high. This rating depends on the availability of habitat in the community and the protection and management guidelines for these species and guidelines for biodiversity offsets of the Department of Agriculture, Forestry and Fisheries, DAFF).

*Category rating:*

None	(0 species)	= 0
Low	(1 or 2 species)	= 1
Moderate	(3 – 4 species)	= 2
High	(>4 species)	= 3

4. Presence of Northern Cape protected plant species (Northern Cape Nature Conservation Act, Act No. 9 of 2009):



The presence of 'specially protected species' and 'protected species' in a vegetation type is rated as low, moderate or high depending on the number of protected species in relation to the total plant species per community.

*Category rating:*

None	(0%)	= 0
Low	(>0 - 5%)	= 1
Moderate	(>5 – 10%)	= 2
High	(>10%)	= 3

5. Percentage of plant species endemic to the regional vegetation type (Van Wyk & Smith 2001; Mucina & Rutherford 2006).

The scale ranges from none, low, moderate to high, and depends on the availability of habitat in the community. The number of species is expressed as a percentage of the number of species per community.

*Category rating:*

None	(0%)	= 0
Low	(>0 - 2%)	= 1
Moderate	(>2–5%)	= 2
High	(>5%)	= 3

6. Conservation value of the terrain type and/or habitat.

The criteria are low, moderate and high. The presence of e.g. quartzitic outcrops, ridges, wetlands and dunes should be considered to have a moderate to high conservation value. However, this should be seen in the context of the presence of representative habitat in the broader region or in conservation areas.

*Category rating:*

Low		= 1
Moderate		= 2
High		= 3

7. Community species richness

The species-richness (number of species per community) will depend on the region, climate, topography, ecosystem and degree of transformation. The scale ranges from low, moderate to high.

*Category rating:*

Low	(<30)	= 1
Moderate	(30 – 50)	= 2
High	(>50)	= 3

8. Degree of connectivity and/or fragmentation of the ecosystem

The degree of connectivity with surrounding or adjacent natural areas and/or fragmentation of plant communities, is indicated as low, moderate or high, e.g. high connectivity with surrounding similar habitat, or low fragmentation of habitat is considered as having a low rating.

*Category rating* (note reverse order):

Low	= 3
Moderate	= 2
High	= 1

9. Erosion potential of the soil

The erosion potential of the soil is indicated as low, moderate or high, e.g. coarse sandy soils on plains have a low erosion potential.

*Category rating*:

Low	= 1
Moderate	= 2
High	= 3

10. Resilience is a measure of the ability of a particular habitat/plant community to recover after an impact, i.e. high resilience infers low rating.

*Category rating* (note reverse order):

Low	= 3
Moderate	= 2
High	= 1

## 7.2 Weighting of sensitivity criteria

Threatened status of the vegetation type	= x5
Percentage of red list plant species	= x4
Number of NFA protected tree species	= x3
Percentage of NCNCA protected species	= x4
Percentage of endemic species	= x2
Conservation value (habitat)	= x4
Plant community species richness	= x2
Degree of connectivity/fragmentation of habitat	= x2
Erosion	= x2
Resilience	= x3

## 7.3 Sensitivity rating

≤30 = very low (VL) (rating scale = 1)

31 – 40	= low	(L)	(rating scale = 2)
41 – 50	= moderate	(M)	(rating scale = 3)
51 – 65	= high	(H)	(rating scale = 4)
>65	= very high	(VH)	(rating scale = 5)

Table 6: Sensitivity of the plant community/habitat of the Pella site (see Figures 13 &amp; 24)

Plant communities	1
Threatened status (x5)	5
% Red data species (x4)	0
Number protected trees (x3)	3
% NCNCA species (x4)	4
% Endemic species (x2)	2
Conservation value (x4)	4
Species richness (x2)	2
Connectivity (x2)	2
Erosion (x2)	2
Resilience (x3)	6
Sum:	28
Sensitivity rating:	VL

Overall, the sensitivity rating of the habitat on site was **Very Low (VL)**.

#### Explanation of sensitivity ratings:

- **Very low** (1) sensitivity means that a minimum score is allocated to almost all the sensitivity criteria used. It is usually applicable to habitats in poor condition or that have been transformed, especially by human activities.
- **Low** (2) sensitivity means the sensitivity is not significant enough and should not have an influence on the decision about the project. However, any protected species may not be removed/destroyed without a permit.
- **Moderate** (3) means a sensitivity rating that is real and sufficiently important to require management, e.g. mitigation measures, management or protection of the rare/threatened fauna and flora, protection of the specific habitat on the property and/or rehabilitation.
- **High** (4) means a sensitivity rating where the habitat should be excluded from any development.
- **Very high** (5) means a sensitivity rating that should influence the decision whether or not to proceed with the project.

## CHAPTER 8

# ASSESSMENT OF SIGNIFICANCE OF ENVIRONMENTAL IMPACTS

### 8.1 Introduction

The identification of potential impacts includes impacts that may occur during the construction or operational phases of the proposed development. The assessment of impacts includes direct, indirect as well as cumulative impacts.

### 8.2 Methodology and definitions

- **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.
- **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity. These impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.
- **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.
- **Nature of impact** - this reviews the type of effect that a proposed activity will have on the environment and includes what will be affected and how?
- **Spatial extent** – The size of the area that will be affected by the risk/impact:
  - Site specific (within boundaries of site and immediately adjacent to project site)
  - Local (<10 km from site)
  - Regional (<100 km of site)
  - National
  - International (e.g. Greenhouse Gas emissions or migrant birds).
- **Duration** – The timeframe during which the risk/impact will be experienced:
  - Very short term (instantaneous; less than 6 months)
  - Short term (less than 1 year)
  - Medium term (1 to 10 years)
  - Long term (the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration))
  - Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient i.e. the impact will occur beyond the project decommissioning).
- **Probability** – The probability of the impact occurring:

- Extremely unlikely (little to no chance of occurring)
- Very unlikely (<30% chance of occurring)
- Unlikely (30-50% chance of occurring)
- Likely (51 – 90% chance of occurring)
- Very Likely (>90% chance of occurring regardless of prevention measures).
- **Consequence** – The anticipated severity of the impact:
  - Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease)
  - Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);
  - Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease)
  - Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner)
  - Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).
- **Significance** – To determine the significance of an identified impact/risk, the consequence is "multiplied" by probability (qualitatively as shown in Figure 16 below). Will the impact cause a notable alteration of the environment?

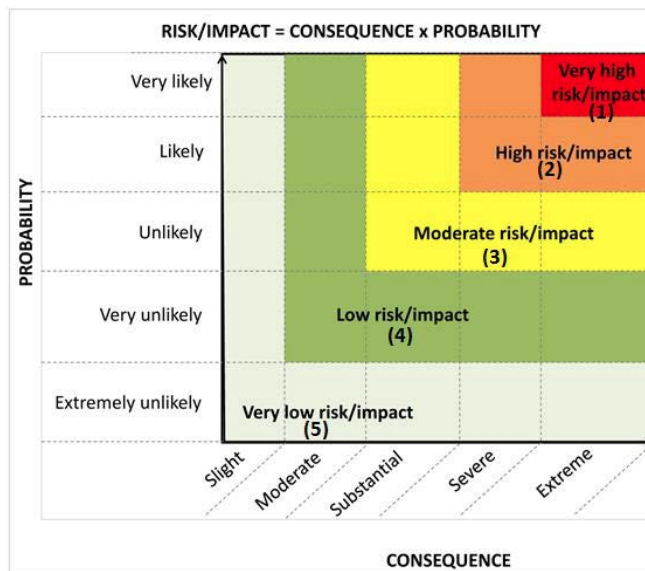


Figure 16: Guide to assessing impact significance as a result of severity (consequence) and probability.

- Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making)
- Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making)

- Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated)
- High (the risk/impacts will result in a major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making)
- Very high (the risk/impacts will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making, i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating).
- **Confidence** – The degree of confidence in predictions based on available information and specialist knowledge:
  - Low
  - Medium
  - High

### 8.3 Impacts during the construction phase, proposed mitigation measures and their significance

#### 8.2.1 Direct impacts during the construction phase

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##### Loss of indigenous vegetation

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**Nature:** Some indigenous vegetation will have to be cleared for the proposed housing development. The removal of natural vegetation will result in negative effects. The loss of the protected and endemic species will also be accompanied by a loss of faunal habitat. Overall, this may lead to a loss of biodiversity. Vegetation loss is also invariably associated with increased water run-off and erosion, both water and wind erosion.

The building of houses will lead to permanent loss of species with no mitigation possible (at the footprint of each house). Unnecessary clearing of vegetation beyond the footprint of the development can largely be avoided. **Due to the degraded state of the vegetation on site, the severity of the impact is rated as moderate. However, the removal of any individual of the protected tree *Vachellia erioloba* is discouraged and is depended on the necessary permits from DAFF.**

##### Proposed mitigation measures:

- Vegetation clearance should be confined to the footprint of the proposed housing development.
- The position of each dwelling should be micro-sited to accommodate the trees where possible.
- The use of arboricides for the clearing of vegetation is not recommended.

**Significance without and with mitigation (residual) measures (assessment refers to the site):**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Medium term	Medium term
Consequence	Moderate	Slight
Probability	Very likely	Unlikely
Significance	<b>Low</b>	<b>Very low</b>
Confidence level	High	Medium

**The loss of individuals of Species of Conservation Concern (SCC)**

**Nature:** The loss of the vegetation due to the housing development may cause a loss of individuals of SCC, i.e. *Vachellia erioloba*.

**Comment:** Permit applications should be done as required by DAFF for the removal of *Vachellia erioloba* and by DENC for *Jamesbrittenia maxii*.

**Proposed mitigation measures:**

- The position of each dwelling should be micro-sited to accommodate the individuals of *Vachellia erioloba* where possible.
- Vegetation clearance should be confined to the footprint of the proposed housing development and unnecessary clearance should be avoided.

**Significance without and with mitigation measures (assessment refers to the site):**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Medium term	Medium term
Consequence	Moderate	Slight
Probability	Likely	Unlikely
Significance	<b>Low</b>	<b>Very low</b>
Confidence level	Medium	Medium

**The loss of faunal habitat**

**Nature:** The loss of the vegetation for the proposed housing development will be accompanied by a loss of faunal habitat.

**Proposed mitigation measures:**

- Vegetation clearance should be confined to the footprint of the development and unnecessary clearance should be avoided.

- The position of each dwelling should be micro-sited to accommodate the individuals of *Vachellia erioloba* where possible.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Long-term	Long-term
Severity	Moderate	Moderate
Probability	Likely	Likely
Significance	<b>Low</b>	<b>Low</b>
Confidence level	High	Medium

**Increased dust deposition**

**Nature:** Increased dust deposition may harm physiological processes of plants and a reduction in the photosynthetic capacity of the plants may occur.

**Proposed mitigation measures:**

- Excessive dust can be reduced by spraying water regularly to control dust generation. Other suitable dust control mitigation measures can also be considered.
- Increased dust levels are largely temporary and primarily applicable to the construction phase.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence	Slight	Slight
Probability	Likely	Unlikely
Significance	<b>Very low</b>	<b>Very low</b>
Confidence level	High	Medium

**Increased noise levels**

**Nature:** Construction activities will increase noise levels at the site. The elevated noise levels may alter the behavioural patterns of some animals.

**Proposed mitigation measures:**

- The SANS noise standards should be adhered to.
- No construction should be done at night.



**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Short-term	Short-term
Consequence	Moderate	Moderate
Probability	Likely	Likely
Significance	<b>Low</b>	<b>Low</b>
Confidence level	High	Medium

**8.2.2 Indirect impacts during the construction phase****Establishment of invasive alien vegetation**

**Nature:** As a result of the loss of indigenous vegetation and resulting degradation, alien species might invade the area. The alien invasive species that is currently common in the area is *Prosopis cf. glandulosa*. Disturbance due to construction, import of soil from elsewhere and gardening may however facilitate the introduction of seeds of other alien species. Infestation by invasive alien species may cause changes to the structure and functioning of the ecosystem and often exacerbates the further loss of indigenous vegetation.

**Proposed mitigation measures:**

- A control program to combat declared alien invasive plant species should be employed.
- No invasive alien species should be used in rehabilitation projects or for gardening.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Long-term	Short-term
Consequence	Moderate	Slight
Probability	Likely	Unlikely
Significance	<b>Low</b>	<b>Very low</b>
Confidence level	Medium	Medium

**Increased erosion and water run-off**

**Nature:** Increased water run-off and soil erosion (water and wind) will be caused by the clearing of the indigenous vegetation and paving of driveways and streets.

**Proposed mitigation measures:**

- Clearing of vegetation, compaction and levelling should be restricted to the footprint of the proposed development.
- Streets should be designed to reduce the risk of erosion.
- Planning for storm water drainage (pipes) should be part of the development.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Long-term	Long-term
Consequence	Moderate	Slight
Probability	Likely	Likely
Significance	<b>Low</b>	<b>Very low</b>

## 8.4 Impacts during the operational phase and their significance

### 8.3.1 Direct impacts during the operational phase

#### Loss and / or disturbance of indigenous vegetation

**Nature:** Clearing or disturbance of natural vegetation should be limited during the operational phase.

**Proposed mitigation measures:**

- Establishment of indigenous vegetation in gardens should be encouraged.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Long-term	Long-term
Consequence	Slight	Slight
Probability	Likely	Likely
Significance	<b>Very low</b>	<b>Very low</b>
Confidence level	Medium	Medium

### 8.3.2 Indirect impacts during the operational phase

#### Alteration to hydrological processes

**Nature:** Increased erosion and water run-off will be caused by the clearing of the indigenous vegetation and soil disturbance during the construction phase. Increased run-off and erosion could affect hydrological processes in the area and could change water discharge into the streams and increase silt load.

**Proposed mitigation measures:**

- Proper storm water drainage and road maintenance procedures should be in place.

**Significance without and with mitigation measures:**

Parameter	Without mitigation	Residual
Extent	Site specific	Site specific
Duration	Long-term	Long-term
Consequence	Moderate	Moderate
Probability	Likely	Unlikely
Significance	<b>Low</b>	<b>Low</b>
Confidence level	High	Medium

## CHAPTER 9

# CONCLUDING REMARKS AND RECOMMENDATIONS

The site of about 11 ha occurs in an arid region with a mean rainfall of less than 120 mm per annum, with a marked seasonality, high unpredictability and variance. Therefore, the ecological processes have a rainfall-driven nature. The vegetation of the area, and especially the herbaceous species, react to the occurrence of rainfall events or the lack thereof, resulting in large variations in the annual herbaceous species composition, cover and production from year to year. The focus of this investigation was therefore on the perennial plant species of the area and specifically the presence of a number of individuals of the protected tree *Vachellia erioloba*. The site is located next to the town of Pella and the terrain is disturbed, degraded and overgrazed. The area is currently also experiencing a severe drought and the plant species list is therefore very limited.

The site occurs in the Eastern Gariiep Plains Desert that covers the sandy plains between the mountains south of the Orange River. This vegetation type is classified as "Least threatened" and is not conserved in any statutory conservation areas. The proposed housing site is homogeneous in terms of terrain and vegetation and is described as a sandy plains habitat type with the protected tree *Vachellia erioloba* and the endemic *Sisyndite spartea* the prominent plant species.

The sensitivity of the site was analysed using parameters such as conservation status, presence of threatened species, protected trees and endemic plant species, species richness and degree of fragmentation of the habitat. The sensitivity of the sandy plains habitat is regarded as **very low**.

Except for the protected *Vachellia erioloba*, the impacts of the proposed development on the indigenous vegetation in the sandy plains habitat is regarded as negligible. The disturbed nature of the site, the poor species richness and absence of red listed plant species on the site, leads to an assessment of very low impact. Furthermore, the housing development intends to microsite the houses in such a way as to retain the *Vachellia erioloba* individuals. Therefore, the development will have almost no effect on the biodiversity of the region.

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## APPENDIX A

### Plant species checklist of the Pella site

*Acanthopsis hoffmannseggiana*  
*Aptosimum procumbens*  
*Indigastrium argyroides*  
*Jamesbrittenia maxii*  
*Lotononis* sp.  
*Prosopis* cf. *glandulosa*  
*Rhigozum trichotomum*  
*Schmidtia kalahariensis*  
*Senna italica*  
*Sesamum triphyllum*  
*Sisyndite spartea*  
*Stipagrostis ciliata*  
*Stipagrostis obtusa*  
*Tapinanthus oleifolius*  
*Tribulus zeyheri*  
*Vachellia erioloba*  
*Wahlenbergia* sp.  
*Tetraena simplex*

## APPENDIX B

NEWPOSA (SANBI) LIST OF THE 2019 AA  
QUARTER DEGREE

Family	Genus	Species	Subsp	IUCN	NCNCA
Acanthaceae	<i>Acanthopsis</i>	<i>hoffmannseggiana</i>		DD	
Acanthaceae	<i>Barleria</i>	<i>rigida</i>		LC	
Acanthaceae	<i>Justicia</i>	<i>guerkeana</i>			
Acanthaceae	<i>Justicia</i>	<i>saxatilis</i>			
Acanthaceae	<i>Justicia</i>	<i>spartioides</i>			
Acanthaceae	<i>Petalidium</i>	<i>setosum</i>			
Aizoaceae	<i>Antimima</i>	<i>hantamensis</i>		LC	Protected
Aizoaceae	<i>Conophytum</i>	<i>fulleri</i>		LC	Protected
Aizoaceae	<i>Conophytum</i>	<i>marginatum</i>	subsp. <i>haramoepense</i>	LC	Protected
Aizoaceae	<i>Drosanthemum</i>	<i>intermedium</i>		LC	Protected
Aizoaceae	<i>Drosanthemum</i>	<i>praecultum</i>		LC	Protected
Aizoaceae	<i>Drosanthemum</i>	<i>schoenlandianum</i>		LC	Protected
Aizoaceae	<i>Ebracteola</i>	<i>fulleri</i>		LC	Protected
Aizoaceae	<i>Galenia</i>	<i>namaensis</i>		LC	Protected
Aizoaceae	<i>Lithops</i>	<i>dinteri</i>	subsp. <i>frederici</i>	VU	Protected
Aizoaceae	<i>Mesembryanthemum</i>	<i>crystallinum</i>		LC	Protected
Aizoaceae	<i>Mesembryanthemum</i>	<i>subnodosum</i>			Protected
Aizoaceae	<i>Ruschia</i>	<i>cradockensis</i>	subsp. <i>cradockensis</i>	LC	Protected
Aizoaceae	<i>Ruschia</i>	<i>divaricata</i>		LC	Protected
Aizoaceae	<i>Ruschia</i>	<i>spinosa</i>		LC	Protected
Aizoaceae	<i>Schwantesia</i>	<i>triebneri</i>		LC	Protected
Aizoaceae	<i>Tetragonia</i>	<i>arbuscula</i>		LC	Protected
Aizoaceae	<i>Trianthera</i>	<i>parvifolia</i>	var. <i>rubens</i>	LC	Protected
Amaranthaceae	<i>Amaranthus</i>	<i>capensis</i>	subsp. <i>capensis</i>	LC	
Amaranthaceae	<i>Hermbstaedtia</i>	<i>glauca</i>		LC	
Amaranthaceae	<i>Salsola</i>	<i>barbata</i>		LC	
Amaranthaceae	<i>Sericocoma</i>	<i>avolans</i>		LC	
Amaranthaceae	<i>Sericocoma</i>	<i>pungens</i>		LC	
Amaryllidaceae	<i>Brunsvigia</i>	<i>sp.</i>			Protected
Amaryllidaceae	<i>Haemanthus</i>	<i>sp.</i>			Protected
Anacampserotaceae	<i>Anacampseros</i>	<i>albissima</i>			Protected
Anacampserotaceae	<i>Anacampseros</i>	<i>baeseckei</i>			Protected
Anacampserotaceae	<i>Anacampseros</i>	<i>papyracea</i>	subsp. <i>namaensis</i>		Protected
Anacardiaceae	<i>Ozoroa</i>	<i>dispar</i>		LC	Specially protected
Anacardiaceae	<i>Searsia</i>	<i>burchellii</i>			
Anacardiaceae	<i>Searsia</i>	<i>populifolia</i>			
Apiaceae	<i>Anginon</i>	<i>jaarsveldii</i>		EN	Protected
Apocynaceae	<i>Ectadium</i>	<i>virgatum</i>		NT	Protected
Apocynaceae	<i>Gomphocarpus</i>	<i>filiformis</i>		LC	Protected
Apocynaceae	<i>Microloma</i>	<i>incanum</i>		LC	Protected
Apocynaceae	<i>Microloma</i>	<i>sagittatum</i>		LC	Protected
Apocynaceae	<i>Pachypodium</i>	<i>namaquanum</i>		LC	Specially Protected
Apocynaceae	<i>Stapelia</i>	<i>similis</i>		LC	Protected
Asparagaceae	<i>Asparagus</i>	<i>asparagoides</i>		LC	
Asparagaceae	<i>Asparagus</i>	<i>ovatus</i>		LC	
Asphodelaceae	<i>Aloe</i>	<i>dabenerisana</i>		LC	Specially protected
Asphodelaceae	<i>Aloe</i>	<i>garipeensis</i>		LC	Protected

Asphodelaceae	<i>Bulbine</i>	<i>striata</i>		LC	Protected
Asphodelaceae	<i>Trachyandra</i>	<i>divaricata</i>		LC	Protected
Aspleniaceae	<i>Asplenium</i>	<i>cordatum</i>		LC	
Asteraceae	<i>Arctotis</i>	<i>leiocarpa</i>		LC	
Asteraceae	<i>Arctotis</i>	<i>venusta</i>		LC	
Asteraceae	<i>Berkheya</i>	<i>chamaepeuce</i>		LC	
Asteraceae	<i>Berkheya</i>	<i>spinosissima</i>	subsp. <i>spinosissima</i>	LC	
Asteraceae	<i>Chrysocoma</i>	<i>sparsifolia</i>		LC	
Asteraceae	<i>Crassothonna</i>	<i>sedifolia</i>		LC	
Asteraceae	<i>Dicoma</i>	<i>capensis</i>		LC	
Asteraceae	<i>Dimorphotheca</i>	<i>polyptera</i>		LC	
Asteraceae	<i>Dimorphotheca</i>	<i>sinuata</i>		LC	
Asteraceae	<i>Doellia</i>	<i>cafra</i>		LC	
Asteraceae	<i>Eriocephalus</i>	<i>merxmulleri</i>		LC	
Asteraceae	<i>Eriocephalus</i>	<i>scariosus</i>		LC	
Asteraceae	<i>Euryops</i>	<i>dregeanus</i>		LC	
Asteraceae	<i>Euryops</i>	<i>multifidus</i>		LC	
Asteraceae	<i>Euryops</i>	<i>subcarnosus</i>	subsp. <i>vulgaris</i>	LC	
Asteraceae	<i>Felicia</i>	<i>muricata</i>	subsp. <i>muricata</i>	LC	
Asteraceae	<i>Felicia</i>	<i>namaquana</i>		LC	
Asteraceae	<i>Foveolina</i>	<i>dichotoma</i>		LC	
Asteraceae	<i>Gazania</i>	<i>lichtensteinii</i>		LC	
Asteraceae	<i>Geigeria</i>	<i>pectidea</i>		LC	
Asteraceae	<i>Geigeria</i>	<i>vigintisquamea</i>		LC	
Asteraceae	<i>Gorteria</i>	<i>corymbosa</i>		LC	
Asteraceae	<i>Helichrysum</i>	<i>hernarioides</i>		LC	
Asteraceae	<i>Ifloga</i>	<i>molluginoides</i>		LC	
Asteraceae	<i>Kleinia</i>	<i>cephalophora</i>		LC	
Asteraceae	<i>Orbivestus</i>	<i>cinerascens</i>		LC	
Asteraceae	<i>Pegolettia</i>	<i>retrofracta</i>		LC	
Asteraceae	<i>Pentatrichia</i>	<i>petrosa</i>		LC	
Asteraceae	<i>Pteronia</i>	<i>lucilioides</i>		LC	
Asteraceae	<i>Senecio</i>	<i>flavus</i>		LC	
Asteraceae	<i>Senecio</i>	<i>niveus</i>		LC	
Asteraceae	<i>Senecio</i>	<i>sisymbriifolius</i>		LC	
Asteraceae	<i>Ursinia</i>	<i>nana</i>	subsp. <i>nana</i>	LC	
Boraginaceae	<i>Codon</i>	<i>royenii</i>		LC	
Boraginaceae	<i>Trichodesma</i>	<i>africanum</i>		LC	
Boraginaceae	<i>Wellstedtia</i>	<i>dinteri</i>	subsp. <i>dinteri</i>	LC	
Brassicaceae	<i>Heliophila</i>	<i>carnosa</i>		LC	
Brassicaceae	<i>Heliophila</i>	<i>trifurca</i>		LC	
Campanulaceae	<i>Wahlenbergia</i>	<i>annularis</i>		LC	
Campanulaceae	<i>Wahlenbergia</i>	<i>divergens</i>		DD	
Campanulaceae	<i>Wahlenbergia</i>	<i>prostrata</i>		LC	
Capparaceae	<i>Boscia</i>	<i>foetida</i>	subsp. <i>foetida</i>	LC	Protected
Caryophyllaceae	<i>Dianthus</i>	<i>namaensis</i>			
Celastraceae	<i>Gymnosporia</i>	<i>heterophylla</i>		LC	Protected
Cleomaceae	<i>Cleome</i>	<i>angustifolia</i>	subsp. <i>diandra</i>	LC	
Cleomaceae	<i>Cleome</i>	<i>foliosa</i>	var. <i>lutea</i>	LC	
Cleomaceae	<i>Cleome</i>	<i>oxyphylla</i>	var. <i>oxyphylla</i>	LC	
Crassulaceae	<i>Cotyledon</i>	<i>orbiculata</i>	var. <i>orbiculata</i>	LC	Protected
Crassulaceae	<i>Crassula</i>	<i>corallina</i>	subsp. <i>macrorrhiza</i>		Protected
Crassulaceae	<i>Crassula</i>	<i>garibina</i>	subsp. <i>garibina</i>		Protected
Crassulaceae	<i>Crassula</i>	<i>muscosa</i>	var. <i>muscosa</i>		Protected
Crassulaceae	<i>Crassula</i>	<i>sericea</i>	var. <i>sericea</i>		Protected
Crassulaceae	<i>Crassula</i>	<i>sericea</i>	var. <i>velutina</i>		Protected
Crassulaceae	<i>Crassula</i>	<i>tabularis</i>			Protected
Crassulaceae	<i>Tylecodon</i>	<i>rubrovenosus</i>			Protected
Crassulaceae	<i>Tylecodon</i>	<i>sulphureus</i>	var. <i>armianus</i>		Protected
Cucurbitaceae	<i>Cucumis</i>	<i>africanus</i>		LC	
Didiereaceae	<i>Portulacaria</i>	<i>fruticulosa</i>		LC	
Didiereaceae	<i>Portulacaria</i>	<i>namaquensis</i>			
Ebenaceae	<i>Diospyros</i>	<i>acocksii</i>		LC	
Ebenaceae	<i>Euclea</i>	<i>pseudebenus</i>			

Ebenaceae	<i>Euclea</i>	<i>undulata</i>			LC	
Euphorbiaceae	<i>Euphorbia</i>	<i>gariepina</i>	subsp.	<i>gariepina</i>	LC	Protected
Euphorbiaceae	<i>Euphorbia</i>	<i>gregaria</i>			LC	Protected
Euphorbiaceae	<i>Euphorbia</i>	<i>gummifera</i>			LC	Protected
Euphorbiaceae	<i>Jatropha</i>	<i>orangeana</i>			LC	
Fabaceae	<i>Adenolobus</i>	<i>garipensis</i>			LC	
Fabaceae	<i>Calobota</i>	<i>spinescens</i>			LC	
Fabaceae	<i>Indigostrum</i>	<i>argyroides</i>			LC	
Fabaceae	<i>Indigofera</i>	<i>heterotricha</i>	subsp.	<i>pechuelii</i>	LC	
Fabaceae	<i>Indigofera</i>	<i>pungens</i>			LC	
Fabaceae	<i>Leobordea</i>	<i>platycarpa</i>			LC	
Fabaceae	<i>Lotononis</i>	<i>rabenaviana</i>			LC	
Fabaceae	<i>Parkinsonia</i>	<i>africana</i>			LC	
Fabaceae	<i>Prosopis</i>	<i>glandulosa</i>	var.	<i>glandulosa</i>	NE	
Fabaceae	<i>Prosopis</i>	<i>velutina</i>			NE	
Fabaceae	<i>Rhynchosia</i>	<i>totta</i>	var.	<i>totta</i>	LC	
Geraniaceae	<i>Monsonia</i>	<i>ciliata</i>			LC	
Geraniaceae	<i>Pelargonium</i>	<i>spinosum</i>			LC	Specially protected
Geraniaceae	<i>Pelargonium</i>	<i>xerophyton</i>			LC	Specially protected
Gisekiaceae	<i>Gisekia</i>	<i>africana</i>	var.	<i>africana</i>	LC	
Hyacinthaceae	<i>Bowiea</i>	<i>volubilis</i>	subsp.	<i>gariepensis</i>		
Hyacinthaceae	<i>Ledebouria</i>	<i>undulata</i>			LC	
Hypoxidaceae	<i>Pauridia</i>	<i>scullyi</i>			LC	
Iridaceae	<i>Gladiolus</i>	<i>saccatus</i>			LC	Protected
Iridaceae	<i>Lapeirousia</i>	<i>littoralis</i>	subsp.	<i>littoralis</i>	LC	Protected
Iridaceae	<i>Lapeirousia</i>	<i>plicata</i>	subsp.	<i>foliosa</i>		Protected
Lamiaceae	<i>Acrotome</i>	<i>pallescens</i>			LC	
Lamiaceae	<i>Stachys</i>	<i>linearis</i>			LC	
Limeaceae	<i>Limeum</i>	<i>aethiopicum</i>	var.	<i>lanceolatum</i>	NE	
Loasaceae	<i>Kissenia</i>	<i>capensis</i>			LC	
Loranthaceae	<i>Septulina</i>	<i>glauca</i>			LC	
Malvaceae	<i>Abutilon</i>	<i>pycnodon</i>			LC	
Malvaceae	<i>Hermannia</i>	<i>cernua</i>			LC	
Malvaceae	<i>Hermannia</i>	<i>gariepina</i>			LC	
Malvaceae	<i>Hermannia</i>	<i>minutiflora</i>			LC	
Malvaceae	<i>Hermannia</i>	<i>stricta</i>			LC	
Malvaceae	<i>Hibiscus</i>	<i>elliottiae</i>			LC	
Molluginaceae	<i>Suessenguthiella</i>	<i>scleranthoides</i>			LC	
Montiniaceae	<i>Montinia</i>	<i>caryophyllacea</i>			LC	
Moraceae	<i>Ficus</i>	<i>cordata</i>	subsp.	<i>cordata</i>	LC	
Moraceae	<i>Ficus</i>	<i>ilicina</i>			LC	
Neuradaceae	<i>Grielum</i>	<i>humifusum</i>	var.	<i>humifusum</i>	LC	
Orobanchaceae	<i>Hyobanche</i>	<i>rubra</i>			LC	Protected
Oxalidaceae	<i>Oxalis</i>	<i>pes-caprae</i>	var.	<i>pes-caprae</i>	LC	Protected
Passifloraceae	<i>Adenia</i>	<i>repanda</i>			LC	
Phyllanthaceae	<i>Phyllanthus</i>	<i>parvulus</i>	var.	<i>parvulus</i>	LC	
Poaceae	<i>Aristida</i>	<i>adscensionis</i>			LC	
Poaceae	<i>Aristida</i>	<i>engleri</i>	var.	<i>engleri</i>	LC	
Poaceae	<i>Danthoniopsis</i>	<i>ramosa</i>			LC	
Poaceae	<i>Digitaria</i>	<i>eriantha</i>			LC	
Poaceae	<i>Enneapogon</i>	<i>desvauxii</i>			LC	
Poaceae	<i>Enneapogon</i>	<i>scaber</i>			LC	
Poaceae	<i>Eragrostis</i>	<i>homomalla</i>			LC	
Poaceae	<i>Eragrostis</i>	<i>nindensis</i>			LC	
Poaceae	<i>Eragrostis</i>	<i>rotifer</i>			LC	
Poaceae	<i>Leucophrys</i>	<i>mesocoma</i>			LC	
Poaceae	<i>Melinis</i>	<i>repens</i>	subsp.	<i>grandiflora</i>	LC	
Poaceae	<i>Panicum</i>	<i>arbusculum</i>			LC	
Poaceae	<i>Schmidtia</i>	<i>kalahariensis</i>			LC	
Poaceae	<i>Sporobolus</i>	<i>nervosus</i>			LC	
Poaceae	<i>Stipagrostis</i>	<i>hochstetteriana</i>	var.	<i>secalina</i>	LC	
Poaceae	<i>Stipagrostis</i>	<i>uniplumis</i>	var.	<i>uniplumis</i>	LC	

Poaceae	<i>Tragus</i>	<i>berteronianus</i>			LC
Poaceae	<i>Tricholaena</i>	<i>capensis</i>	subsp.	<i>capensis</i>	LC
Poaceae	<i>Triraphis</i>	<i>ramosissima</i>			LC
Polygalaceae	<i>Polygala</i>	<i>leptophylla</i>			LC
Polygalaceae	<i>Polygala</i>	<i>seminuda</i>			LC
Pteridaceae	<i>Cheilanthes</i>	<i>deltoidea</i>	subsp.	<i>deltoidea</i>	LC
Rubiaceae	<i>Anthospermum</i>	<i>spathulatum</i>	subsp.	<i>spathulatum</i>	LC
Rubiaceae	<i>Kohautia</i>	<i>caespitosa</i>	subsp.	<i>brachyloba</i>	LC
Rubiaceae	<i>Plocama</i>	<i>crocyllis</i>			LC
Ruscaceae	<i>Eriospermum</i>	<i>ernstii</i>			LC
Ruscaceae	<i>Eriospermum</i>	<i>pusillum</i>			LC
Sapindaceae	<i>Pappea</i>	<i>capensis</i>			LC
Scrophulariaceae	<i>Antherothamnus</i>	<i>pearsonii</i>			LC
Scrophulariaceae	<i>Aptosimum</i>	<i>procumbens</i>			LC
Scrophulariaceae	<i>Jamesbrittenia</i>	<i>aridicola</i>			LC Protected
Scrophulariaceae	<i>Jamesbrittenia</i>	<i>maxii</i>			LC Protected
Scrophulariaceae	<i>Jamesbrittenia</i>	<i>ramosissima</i>			LC Protected
Scrophulariaceae	<i>Lyperia</i>	<i>tristis</i>			LC
Scrophulariaceae	<i>Manulea</i>	<i>gariepina</i>			LC Protected
Scrophulariaceae	<i>Manulea</i>	<i>nervosa</i>			LC Protected
Scrophulariaceae	<i>Nemesia</i>	<i>maxii</i>			LC Protected
Scrophulariaceae	<i>Peliostomum</i>	<i>leucorrhizum</i>			LC
Scrophulariaceae	<i>Polycarena</i>	<i>pubescens</i>			LC
Solanaceae	<i>Solanum</i>	<i>humile</i>			LC
Urticaceae	<i>Forsskaolea</i>	<i>candida</i>			LC
Verbenaceae	<i>Chascanum</i>	<i>garipense</i>			LC
Zygophyllaceae	<i>Sisyndite</i>	<i>spartea</i>			LC
Zygophyllaceae	<i>Tetraena</i>	<i>simplex</i>			LC
Zygophyllaceae	<i>Tribulus</i>	<i>pterophorus</i>			LC
Zygophyllaceae	<i>Tribulus</i>	<i>zeyheri</i>	subsp.	<i>zeyheri</i>	LC
Zygophyllaceae	<i>Zygophyllum</i>	<i>dregeanum</i>			LC

## APPENDIX C

*Vachellia erioloba* on the proposed Pella housing site and nearby areas

Individuals of *Vachellia erioloba* within the boundaries of the proposed housing development site:

Number	Height (m)	Stem diameter (cm)	GPS (degree, minutes, seconds)
1	4.5	30	29 02 29.04 S; 19 09 05.50 E
2	2.5	10	29 02 28.18 S; 19 09 06.30 E
3	8.5	50	29 02 26.52 S; 19 09 07.03 E
4	9.5	150	20 02 24.08 S; 19 09 05.66 E
5	12.0	150	29 02 26.42 S; 19 09 05.19 E
6	12.5	200	29 02 26.09 S; 19 09 03.62 E
7	12.0	150	29 02 26.19 S; 19 09 03.05 E
8	9.5	150	29 02 27.25 S; 19 09 02.64 E
9	11.0	180	29 02 28.00 S; 19 09 02.58 E
10	12.0	130	29 02 27.05 S; 19 09 01.99 E
11	6.0	30	29 02 23.15 S; 19 09 02.09 E
12	3.5	25	29 02 23.08 S; 19 09 02.32 E
13	5.5	30	29 02 22.22 S; 19 09 01.14 E
14	7.0	35	29 02 22.40 S; 19 08 59.69 E
15	5.5	25	29 02 22.33 S; 19 08 58.81 E
16	1.2	5	29 02 23.27 S; 19 08 59.48 E
17	7.5	50	29 02 22.77 S; 19 08 59.28 E
18	4.5	18	29 02 23.97 S; 19 08 57.28 E
19	6.0	40	29 02 25.78 S; 19 08 58.18 E
20	3.5	10	29 02 26.04 S; 19 08 59.92 E
21	4.0	12	29 02 26.10 S; 19 09 00.20 E
22	5.0	30	29 02 26.09 S; 19 09 00.76 E
23	3.5	12	29 02 27.38 S; 19 09 00.96 E
24	6.5	50	29 02 28.43 S; 19 08 58.35 E
25	7.0	40	29 02 29.84 S; 19 09 02.53 E

Individuals of *Vachellia erioloba* west and south of the site and west of Pella Road:

Number	Height (m)	Stem diameter (cm)	GPS (degree, minutes, seconds)
26	7.0	40	29 02 19.02 S; 19 08 52.59 E
27	7.0	50	29 02 28.86 S; 19 08 58.32 E
28	9.0	70	29 02 33.21 S; 19 08 56.33 E
29	3.0	10	29 02 33.25 S; 19 08 57.34 E
30	12.0	170	29 02 34.40 S; 19 08 58.92 E
31	3.5	15	29 02 35.11 S; 19 08 57.26 E
32	4.0	20	29 02 37.74 S; 19 08 55.85 E
33	13.5	150	29 02 35.19 S; 19 08 59.52 E
34	6.0	40	29 02 36.77 S; 19 08 59.10 E
35	4.0	20	29 02 39.04 S; 19 08 58.80 E
36	11.0	120	29 02 40.07 S; 19 08 58.74 E
37	7.0	40	29 02 39.77 S; 19 09 00.23 E
38	6.0	25	29 02 39.66 S; 19 09 00.53 E
39	5.0	30	29 02 37.71 S; 19 09 02.27 E
40	8.0	40	29 02 34.94 S; 19 09 04.06 E
41	5.0	40	29 02 34.93 S; 19 09 02.31 E
42	4.5	20	29 02 34.28 S; 19 09 01.87 E
43	8.0	50	29 02 33.44 S; 19 09 01.83 E
44	11.0	120	29 02 32.15 S; 19 09 01.35 E
45	10.0	80	29 02 35.01 S; 19 09 03.71 E
46	2.5	5	29 02 19.83 S; 19 08 48.38 E
47	2.0	5	20 02 20.62 S; 19 08 47.16 E
48	13.0	140	29 02 40.16 S; 19 08 57.50 E

Individuals outside the boundaries of the site and east of Pella Road (along the dry water course):

Number	Height (m)	Stem diameter (cm)	GPS (degree, minutes, seconds)
49	5.0	25	29 02 31.35 S; 19 09 07.90 E
50	8.0	50	29 02 32.05 S; 19 09 09.45 E
51	7.5	60	29 02 33.33 S; 19 09 08.64 E
52	8.0	45	29 02 34.53 S; 19 09 08.20 E
53	9.0	55	29 02 37.27 S; 19 09 05.28 E
54	12.0	75	29 02 36.73 S; 19 09 06.41 E
55	10.0	50	29 02 35.34 S; 19 09 10.26 E
56	9.0	50	29 02 36.45 S; 19 09 09.93 E
57	5.0	15	29 02 26.68 S; 19 09 09.20 E
58	4.0	13	29 02 26.75 S; 19 09 08.99 E
59	2.0	8	29 02 27.84 S; 19 09 10.12 E



## APPENDIX D

## Curriculum vitae: DR NOEL VAN ROOYEN

## 1. Biographical information

Surname	<b>Van Rooyen</b>
First names	<b>Noel</b>
ID number	<b>501225 5034 084</b>
Citizenship	<b>South African</b>
Business address	<b>Ekotrust CC 7 St George Street Lionviham 7130 Somerset West South Africa</b>
Mobile	<b>082 882 0886</b>
e-mail	<a href="mailto:noel@ekotrust.co.za">noel@ekotrust.co.za</a>
Current position	<b>Member of Ekotrust cc</b>
Professional registration	<b>Botanical Scientist : Pr.Sci.Nat; Reg no. 401430/83</b>

Academic qualifications include BSc (Agric), BSc (Honours), MSc (1978) and DSc degrees (1984) in Plant Ecology at the University of Pretoria, South Africa. Until 1999 I was Professor in Plant Ecology at the University of Pretoria and at present I am a member of Ekotrust cc.

## 2. Publications

I am the author/co-author of 127 peer reviewed research publications in national and international scientific journals and was supervisor or co-supervisor of 9 PhD and 33 MSc students. More than 350 projects were undertaken by Ekotrust cc as consultant over a period of more than 28 years.

## Books

VAN ROOYEN, N. 2001. *Flowering plants of the Kalahari dunes*. Ekotrust CC, Pretoria. (In collaboration with H. Bezuidenhout & E. de Kock).

Author / co-author of various chapters on the Savanna and Grassland Biomes in:

LOW, B. & REBELO, A.R. 1996. *Vegetation types of South Africa, Lesotho and Swaziland*, Department of Environmental Affairs and Tourism, Pretoria.

KNOBEL, J. (Ed.) 1999, 2006. *The Magnificent Natural Heritage of South Africa*. (Chapters on the Kalahari and Lowveld).

VAN DER WALT, P.T. 2010. *Bushveld*. Briza, Pretoria. (Chapter on Sour Bushveld).

Contributed to chapters on vegetation, habitat evaluation and veld management in the book:

BOTHMA, J. du P. & DU TOIT, J.G. (Eds). 2016. *Game Ranch Management*. 5th edition. Van Schaik, Pretoria.

Co-editor of the book:

BOTHMA, J. du P. & VAN ROOYEN, N. (eds). 2005. *Intensive wildlife production in southern Africa*. Van Schaik, Pretoria.

## 2. Ekotrust CC: Core Services

Ekotrust CC specializes in vegetation surveys, classification and mapping, wildlife management, wildlife production and economic assessments, vegetation ecology, veld condition assessment, carrying capacity, biodiversity assessments, rare species assessments, carbon pool assessments and alien plant management.

## 3. Examples of projects

Numerous vegetation surveys and vegetation impact assessments for Baseline, Scoping and Environmental Impact Assessments (EIA's) were made both locally and internationally.

Numerous projects have been undertaken in game ranches and conservation areas covering aspects such as vegetation surveys, range condition assessments and wildlife management. Of note is the Kgalagadi Transfrontier Park; iSimangaliso Wetland Park, Ithala Game Reserve, Phinda Private Game Reserve, Mabula Game Reserve, Tswalu Kalahari Desert Reserve, Maremani Nature Reserve and Associate Private Nature Reserve (previously Timbavati, Klaserie & Umbabat Private Game Reserve).

Involvement in various research programmes: vegetation of the northern Kruger National Park, Savanna Ecosystem Project at Nylsvley, Limpopo; Kuiseb River Project (Namibia); Grassland Biome Project; Namaqualand and Kruger Park Rivers Ecosystem research programme.

#### 4. Selected references of projects done by Ekotrust CC

- VAN ROOYEN, N., THERON, G.K., BREDEKAMP, G.J., VAN ROOYEN, M.W., DEUTSCHLÄNDER, M. & STEYN, H.M. 1996. *Phytosociology, vegetation dynamics and conservation of the southern Kalahari*. Final report: Department of Environmental Affairs & Tourism, Pretoria.
- VAN ROOYEN, N. 1999 & 2017. The vegetation types, veld condition and game of Tswalu Kalahari Desert Reserve.
- VAN ROOYEN, N. 2000. Vegetation survey and mapping of the Kgalagadi Transfrontier Park. Peace Parks Foundation, Stellenbosch.
- VAN ROOYEN, N, VAN ROOYEN, M.W. & GROBLER, A. 2004. Habitat evaluation and stocking rates for wildlife and livestock - PAN TRUST Ranch, Ghanzi, Botswana.
- VAN ROOYEN, N. 2004. Vegetation and wildlife of the Greater St Lucia Wetland Park, KZN.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2008. Vegetation classification, habitat evaluation and wildlife management of the proposed Royal Big Six Nsubane-Pongola Transfrontier Park, Swaziland. Ekotrust cc.
- VAN ROOYEN, N., VAN DER MERWE, H. & Van Rooyen, M.W. 2011. The vegetation of Vaalputs. Report to NECSA.
- VAN ROOYEN, M.W. & VAN ROOYEN, N. 2013. Carbon in the woody vegetation in the Mayoko area, Republic of Congo. Report to Flora, Fauna & Man Ecological Consultants.
- VAN ROOYEN, M.W. & VAN ROOYEN, N. 2013. Resource assessment of *Elephantorrhiza elephantina* on farms (or portions) of Abbey, Tweed, Concordia and Bellville, Northern Cape. Report to CSIR.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2014. Ecological evaluation and wildlife management on Ndzalama Nature Reserve and adjacent farms, Gravelotte, Limpopo province.
- VAN ROOYEN, M.W. & VAN ROOYEN, N. & VAN DEN BERG, H. 2016. Kathu Bushveld study: Research offset for first development phase of Adams Solor Energy Facility. Project conducted for Department of Environment and Nature Conservation Northern Cape (DENC) and the Department of Agriculture, Forestry and Fisheries (DAFF).
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2016. Ecological evaluation of the farm Springbokoog in the Van Wyksvlei region of Northern Cape, including a habitat assessment for the introduction of black rhinoceros. Ekotrust cc.

## 5. Selected publications

- VAN ROOYEN, N. 1978. A supplementary list of plant species for the Kruger National Park from the Pafuri area. *Koedoe* 21: 37 - 46.
- VAN ROOYEN, N., THERON, G.K. & GROBBELAAR, N. 1981. A floristic description and structural analysis of the plant communities of the Punda Milia - Pafuri - Wambiya area in the Kruger National Park, Republic of South Africa. 2. The sandveld communities. *Jl S. Afr. Bot.* 47: 405 - 449.
- VAN ROOYEN, N., THERON, G.K. & GROBBELAAR, N. 1986. The vegetation of the Roodeplaat Dam Nature Reserve. 4. Phenology and climate. *S. Afr. J. Bot.* 52: 159 - 166.
- VAN ROOYEN, N. 1989. Phenology and water relations of two savanna tree species. *S. Afr. J. Sci.* 85: 736 - 740.
- VAN ROOYEN, N., BREDEKAMP, G.J. & THERON, G.K. 1991. Kalahari vegetation: Veld condition trends and ecological status of species. *Koedoe* 34: 61 - 72.
- VAN ROOYEN, M.W., GROBBELAAR, N., THERON, G.K. & VAN ROOYEN, N. 1992. The ephemerals of Namaqualand: effect of germination date on development of three species. *J. Arid. Environ.* 22: 51 - 66.
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- STEYN, H.M., VAN ROOYEN, N., VAN ROOYEN, M.W. & THERON, G.K. 1996. The phenology of Namaqualand ephemeral species: the effect of sowing date. *J. Arid Environ.* 32: 407 - 420.
- JELTSCH, F., MILTON, S.J., DEAN, W.R.J. & VAN ROOYEN, N. 1997. Analyzing shrub encroachment in the southern Kalahari: a grid-based modelling approach. *Journal of Applied Ecology* 34 (6): 1497 - 1509.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 1998. Vegetation of the south-western arid Kalahari: an overview. *Trans. Roy. Soc. S. Afr.* 53: 113 -140.
- DE VILLIERS, A.J., VAN ROOYEN, M.W., THERON, G.K. & VAN ROOYEN, N. 1999. Vegetation diversity of the Brand-se-Baai coastal dune area, West Coast, South Africa: a pre-mining benchmark survey for rehabilitation. *Land Degradation & Development* 10: 207 - 224.
- VAN ESSEN, L.D., BOTHMA, J. DU P., VAN ROOYEN, N. & TROLLOPE, W.S.W. 2002. Assessment of the woody vegetation of Ol Choro Oiroua, Masai Mara, Kenya. *Afr. J. Ecol.* 40: 76 - 83.
- MATTHEWS, W.S., VAN WYK, A.E., VAN ROOYEN, N. & BOTHA, G.A. 2003. Vegetation of the Tembe Elephant Park, Maputaland, South Africa. *South African Journal of Botany* 67: 573-594.
- BOTHMA, J. DU P., VAN ROOYEN, N. & VAN ROOYEN, M.W. 2004. Using diet and plant resources to set wildlife stocking densities in African savannas. *Wildlife Society Bulletin* 32 (3): 840-851.

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- VAN DER MERWE, H., VAN ROOYEN, M.W. & VAN ROOYEN, N. 2008. Vegetation of the Hantam-Tanqua-Roggeveld subregion, South Africa Part 2. Succulent Karoo Biome-related vegetation. *Koedoe* 50: 160-183.
- VAN ROOYEN, M.W., VAN ROOYEN, N. & BOTHMA, J. DU P. 2008. Landscapes in the Kalahari Gemsbok National Park, South Africa. *Koedoe*: 50: 32-41.
- VAN ROOYEN, M.W., HENSTOCK, R., VAN ROOYEN, N. & VAN DER MERWE, H. 2010. Plant diversity and flowering displays on old fields in the arid Namaqua National Park, South Africa. *Koedoe* 52: Art. #1004, 7 pages. DOI: 10.4102/koedoe.v52i1.1004.
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- VAN ROOYEN, M.W., VAN ROOYEN, N., ORBAN, B., GAUGRIS, B., MOUTSAMBOTÉ, J.M., NSONGOLA' G. & MIABANGANA, E.S. 2016. Floristic composition, diversity and stand structure of the forest communities in the Kouilou Département, Republic of Congo. *Tropical Ecology*: 54: 805-824.

## APPENDIX E

## Curriculum vitae: PROF M.W. (Gretel) VAN ROOYEN

## 6. Biographical information

Surname	Van Rooyen	Maiden name	Rösch
First names	Margaretha Wilhelmine		
ID number	5004130033084	Citizenship	South African
Home address	7 St George Street Lionviham 7130 Somerset West	Work address	Department of Botany University of Pretoria Pretoria 0002 South Africa
Mobile	072 0253386		
e-mail	gretel@ekotrust.co.za		
Current position	Honorary Professor in Plant Ecology Scientific advisor - Ekotrust		
Academic qualifications	BSc; BSc (Hons), HNOD, MSc (Botany), PhD (Plant ecology)		

## 2. Publications

I am author / co-author of more than 100 peer reviewed research publications and have presented / co-presented more than 100 posters or papers at international and national conferences. Five PhD-students and 29 Masters students have completed their studies under my supervision / co-supervision. I have co-authored a book as part of a series on the Adaptations of Desert Organisms by Springer Verlag (Van Rheedee van Oudtshoorn, K. & Van Rooyen, M.W. 1999. *Dispersal biology of desert plants*. Springer Verlag, Berlin) and two wildflower guides (Van Rooyen, G., Steyn, H. & De Villiers, R. 1999. *Cederberg, Clanwilliam and Biedouw Valley*. Wild Flower Guide of South Africa no 10. Botanical Society of South Africa, Kirstenbosch, and Van der Merwe, H. & Van Rooyen, G. *Wild flowers of the Roggeveld and Tanqua*). I have also contributed to six chapters in the following books: (i) Dean, W.R.J. & Milton, S.J. (Eds) *The Karoo: Ecological patterns and processes*. Cambridge University Press, Cambridge. pp. 107-122; (ii) Knobel, J. (ed.) *The magnificent heritage of South Africa*. Sunbird Publishing, Llandudno. pp. 94-107; (iii) Hoffman, M.T., Schmiedel, U., Jürgens, N. [Eds]: *Biodiversity in southern Africa. Vol. 3: Implications for landuse and management*: pp. 109–150, Klaus Hess Publishers, Göttingen & Windhoek; (iv) Schmiedel, U., Jürgens, N. [Eds]: *Biodiversity in southern Africa. Vol. 2: Patterns and processes at regional scale*: pp. 222-232, Klaus Hess Publishers, Göttingen & Windhoek; (v) Stoffberg, H., Hinds, C. & Muller, L. *South African Landscape Architecture: A Compendium and A Reader*. Chapter 10, pp. 129 – 140; and (vi) Stoffberg, H., Hinds, C. & Muller, L. *South African Landscape Architecture: A Compendium and A Reader*. Chapter 11, pp. 141 – 146.

## 8. Research interests

My primary research interests lie in population biology and vegetation dynamics. The main aim of the research is to gain an understanding of ecosystem dynamics and to use this understanding to develop strategies to conserve, manage, use sustainably or restore ecosystems. Geographically the focus of the studies has been primarily in Namaqualand (Northern Cape Province, South Africa; classified as Succulent Karoo) and the Kalahari although several studies were conducted in Maputaland (Northern KwaZulu-Natal) and Namibia.

## 9. Projects

Over the past 40 years my research has centred around the population biology, vegetation dynamics and classification of the vegetation in the Succulent Karoo (Namaqualand, Tanqua, Hantam, Roggeveld), Kalahari (arid grassland) and Namib Desert in Namibia. All three regions are relevant to the current project area. A brief selection of projects undertaken for industry or the private sector in these regions is provided:

Initially the research carried out in Namaqualand was done on behalf of the **Department of Environmental Affairs and Tourism**, South Africa. The objective of the research is to develop scientifically sound management plans for the optimal land-use of this area whether for conservation, ecotourism or farming. A main topic of this research centres around the effects of disturbance on the annual vegetation. This is an important issue to **South African National Parks** and they requested a study, which could indicate the minimum disturbance required to produce mass flowering displays in the Namaqua National Park. Recommendations are made to SANParks on the management of the vegetation on abandoned fields in the Namaqua National Park to attract tourists.

Several projects were also conducted for Anglo American Association (**Namaqua Sands**) on the rehabilitation of mined areas along the West Coast. Ekotrust was also requested to evaluate the rehabilitation at Namaqua Sands for the **Department of Minerals Affairs and Energy** and to do an Environmental Audit of Namaqua Sands.

Several projects in Namaqualand are currently still running on behalf of **Northern Cape Nature Conservation Services** on vegetation change and stocking densities in Goegap Nature Reserve.

I was collaborator in **BIOTA** Southern Africa – a program that was funded by the **German Ministry of Education and Research**. This multidisciplinary program investigated changes due to **land-use and climate change** and aimed at sustainable use and conservation of biodiversity. I was also part of the **Succulent Karoo Ecosystem Plan (SKEP)** that was launched to gather information on biodiversity and land-use pressures in the Succulent Karoo. The aim was to use systematic conservation planning methods to identify priorities for conservation action in the region.

Ekotrust was also commission by **South African Nuclear Energy Corporation (NECSA)** to classify and map the vegetation; determine veld condition; calculate grazing capacity; and to prepare a wildlife management plan on their Vaalputs site in Bushmanland. Vaalputs is the only South African radioactive waste-disposal facility. It is located about 100 km southeast of Springbok and covers an area of approximately 10 000 hectare.

Research conducted in Namibia includes (a) the Kuiseb River; (b) the fairy circles; (c) environmental impact assessments for proposed uranium mines in the Namib and (d) seed bank studies in the vicinity of Keetmanshoop (Karas region).

## 10. Selected project references

- UYS, N. & VAN ROOYEN, M.W. 2008. The status of *Aloe dichotoma* subsp. *dichotoma* (quiver tree) populations in Goegap Nature Reserve. Report to Northern Cape Nature Conservation.
- VAN ROOYEN, M.W, VAN ROOYEN, N., BOTHMA, J. DU P. & VAN DEN BERG, H.M. 2007. Landscapes in the Kalahari Gemsbok National Park, South Africa. Report to SANParks.
- VAN ROOYEN, M.W. 2000. Effect of disturbance on the annual vegetation in Namaqualand. Final Report for South African National Parks on Skilpad Disturbance Plots.
- VAN ROOYEN, M.W., THERON, G.K. & VAN ROOYEN, N. 1997. Studies on the ephemerals of Namaqualand. Report on a project executed on behalf of the Department of Environmental Affairs and Tourism 1994 – 1996.
- VAN ROOYEN, M.W., VAN ROOYEN, N. & GAUGRIS, J.Y. 2018. Vegetation, plants and habitats of the Dish Mountain Project, Ethiopia. Biodiversity Baseline Report by FLORA FAUNA & MAN, Ecological Services Ltd.
- VAN ROOYEN, N., THERON, G.K., BREDEKAMP, G.J., VAN ROOYEN, M.W., DEUTSCHLÄNDER, M. & STEYN, H.M. 1996. *Phytosociology, vegetation dynamics and conservation of the southern Kalahari*. Final report on a project executed on behalf of the Department of Environmental Affairs & Tourism, Pretoria.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2000. Environmental audit of Namakwa Sands Mine at Brand-se-Baai, Western Cape. Report for Namaqua Sands to Department of Mineral Affairs and Energy.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2004. Vegetation of the Langer Heinrich area, Swakopmund, Namibia. Report to SoftChem.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2004. Vegetation of the Power Line Route from Walvisbaai to Langer Heinrich. Namibia. Ekotrust cc, Pretoria.
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- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2010. *Vegetation of the Inca, Tubas and Shiyela sites of Reptile Uranium Namibia, Swakopmund, Namibia*. Ekotrust cc, Pretoria.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2011. Ecological evaluation of Kalahari Game Lodge, Namibia. Ekotrust cc, Pretoria.
- VAN ROOYEN, N. VAN DER MERWE, M.W. & VAN ROOYEN, M.W. 2011. The vegetation, veld condition and wildlife of Vaalputs. Report to NECSA.
- VAN ROOYEN, N., VAN ROOYEN, M.W. & VAN DER MERWE, H. 2012. The vegetation of Ratelkraal, Northern Cape. Report to Northern Cape Nature Conservation.
- VAN ROOYEN, N., & VAN ROOYEN, M.W. 2013. Vegetation of the Ongolo and Tumas sites of Reptile Uranium Namibia (RUN), Swakopmund, Namibia. Ekotrust cc, Pretoria.
- VAN ROOYEN, N. & VAN ROOYEN, M.W. 2013. Vegetation Monitoring Report: 2013 Veld condition Vaalputs. Report to NECSA.
- VELDSMAN, S. & VAN ROOYEN, M.W. 2003. An analysis of the vegetation of the Witsand Nature Reserve. Report to Northern Cape Nature Conservation.

## 11. Selected research publications

- BENEKE, K., VAN ROOYEN, M.W., THERON, G.K. & VAN DE VENTER, H.A. 1993. Fruit polymorphism in ephemeral species of Namaqualand: III. Germination differences between polymorphic diaspores. *Journal of Arid Environments* 24: 333-344.
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- ephemeral species of Namaqualand: I. Anatomical differences between polymorphic diaspores of two *Dimorphotheca* species. *South African Journal of Botany* 58: 448 - 455.
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