Appendix D

Specialist Reports:

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

Wetland Assessment for the proposed upgrading of the road between Ga-Sese and Washington, situated to the north of Kuruman, Northern Cape Province.

December 2024

Prepared by:

Darius van Rensburg
Pr.Sci.Nat. 400284/13
T 083 410 0770
darius@dprecologists.co.za
P.O. Box 12726 | 61 Topsy Smith Street
Brandhof | Langenhovenpark
9324 | 9300

Prepared for:
Environmental Management Group
P.O. Box 28242
Danhof
9310

DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	**Final 1.0**		
Title	**Wetland Assessment for the proposed upgrading of the road between Ga-Sese and Washington, situated to the north of Kuruman, Northern Cape Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Dec'24**

Executive Summary

The proposed road upgrade will be undertaken along the gravel road, stretching from the town of Hotazel in the west towards Kuruman in the east. The road is situated along and services numerous small settlements which include, from west to east, Ga-Sese, Tsineng, Ga-Diboye, Ga-Lotlhare, Cottenend, Cardington and Washington. The road section is fairly extensive and has an approximate length of 100 km. The road will require crossing of several small ephemeral watercourses, as well as a few larger watercourses, of which the Manyeding River is fed by an artesian eye and containing perennial flows (Appendix A: Map 1 & 2). The proposed road upgrade is therefore likely to have significant impacts on these systems.

The area contains numerous watercourses which range from large systems to fairly small drainage lines (Appendix A: Map 2). Given the flat topography of the region, these amount of watercourses are fairly low, in view of the large section of road proposed for upgrading (approximately 100 km). All watercourses are clearly defined, containing a main channel with active channel banks. Smaller drainage lines may be less prominent, though still containing a clear channel. A few depression wetlands were also observed, and though none of these will be directly affected by the road construction, they will still be included in the assessment, to ensure that they are completely avoided by any construction activities. Almost all of these are clearly ephemeral systems which will only flow for short periods after heavy rainfall events. The only exception being the Manyeding River, which is being fed by the Manyeding Eye, an artesian fountain which ensures a perennial flow. The larger river systems (Kuruman, Matlwaring and Manyeding Rivers) contain a larger channel but also with a wide floodplain where flow slows down. Watercourses vary from containing only riparian conditions, to containing more prominent wetland conditions and longer periods of saturation during the rainy season. All of the affected watercourses form part of the same drainage system, with the Kuruman River forming the main river system, with all other watercourses forming tributaries of it, and draining into it. These watercourses are all largely intact and though functioning naturally, they contain a significant level of disturbances and are therefore still likely to be affected by the proposed road construction (Appendix A: Map 1 & 2).

As indicated, the affected watercourses are generally intact with their functioning being largely natural. They do however contain varying degrees of disturbances, associated with rural settlements, as well as high levels of overgrazing by domestic livestock. These impacts decrease the vegetation cover, resulting in the modification of the vegetation structure and species composition while infestation by invasive *Prosopis glandulosa* is also prominent. The presence of wetland conditions varies significantly between these watercourses where larger river systems generally contain more prominent wetland conditions, while smaller drainage lines are devoid of wetland conditions.

The affected watercourses and their associated wetland and riparian conditions were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C):

- All of the smaller drainage lines are devoid of wetland conditions. However, a distinct channel, with some riparian vegetation and flooding debris, does indicate that they must still be regarded as watercourses though being devoid of wetland conditions. These drainage lines are characterised by faster flow and being smaller systems, this also prevents long periods of saturation which in turn prevents the formation of wetland conditions.

- The lower lying, larger watercourses contain at least seasonal wetland conditions. These watercourses are larger and being situated in the lower lying bottomlands, flow slows down allowing for floodplains to form where water resides for longer periods and allows for the formation of seasonal wetland conditions. Irrespective of the presence of wetland conditions or not, all affected watercourses are quite clearly defined with prominent channels and riparian vegetation.
- The Manyeding River is being fed by an artesian fountain, the Manyeding Eye which results in a near perennial flow within it. Because this enables a continuous diffuse flow to occur, the Manyeding can be regarded a river system but with characteristics of a floodplain wetland. Along this system, wetland conditions are prominent and indicative of a perennial zone of wetness. This is confirmed through both soil samples and wetland vegetation.
- The main system, the Kuruman River system also contains a large and prominent main channel, which is clearly only activated on an ephemeral basis and will only contain connected main channel flow during years of exceptional rainfall. Nonetheless, wetland conditions are prominent within the main channel.
- A few small depression wetlands occur in close proximity to the proposed road upgrade. These are very small and wetland conditions are not prominent. Both in terms of soil samples and vegetation composition, wetland conditions cannot be considered to be conclusively present. However, the combination of topography (forming a shallow depression) and vegetation composition which contains some riparian species, confirms that these should nonetheless still be regarded as depression wetlands.

As indicated, the Kuruman River forms the main system within the study area, with all other tributaries flowing into it. Several of these tributaries are also substantial watercourses, especially the Manyeding River. They are also listed as National Freshwater Ecosystem Priority Areas (NFEPA): Upstream systems which have a very high conservation value and sensitivity (Appendix A: Map 2). It is clear that the river system still provides vital services, including water transportation, storm water management, flood dissipation, riparian habitat and groundwater recharge. The entire system should therefore still be considered as sensitive, and the proposed development should not lead to altering it any further.

The Kuruman River and all tributaries which will be affected by the road construction are situated within quaternary catchment D41L. The Kuruman River and tributaries which will be affected by the proposed road construction are considered to be affected by several significant impacts with the most prominent being over-utilisation by domestic stock. An Index of Habitat Integrity (IHI) was conducted for the main Kuruman River system to serve as representative of the other smaller watercourses (Appendix D). The results of the IHI indicated that the system has an Instream IHI of Category C: Moderately Modified and Riparian IHI of Category C: Moderately Modified. In order to further improve the accuracy of this determination, an additional WET-Health assessment was conducted for the floodplain wetland system associated with the Manyeding River and the results indicate a PES of Category C: Moderately Modified (Appendix D). This is mostly associated with the impacts of overgrazing, coupled with erosion and higher sediment inputs, but is also associated with the existing road crossings, which clearly act as barriers to the natural flow regime. The EI&S of the affected watercourse systems has been rated as being High.

Table of contents

Wetland Assessment

1. Introduction

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity, it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered, the development should be moved to another location or cease altogether.

South Africa has a large number of endemic species and in terms of biological diversity ranks among the ten highest in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

South Africa's water resources have become a major concern in recent times. As a water scarce country, we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

In recent times the state of South Africa's roads has become a priority. It is imperative to construct new roadways and maintain and upgrade existing roads. However, this should take into account sensitive areas. These sensitive areas, such as areas where the road crosses streams, wetlands, rivers or ridges should be identified and the necessary precautions taken to mitigate the impact that road construction would have on these areas.

The proposed road upgrade will be undertaken along the gravel road, stretching from the town of Hotazel in the west towards Kuruman in the east. The road is situated along and services numerous small settlements which include, from west to east, Ga-Sese, Tsineng, Ga-Diboye, Ga-Lotlhare, Cottenend, Cardington and Washington. The road section is fairly extensive and has an approximate length of 100 km. The road will require crossing of several small ephemeral watercourses, as well as a few larger watercourses, of which the Manyeding River is fed by an artesian eye and containing perennial flows (Appendix A: Map 1 & 2). The proposed road upgrade is therefore likely to have significant impacts on these systems. Existing impacts on these watercourses are mainly associated with high levels of overgrazing by domestic livestock as well as existing road networks and crossings, low density residential areas and refuse dumping. As a result, these watercourses are already modified to some degree.

A site visit was conducted on 9 October 2024. The study area consisted of the entire road section proposed for upgrading and all watercourses which are likely to be affected by it (Appendix A:

Map 1 & 2). The survey was conducted by means of numerous sample survey sites within these watercourses. The survey was undertaken during early spring and before the onset of the rainy season and coupled with disturbance caused by overgrazing and -browsing, the vegetation identification on the site was limited. However, in combination with soil sampling, adequate and accurate delineation of the wetland boundaries could still be done.

As a result of the above it is necessary to determine the extent of water sources and any associated wetland conditions and the likelihood that construction may impact on them.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed road construction on watercourses.

1.2 Value of wetlands and watercourses

Freshwater ecosystems provide valuable natural resources, which contribute toward economic, aesthetic, spiritual, cultural and many recreational values. Yet the integrity of freshwater ecosystems in South Africa has been rapidly declining in recent times. This crisis is largely a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (the need to utilise these resources between different stakeholders, i.e. individuals, communities, corporate and industrial) and institutional (implementing appropriate governance and management). Water affects every activity and aspiration of human society and sustains all ecosystems.

Freshwater ecosystems provide many of our fundamental needs, enable important regulating ecosystem services, supports functional faunal and floral communities:

- Water for drinking and irrigation
- Food, such as fish and water plants.
- Building material, such as clay and reeds.
- Preventing floods and easing the impacts of droughts.
- Removing excess nutrients and toxic substances from water
- Rivers, wetlands and groundwater systems maintain water supplies and buffer the effects of storms, reducing the loss of life and property to floods.
- Riverbanks help to trap sediments, stabilise
- river banks and break down pollutants draining from the surrounding land.

1.3 Details and expertise of specialist

DPR Ecologists and Environmental Services (Pty) Ltd.
Darius van Rensburg *Pr. Sci. Nat.*
61 Topsy Smith Street
Langenhoven Park
Bloemfontein
9300
Tel: 083 410 0770
darius@dprecologists.co.za

Professional registration:
South African Council for Natural Scientific Professions No. (400284/13) (Ecological Science).

Membership with relevant societies and associations:

- South African Society of Aquatic Scientists (SASAQS0091)
- South African Association of Botanists
- South African Wetlands Society (3SLY4IG4)

Expertise:

- Qualifications: B.Sc. (Hons) Botany (2008), M.Sc. in Vegetation Ecology (2012) with focus on ephemeral watercourses.
- Vegetation ecologist with over 10 years' experience of conducting ecological assessments.
- Founded DPR Ecologists & Environmental Services (Pty) Ltd. in 2016.
- Has conducted over 200 ecological and wetland assessments for various developments.
- Regularly attends conferences and courses in order to stay up to date with current methods and trends:

  2017: Kimberley Biodiversity Symposium.
  2018: South African Association of Botanists annual conference.
  2018: National Wetland Indaba Conference.
  2019: SASS5 Aquatic Biomonitoring Training.
  2019: Society for Ecological Restoration World Congress 2019.
  2019: Wetland rehabilitation: SER 2019 training course.
  2020: Tools For Wetlands (TFW) training course.
  2022: National Wetland Indaba Conference.

2. Scope and limitations

- To provide a description of watercourses, wetlands and riparian vegetation included within the study area.
- To identify watercourses, including rivers, streams, pans and wetlands and determine the presence of wetland conditions within these systems.
- Where wetland conditions have been identified, the classification of the wetland system will be given.
- To identify possible negative impacts that could be caused by the road construction.
- To evaluate the present state of the wetlands and riparian vegetation in close proximity to the development. The importance of the ecological function and condition will also be assessed.
- To determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in close proximity to the development.
- To conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Riparian Vegetation

Aspects of the riparian vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The overall status of the riparian vegetation along the wetlands and watercourses in the study area.
- Species composition with the emphasis on dominant-, rare- and endangered species.
- Presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.

The amount of disturbance present in the study area assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Wetlands and watercourses

Aspects of the wetlands and watercourses that will be assessed include:

- Identification of watercourses, including rivers, streams, pans and wetlands.
- Determining the presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.
- Describing watercourses and wetlands and their importance relative to the larger system.
- Conducting habitat integrity assessment of watercourses to inform the condition and status of these systems.

2.4 Limitations

- Some geophytic or succulent species may have been overlooked due to a specific flowering time or cryptic nature.
- Although a comprehensive survey of the site was done, it is still likely that several species were overlooked.

- Due to high levels of overgrazing and -browsing, many plant species were not easily identifiable and may have been mis-identified or overlooked.
- Due to time constraints only limited soil sampling could be done.
- Smaller watercourses, depressions or wetland areas may have been overlooked where a distinct channel or riparian vegetation is absent.

3. Methodology

3.1 Several literature works were used for additional information.

General ecology:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE).
- NBA 2018 Technical Report: Inland Aquatic (Freshwater) Realm.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- North West Province Biodiversity Sector Plan (2015).

Vegetation:

- Red Data List (Raymondo *et al.* 2009)
- Vegetation types (Mucina & Rutherford 2006)
- Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al.* 2015, Gerber *et al.* 2004, Gibbs-Russell *et al.* 1990, Griffiths & Picker 2015, Manning 2009, Pooley 1998, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Van Ginkel & Cilliers 2020, Van Ginkel *et al.* 2011, Van Oudtshoorn 2004, Van Rooyen 2001, Van Rooyen & Van Rooyen 2019, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997).

Wetland methodology, delineation and identification:

- Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al.* 2008, Marnewecke & Kotze 1999, Nel *et al.* 2011, SANBI 2009.

3.2 Survey

The site was assessed by means of transects and sample plots. Observation w.r.t. the general ecology of the area includes:

- Noted species include rare and dominant species.
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
- The state of the habitat was also assessed.

All rivers, streams, pans and wetlands were identified and surveyed where they occurred in the study area. These systems were determined by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix B & C). The following outlines the process applied during the on-site survey in order to obtain all required data:

- Perform desktop overview of the study area utilising available resources (Section 3.1). From the desktop overview identify the different landscape forms, possible wetland areas, watercourses and their relative flow patterns. Using this information, identify transects and sample plots for possible on-site survey. This should be both

representative of the wetland or watercourse as a whole but should also include any prominent or significantly unique features.

- Possible sites identified during the desktop overview should be surveyed on-site. Where access is not possible or where desktop features are considered poor representatives of the wetland or watercourse, the survey site or transect should be moved to another location, without compromising a comprehensive overview of the system.
- Where a lateral transect is taken of a watercourse, this is done from the water's edge, across the marginal, lower and upper zones and extended across the floodplain until the edge of the riparian zone is reached.
- Where a transect is taken of a wetland system, this should preferably be taken across the entire wetland at its widest part or where it is most relevant to the proposed development, from the terrestrial surroundings, across the temporary, seasonal and perennial zones across the wetland.
- Soil samples are taken at 10 metres intervals along the survey transect, or where a distinct transition into a different zone is observed.
- A survey of the plant species within each distinct riparian or wetland zone is undertaken and includes the identification of obligate wetland species, riparian species, terrestrial species, exotic species and the general species composition and vegetation structure which allows for an accurate description of the watercourse or wetland.
- Visual survey of the general topography which substantiates the presence of riparian zones and wetland forms.
- Other general observations include any impacts observed, the overall ecosystem function, presence of fauna, surrounding land uses and the overall condition of the watercourse or wetland.
- Data is recorded by means of photographs with GPS coordinates taken at all relevant soil sampling sites and borders of riparian and wetland zones.

Data obtained during the on-site survey is utilised to provide the following information on the system:

- Desktop overview and assimilation of information on the likely impacts and functioning of the wetland system.
    - Review all available spatial data and resources in order to provide an estimate of the likely impacts and condition of the wetland or watercourse system.
- Confirm the presence of the wetland or watercourse system and provide an estimate of its borders.
    - The border of wetland conditions or the edge of the riparian zone will be confirmed by using soil sampling, obligate wetland vegetation and topography. This will also include the delineation of any temporary, seasonal or perennial zones of wetness along wetlands and the marginal, lower, upper and riparian zones along watercourses.
- Provide a description of the wetland or watercourse.
    - Provide the hydrogeomorphic setting of the wetland, a longitudinal profile which will aid in determining the erodibility of the wetland and provide an overall description of the wetland and impacts affecting it.
    - Provide a general description of the lateral zonation of the watercourse banks including the marginal, lower, upper and riparian zones and a description of the riparian vegetation along the banks of the watercourse. This will also include the description of any impacts or modification of the watercourse.

- Assess the current condition of the wetland or watercourse.
    - Utilising information obtained from the assessments listed above, determine the condition of this portion of the wetland by applying the WET-Health 2 tool.
    - Utilising information obtained from the assessments listed above, determine the condition of the relevant section of the watercourse by applying the Index of Habitat Integrity (IHI) tool.
- Utilising all of the information obtained from the assessment, provide recommendations to mitigate anticipated impacts that the development will have.

The following guidelines and frameworks were also used to determine the presence of the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses or wetlands in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aid in determining the boundary of these systems.

The following were utilised to inform the condition and status of watercourses:

- Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity. Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

The following were utilised to inform the condition and status of wetlands:

- Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. 2020. WET-Health (Version 2.0): a refined suite of tools for assessing the present ecological state of wetland ecosystems. WRC Report No. TT 820/20.

A Risk Assessment will be conducted for the proposed development in or near watercourses and wetlands in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment.

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single niche – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas can vary significantly though, e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practices (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climatic and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.

Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs show signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little sign of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. Wetland Assessment

For the purpose of this report the general ecology of the study area will first be discussed followed by a discussion of the watercourses and wetland systems.

4.1 Ecology and description of the study area

Refer to the list of species encountered on the site in Appendix B.

The proposed road upgrade will be undertaken along the gravel road, stretching from the town of Hotazel in the west towards Kuruman in the east. The road is situated along and services numerous small settlements which include, from west to east, Ga-Sese, Tsineng, Ga-Diboye, Ga-Lotlhare, Cottenend, Cardington and Washington. The road section is fairly extensive and has an approximate length of 100 km. The road will require crossing of several small ephemeral watercourses, as well as a few larger watercourses, of which the Manyeding River is fed by an artesian eye and containing perennial flows (Appendix A: Map 1 & 2). The proposed road upgrade is therefore likely to have significant impacts on these systems. Existing impacts on these watercourses are mainly associated with high levels of overgrazing by domestic livestock as well as existing road networks and crossings, low density residential areas and refuse dumping. As a result, these watercourses are already modified to some degree.

According to Mucina & Rutherford (2006) the area consists of Kuruman Thornveld (SVk 9), Kathu Bushveld (SVk 12) and Kuruman Vaalbosveld (SVk 8) (Appendix A: Map 1). All of these vegetation types cover large areas and are still widespread and currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). As a result, areas of remaining natural vegetation will have a lower conservation value. The survey and desktop resources (National Biodiversity Assessment 2018), indicate that the area is still largely natural, though the existing road and road reserve is degraded from the natural condition. Furthermore, the area is well-known to be heavily affected by overgrazing and -browsing by domestic livestock, which also further decrease the conservation value.

The Northern Cape Critical Biodiversity Areas Plan (2016) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e., Critical Biodiversity Areas. The study area is largely situated within an Other Natural Area (ONA), which indicates that it is not considered as essential to meeting conservation targets. However, watercourses and wetlands are listed as Ecological Support Areas (ESA), which aid in support of these systems and it is therefore important to maintain their integrity. Road construction should therefore not result in any significant modification of the functioning of these systems.

The road section proposed for upgrading is situated within a natural area, and although of low density, rural settlements are abundant in this area, especially along the watercourses and these do also contribute to localised disturbances. These urban areas result in a variety of impacts and may include localised agriculture, buildings, infrastructure, roads and dirt tracks (Appendix A: Map 1). The main impact in this region, especially along watercourses, would however be associated with the heavy over-utilisation of the watercourses for grazing by domestic livestock. This results in a substantial decrease in the vegetation cover, an increase in unpalatable species and exotic weeds and high levels of trampling, especially around watercourses (which contain a higher abundance of fodder). Though these watercourses clearly contain significant levels of

disturbance, their functioning is still largely intact and they remain important in terms of the surface water transportation and groundwater resources of the region.

The vegetation structure in the area is dominated by savannah which consists of a well-developed but significantly decreased grass layer, while the shrub and tree layer is also modified to a significant degree by tree cutting and an increase in encroacher species, such as *Senegalia mellifera* subsp. *detinens*. The main impact responsible for the change in vegetation structure and species composition is however, overgrazing and -browsing by domestic livestock. The natural vegetation structure and species composition is therefore considered to be modified to some degree.

The region has an approximate mean annual rainfall of 340 mm with most rainfall occurring in summer to autumn. This is considered a relatively low rainfall and causes the area to form part of the more arid parts of South Africa. This therefore does not promote the formation of wetlands and watercourses in the area. The average temperature ranges from 11.2˚C in July to 26.1˚C in January with frost common in winter.

The geology of the area consists of the Hotazel Formation which is unconformably overlain by Early Permian Dwyka diamictite (tillite) of the Karoo Supergroup or Cenozoic Kalahari calcrete, clay and windblown sand. The mountainous terrain south of the sites consists of the Asbestos Hills Subgroup within the Transvaal Supergroup and is dominated by banded ironstone, jaspelite and riebeckite-amphibolite.

Dominant soil types within the area are made up of Chromic Cambisols and Ferralic Arenosols. Calcic Solonchaks soils occur within the lower lying areas. Cambisols are characterised as having good structural stability, high porosity, good water holding capacity and good drainage. Ferralic Arenosols are characteristic of having a loamy sand to a coarse type texture, for depths of up to 1 m. The pore spaces for these soils are usually large, allowing for free drainage and increased permeability. The available water capacity (AWC) is therefore low. Solonchaks belong to the soil group that has a high concentration of soluble salts. These can occur in low lying areas or depressions where a strong capillary rise of saline groundwater exists. This is descriptive of the situation along the main river systems in the area (Kuruman, Matlwaring, Manyeding Rivers).

From an overview of the general ecology in the area it is clear that it is still mostly natural with most functions still intact. However, the current land use, and especially the use of land for communal grazing and browsing by domestic stock, does cause a significant decrease in the condition of the natural vegetation. The low density, but extensive, rural settlements also contribute to significant disturbance.

Figure 1: The landscape in this area is dominated by fairly uniform, flat plains, with some habitat diversity occurring along larger watercourses (Red).

Figure 2: One of the main impacts is caused by trampling and overgrazing by domestic livestock, which is most evident along watercourses. Note also significant infestation by invasive *Prosopis gladulosa* trees.

Figure 3: Rural settlements also contribute toward localised disturbances.

4.2 Wetland and Watercourses Assessment

4.2.1 Introduction

From the description of the site, the area contains numerous watercourses which range from large systems to fairly small drainage lines (Appendix A: Map 2). Given the flat topography of the region, these numbers of watercourses are fairly low, in view of the large section of road

proposed for upgrading (approximately 100 km). All watercourses are clearly defined, containing a main channel with active channel banks. Smaller drainage lines may be less prominent, though still containing a clear channel. A few depression wetlands were also observed, and although none of these will be directly affected by the road construction, they will still be included in the assessment, to ensure that they are completely avoided by any construction activities. Almost all of these are clearly ephemeral systems which will only flow for short periods after heavy rainfall events. The only exception being the Manyeding River, which is being fed by the Manyeding Eye, an artesian fountain which ensures a perennial flow. The larger river systems (Kuruman, Matlwaring and Manyeding Rivers) contain a larger channel but also with a wide floodplain where flow slows down. Watercourses vary from containing only riparian conditions, to containing more prominent wetland conditions and longer periods of saturation during the rainy season. All of the affected watercourses form part of the same drainage system, with the Kuruman River forming the main river system, with all other watercourses forming tributaries of it, and draining into it. These watercourses are all largely intact and though functioning naturally, they contain a significant level of disturbances, and are therefore still likely to be affected by the proposed road construction (Appendix A: Map 1 & 2).

As indicated, several watercourses will be affected by road construction and can be summarised as follows:

- The Kuruman River is the main river system with all others draining into it, and which will be crossed by the road upgrade.
- The Manyeding River is the second largest system which is also being fed by an artesian fountain and containing perennial flow.
- Several large, but unnamed tributaries will also be crossed by the proposed road.
- Several smaller drainage lines will also be affected by the road upgrade.
- A few small depression wetlands occur in close proximity to the road and will also be assessed in overview.

As indicated, the affected watercourses are generally intact with their functioning being largely natural. They do however contain varying degrees of disturbances, associated with rural settlements, as well as high levels of overgrazing by domestic livestock. These impacts decrease the vegetation cover, resulting in the modification of the vegetation structure and species composition while infestation by invasive *Prosopis glandulosa* is also prominent. The presence of wetland conditions varies significantly between these watercourses where larger river systems generally contain more prominent wetland conditions, while smaller drainage lines are devoid of wetland conditions. Despite significant levels of disturbance, these watercourses still provide important functions in terms of water transportation and groundwater resources, while their susceptibility to infestation by invasive *Prosopis glandulosa* should also be taken into account.

The larger systems, including the Kuruman- and Manyeding Rivers, have previously been included within the National Wetland Map 5 and the National Freshwater Ecosystem Priority Areas (NFEPA) desktop assessments (Appendix A: Map 1). They are also listed as NFEPA: Upstream systems which will significantly increase their importance and conservation value.

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition is as follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005).

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification (Figure 4). The largest river system, Kuruman River, is listed as a third order lowland system, while the Manyeding, a significant tributary, is listed as a second order system, with all other smaller watercourses being considered as first order tributaries.

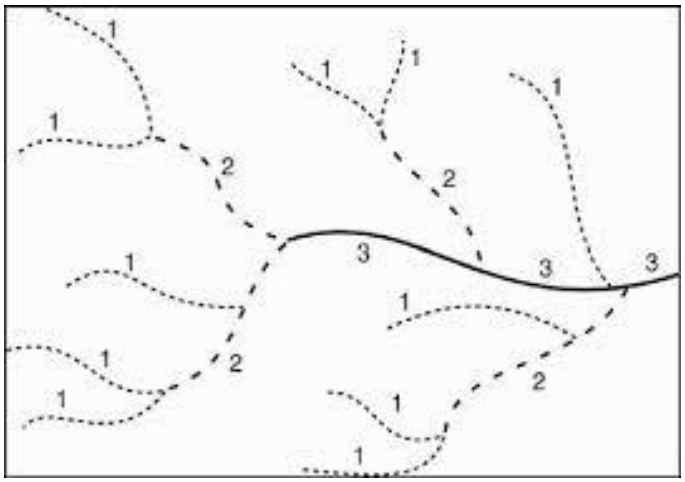


Figure 4: The classification of stream orders from 1 to 3 (Strahler 1952)

4.2.2 Wetland and riparian indicators

The affected watercourses and their associated wetland and riparian conditions were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). The presence or absence of wetland conditions was also confirmed by undertaking a sample survey within the channel of these watercourses which will be affected by the road construction. The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

Obligate wetland vegetation was utilised to determine the presence of wetlands. Riparian vegetation was used to indicate the presence of watercourses and a riparian zone. Soil samples

were used to determine the border and also to confirm the presence of wetland soils within the watercourses. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils (Appendix C).

The soil samples taken within the affected watercourses indicate that all of the smaller drainage lines are devoid of wetland conditions. Here soils consist of yellow, sandy soils with a high calcareous gravel content and without a grey matrix or mottling which is clearly indicative of the absence of wetland conditions. However, a distinct channel, with some riparian vegetation and flooding debris does indicate that they must still be regarded as watercourses though being devoid of wetland conditions. These drainage lines are characterised by faster flow and being smaller systems, this also prevents long periods of saturation which in turn prevents the formation of wetland conditions.

The soil samples taken within the lower lying larger watercourses indicate at least seasonal wetland conditions. These watercourses are larger and being situated in the lower lying bottomlands, flow slows down allowing for floodplains to form where water resides for longer periods allowing for the formation of seasonal wetland conditions. Here a higher clay content is present with a low grey matrix and some mottling which indicates at least a seasonal zone of wetness. Irrespective of the presence of wetland conditions or not, all affected watercourses are quite clearly defined with prominent channels and riparian vegetation.

The Manyeding River is being fed by an artesian fountain, the Manyeding Eye, resulting in a near perennial flow within it. Because this enables a continuous diffuse flow to occur, the Manyeding can be regarded a river system but with characteristics of a floodplain wetland. Along this system, wetland conditions are prominent and indicative of a perennial zone of wetness. This is confirmed through both soil samples and wetland vegetation.

The main system, the Kuruman River system also contains a large and prominent main channel, which is clearly only activated on an ephemeral basis and will only contain connected main channel flow during years of exceptional rainfall. Nonetheless, wetland conditions are prominent within the main channel. It should be kept in mind that though connected flow will rarely occur, soil saturation is likely to occur annually and therefore wetland conditions may still be prominent. The lower zone of the Kuruman River is quite extensive in most areas. It also contains a steeper slope which is rarely subjected to flooding and only during larger floods. Scattered trees also occur, especially along the border with the upper zone. The upper zone of the Kururman River also includes the flood bench and clearly forms the border of the riparian zone. The border between the lower and upper zones includes a drastic increase in slope over a short distance whereafter it levels off. The upper zone will very rarely be flooded and only during exceptional floods, such as a 1:100 years flooding event.

A few small depression wetlands occur in close proximity to the proposed road upgrade. These are very small and wetland conditions are not prominent. Both in terms of soil samples and vegetation composition, wetland conditions cannot be considered to be conclusively present. However, the combination of topography (forming a shallow depression) and vegetation composition which contains some riparian species, confirms that these should nonetheless still be regarded as depression wetlands.

The vegetation composition in these watercourses is also affected by overgrazing and -browsing by domestic livestock. This does make plant species identification difficult though sufficient species identification was possible which indicated the presence of several Obligate Wetland

species, while riparian species were also noted. By using a combination of aerial imagery, surface topography, soils and vegetation, a quite accurate delineation of affected watercourses was able.

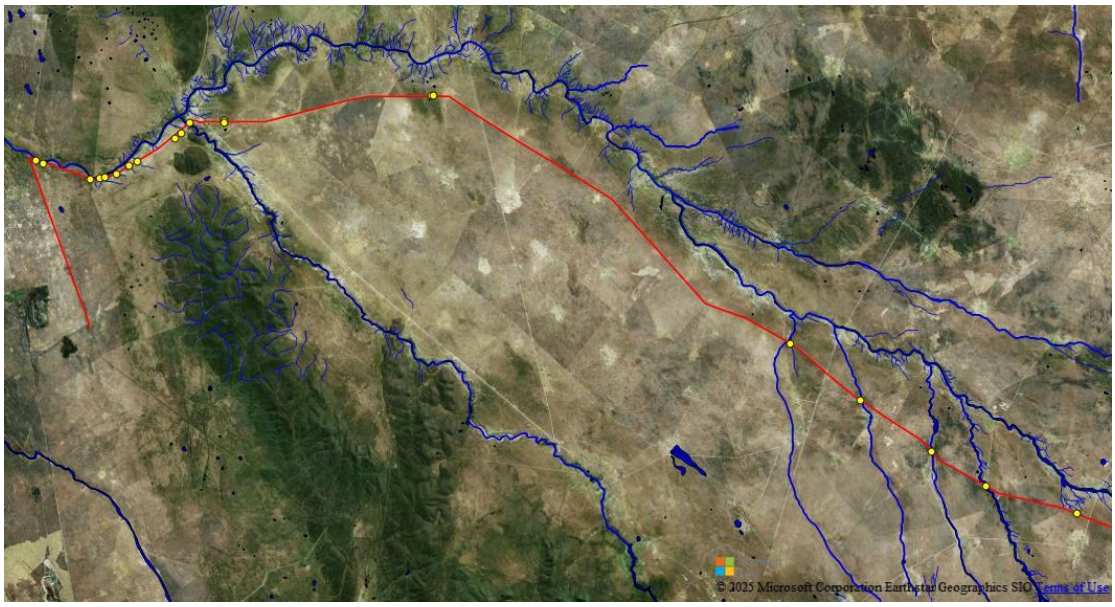


Figure 5: Using aerial images of the study area aids in accurate delineation of the affected watercourses within the section of proposed road upgrading (Red). This indicates the main Kuruman River, significant smaller tributaries, including the Manyeding River and a few small depression wetlands which will be affected by the road construction (Yellow).

The presence or absence of wetland conditions could, in most instances, also be confirmed by obligate wetland vegetation. Obligate wetland species are confined to wetlands and cannot occur in conditions outside of these systems. As a result, where they occur, wetland conditions can be considered to occur. Those drainage lines where wetland conditions were found to be absent, could still be confirmed by the presence of several riparian shrubs and trees with facultative wetland species also being present. A facultative wetland species is often associated with wetlands but is also able to occur in non-wetland areas. These species will be listed in Section 4.2.6.

4.2.3 Classification of wetland systems

Where wetland conditions occur along the larger rivers (Kuruman and Manyeding) which will be affected by the road construction, they can be classified as a specific wetland type (Appendix A: Map 2).

The wetland conditions associated with the larger rivers and watercourses can be characterised as a channel wetland system (SANBI 2009):

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or

streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

This accurately describes the watercourses which will be affected by the road construction. The wetland conditions are confined to the main channel of these systems which experiences surface flow only intermittently. Here wetland conditions are most prominent along the main channel and decrease in distance from the channel. Due to the ephemeral nature of these watercourses, the floodplains are devoid of wetland conditions.

Figure 6: The affected watercourses contain an active channel and well-defined channel banks (Red). Flow also occurs as unidirectional flow within the channel (Arrow).

The Manyeding River is fed by a perennial artesian fountain and therefore contains extensive wetland conditions, most characteristic of a floodplain wetland system (SANBI 2009):

"The mostly flat or gently sloping wetland area adjacent to and formed by a Lowland or Upland Floodplain River, and subject to periodic inundation by overtopping of the channel bank. For purposes of the classification system, the location adjacent to a river in the Lowland or Upland Floodplain Zone is the key criterion for distinguishing a floodplain wetland from a channelled valley-bottom wetland. Water and sediment input to floodplain wetland areas is mainly via overtopping of a major channel, although there could be some overland or subsurface flow from adjacent valley side-slopes (if present). Water movement through the wetland is dominantly horizontal and bidirectional, in the form of diffuse surface flow and interflow, although there can be significant temporary containment of water in depressional areas (within which water movement is dominantly vertical and bidirectional). Water generally exits as diffuse surface flow and/or interflow, but infiltration and evaporation of water from a floodplain wetland can also be significant, particularly if there are a number of depressional areas within the wetland."

This accurately describes the wetland conditions which occur along the Manyeding River. The survey site along the river, is clearly situated within an extensive and quite flat plain and therefore meets the main criterion for a floodplain wetland, as opposed to a valley-bottom system. Floodplain and channelled valley-bottom wetlands are easily confused and do look similar but can mainly be differentiated by a floodplain wetland being associated with a lowland watercourse, while channelled valley-bottom systems are associated with the upper reaches where hills and valley-bottoms are present.

Figure 7: The Manyeding River contains extensive wetland conditions. Note the surrounding topography, which is clearly dominated by a flat plain, while valley side slopes are absent, thus indicating the system being a floodplain wetland.

The wetland conditions associated with a few very small pans near the road construction can be characterised as depression wetlands (SANBI 2009):

"A depression wetland is a basin shaped area with a closed elevation contour with an increase in depth from the perimeter to the central areas that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For 'depressions with channelled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channelled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flat bottomed (in which case they are often referred to as 'pans') or round bottomed (in which case they are often referred to as 'basins') and may have any combination of inlets and outlets or lack them completely. For 'exorheic depressions', water exits as concentrated surface flow while, for 'endorheic depressions', water exits by means of evaporation and infiltration."

This is an accurate description of these small pans and their functioning. They are circular to elongated, but with closed contours, and forming shallow but clearly discernible depressions in the landscape (Appendix A: Map 2). These pans are all endorheic (without outflow).

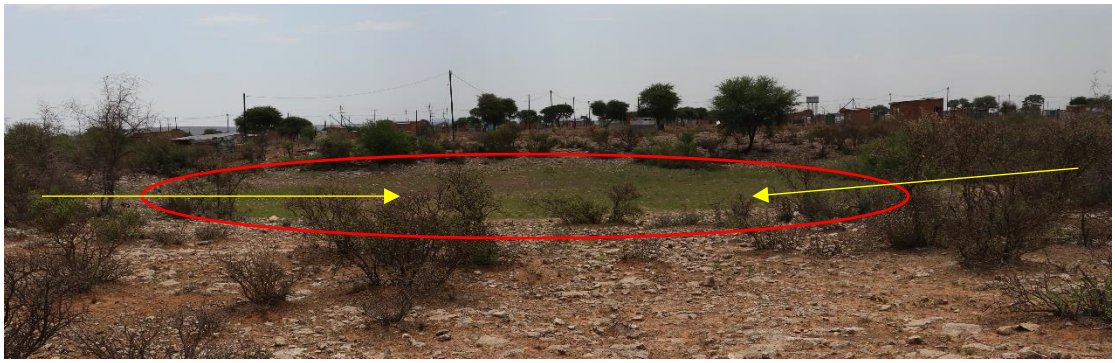


Figure 8: The small depression wetlands are easily characterised; they are situated within a relatively flat area, forming a clear depression in the landscape (Red), with inflow occurring from the surrounding catchment (Yellow).

4.2.4 Current impacts on the affected watercourses

The affected watercourses are all modified to some degree, though their functioning is still considered to be largely natural. Impacts within the catchment of these watercourses include overgrazing and trampling by domestic livestock, while low density urban areas also result in the removal of vegetation. The combination of these impacts result in an increase in sedimentation of watercourses, with some erosion also being evident. The main impact associated with both urban development and livestock trampling results in a decrease in the vegetation cover within the catchment and coupled with many decades of sustained overgrazing and -browsing by domestic livestock the vegetation cover has been decreased even further, with the grass layer being most heavily affected, with unpalatable species (notably *Senegalia mellifera* subsp. *detinens*) increasing. This results in a decrease in surface vegetation which in turn promotes runoff and sheet erosion which will affect the sedimentation of the watercourses. Other impacts also include an extensive road network, dirt tracks and road crossings which affect the natural runoff patterns and will also affect the hydrology of these watercourses to some degree. Where these roads transect a watercourse, they also act as flow barriers and promote erosion within the channel.

The direct impacts on these watercourses are also significant and will certainly result in some manner of modification, at least in terms of increased disturbance and therefore a decrease in their condition. The clearing of and decrease in vegetation cover are also quite prominent within these watercourses, and are mostly associated with the grazing pressures of domestic livestock. These watercourses contain a higher moisture regime during the year and will consequently provide grazing for a longer period. They are therefore quite heavily utilised by livestock. This leads to a serious decrease in the surface vegetation cover. Coupled with these high levels of grazing is also a high amount of trampling. This also further decreases the vegetation cover, disturbs the soil surface and also affects the hydrology of these watercourses. It was notable that especially the Kuruman River, contains high levels of infestation by the invasive *Prosopis glandulosa*, most likely also a consequence of these disturbances. Associated with the rural settlements is also substantial dumping of refuse within the watercourses which will result in further disturbances within them. The affected watercourses are also already affected by culvert crossings by the road, which will be upgraded. These already act as obstructions to flow, especially where culverts do not provide for sufficient flow capacity.

Figure 9: Watercourses and their floodplains are affected by very high levels of overgrazing and trampling by domestic livestock and this leads to a substantial decrease in vegetation cover, which will also contribute toward erosion and sedimentation.

Figure 10: The existing road and culvert crossings also act as barriers to unimpeded flow and in several instances, culverts have become blocked or obstructed, which will further affect the natural flow of these watercourses.

Figure 11: Associated with the rural settlements are also significant littering and refuse dumping, which may also include dumping of used diapers (Red).

Figure 12: Coupled with disturbances as indicated, an extensive infestation of especially the Kuruman River, by invasive *Prosopis gladulosa* has occurred resulting in further modification of the affected system.

The watercourses which will be affected by the proposed road upgrade are still largely intact and functioning naturally but have clearly been affected by several significant disturbances, resulting in some modification of these watercourses. Despite this, these watercourses still provide several important services in terms of riparian habitat, surface water transportation and groundwater resources and the upgrading of the road should aim to minimise any anticipated impacts on these systems (Appendix A: Map 2). Rehabilitation should be comprehensive and ensure recovery of disturbed areas without any long-term deterioration of the watercourses. This is particularly relevant to the prevention and containment of erosion and may also require the implementation of erosion prevention structures, such as gabions.

4.2.5 Condition and importance of the affected watercourses

The watercourses forming part of the study area which will be affected by the road construction all form part of the same drainage system and are all tributaries of the Kuruman River, which is also one of the watercourses that will be affected by the road construction (Appendix A: Map 2). As a result, the affected system can be assessed as a whole (Appendix A: Map 2). A combination of Index of Habitat Integrity (IHI) and WET-Health indices will be used for the determination of the Present Ecological State (PES). The results of these indices will be taken as representative of the Present Ecological State (PES) of this entire system. As indicated, all affected watercourses form part of the same system and therefore an overall assessment of their condition can be undertaken and this is considered to give a good representation of the condition of the watercourses system within the study area.

Table 2 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 3 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 2: Ecological categories for Present Ecological Status (PES).

Ecological Category	Description
A	Unmodified, natural
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Table 3: Ecological importance and sensitivity categories.

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

role in moderating the quantity and quality of water of major rivers.		
Low/marginal Floodplains/wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains/wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

As indicated, the Kuruman River forms the main system within the study area, with all other tributaries flowing into it. Several of these tributaries are also substantial watercourses, especially the Manyeding River. As a result, several have been included within previous desktop assessments of the area (Kleynhans 2000). The Kuruman River and all its connected tributaries, were previously assessed as having a PES of Category B: Largely Natural (Kleynhans 2000), while more recent desktop assessments (Van Deventer *et al.* 2018) indicate a more modified condition of Category C: Moderately Modified. It is also listed as a National Freshwater Ecosystem Priority Areas (NFEPA): Upstream system which has a very high conservation value and sensitivity (Appendix A: Map 2). The on-site observations have however indicated that this is somewhat over-estimated for the system, at least where the crossings will take place. This is mostly as a result of the high over-utilisation of the system, especially by domestic stock, which degrades the riparian condition to a significant extent. The flow- and flooding regime will however still be largely natural, mostly due to the absence of large impoundments. It is clear that the river system still provides vital services, including water transportation, storm water management, flood dissipation, riparian habitat and groundwater recharge. The entire system should therefore still be considered as sensitive and the proposed development should not lead to altering it any further .

The Kuruman River and all tributaries which will be affected by the road construction are situated within quaternary catchment D41L. The Kuruman River and tributaries which will be affected by the proposed road construction are considered to be affected by several significant impacts with the most prominent being over-utilisation by domestic stock. An Index of Habitat Integrity (IHI) was conducted for the main Kuruman River system to serve as representative of the other smaller watercourses (Appendix D). The results of the IHI indicated that the system has an Instream IHI of category C: Moderately Modified and Riparian IHI of category C: Moderately Modified. In order to further improve the accuracy of this determination, an additional WET-Health assessment was conducted for the floodplain wetland system associated with the Manyeding River and the results indicate a PES of Category C: Moderately Modified (Appendix D). This is mostly associated with the impacts of overgrazing, coupled with erosion and higher sediment inputs, but is also associated with the existing road crossings, which clearly act as barriers to the natural flow regime.

The EI&S of the affected watercourse systems has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains/wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. The survey has indicated that the impact on the floodplain and affected watercourses can be fairly large, as they contain important ecosystems and are being fed by artesian fountains, also being a vital resource for the ecosystem and region. All affected watercourses are also listed as NFEPA: Upstream systems, which also significantly increases their importance and sensitivity.

4.2.6 Site specific descriptions

The proposed road upgrade will affect several watercourses and a few small depressions where the road will occur in close proximity or cross over them (Appendix A: Map 1 & 2). A short overall description of these watercourses, their vegetation and their approximate location in relation to the road network will be provided in this section.

Where FW or OW is indicated it refers to Facultative or Obligate Wetland species. A facultative wetland species is often associated with wetlands but is also able to occur in non-wetland areas. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

- Van Ginkel, C.E. & Cilliers, C.J. 2020. Aquatic and wetland plants of Southern Africa. Briza Publications, Pretoria.

Table 4: Overall description of the watercourses which will be affected by the road construction (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species) (Appendix A: Map 1 & 2).

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#1 Lateral drainage lines draining into adjacent Kuruman River – Western section of road, west of Ga-Sese	S 27.120420°, E 22.972772° S 27.121858°, E 22.977877° S 27.131190°, E 23.008631° S 27.130560°, E 23.015052° S 27.129970°, E 23.018677° S 27.128077°, E 23.026018°	Ephemeral drainage lines
Description of watercourse: These are a series of very small drainage lines which are being crossed by the existing road and which drain directly into the Kuruman River which is also situated immediately to the north of the road. These drainage lines drain from low ridges, dominated by calcrete, to the south and consequently a moderate slope is present. Erosion may therefore also be present in some areas and would also be relevant to the proposed road upgrading. Given the arid environment and small size of these drainage lines, they all function as strictly ephemeral or episodic watercourses whereby continuous flow will only take place during large rainfall events which will flush through these drainage lines. Flow will also only occur for short periods and only during the rainy season. Fast flow will occur along the steeper slopes of the ridges to the south, which will slow down where these drainage lines flow into the Kuruman River. These drainage lines are still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover		

and contributing toward erosion and sedimentation of the watercourses. The existing road also crosses over these drainage lines and forms a prominent obstruction to flow which will also affect their functioning.

These drainage lines are all strictly ephemeral and without any wetland conditions being present. Soils within these drainage lines consist of light coloured, sandy soils, with high calcrete gravel content which is devoid of wetland conditions with a grey matrix and mottling being absent. This is also substantiated by the vegetation along the drainage lines which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. These drainage lines contain very small, but clearly defined channels and clearly still form watercourses. In addition, they drain into the Kuruman River immediately adjacent to the site and as a result the floodplain of the river will also be in very close proximity to the proposed road upgrade. Significant infestation by invasive *Prosopis glandulosa* is also present, especially within the floodplain of the Kuruman River.

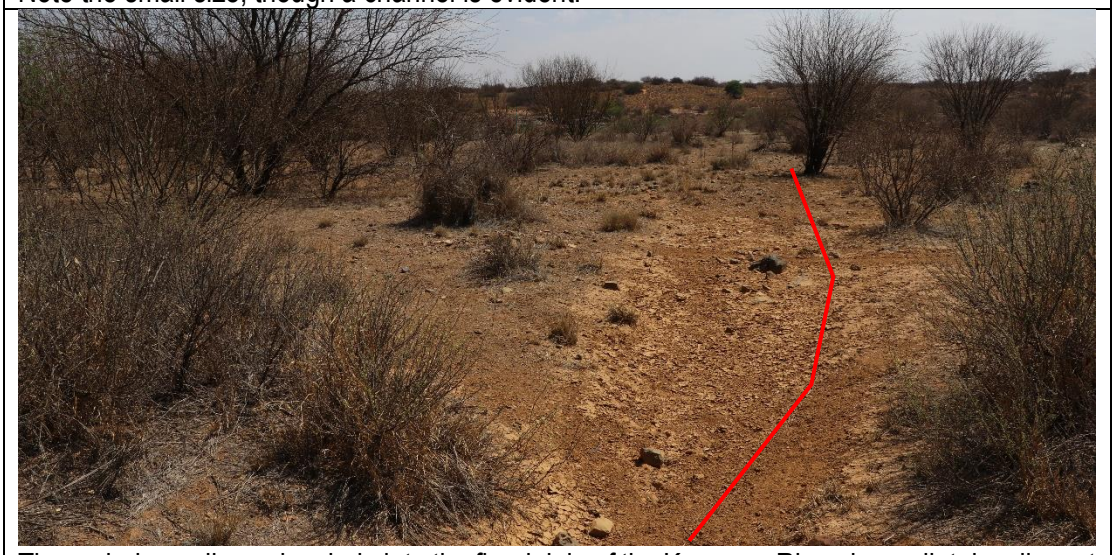
Dominant plant species:
Senegalia mellifera subsp. *detinens, *Prosopis glandulosa, Ziziphus mucronata, Setaria vertticillata, Grewia flava, Vachellia hebeclada, Salsola sp., Aristida congesta, Cenchrus ciliaris, Lycium cinerium, Monechma genistifolium* subsp. *australe, Cynodon dactylon, Euphorbia crassipes, Vachellia erioloba.*

Protected plant species:
Euhorbia crassipes, Vachellia erioloba.

Soil sample:

View of the drainage lines (Yellow), draining from ridges to the south, being crossed by the existing road (Red) and flowing into the Kuruman River immediately to the north.

View of drainage lines, flowing from the adjacent ridges and flowing toward the Kuruman River. Note the small size, though a channel is evident.



These drainage lines also drain into the floodplain of the Kuruman River, immediately adjacent to the site. Here the channel (Red) becomes obscured where it integrates into the floodplain.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#2 Two drainage lines draining into adjacent Kuruman River – Within Ga-Sese settlement	S 27.123614°, E 23.034232° S 27.120750°, E 23.039539°	Ephemeral drainage lines

Description of watercourse:

These are two separate drainage lines, that are also quite small, being crossed by the existing road and which drain directly into the Kuruman River which is situated approximately 300 to 500 metres to the north of the site. These drainage lines drain from low ridges, dominated by calcrete, to the south and consequently a moderate slope is present. Erosion may therefore also be present in some areas and would also be relevant to the proposed road upgrading. Given the arid environment and small size of these drainage lines, they both function as strictly ephemeral or episodic watercourses whereby continuous flow will only take place during large rainfall events which will flush through these drainage lines. Flow will also only occur for short periods and only during the rainy season. Fast flow will occur along the steeper slopes of the ridges to the south, which will slow down where these drainage lines flow into the Kuruman River.

These drainage lines are more heavily modified than previously discussed drainage lines (#1 Drainage Lines). This is mostly associated with the surrounding urban settlement. Here the impacts associated with overgrazing by domestic livestock, are much higher, with vegetation greatly reduced. Erosion is clearly quite significant, with refuse dumping also being prominent and these drainage lines are quite degraded. The existing road also crosses over these drainage lines and forms a prominent obstruction to flow which will also affect their functioning.

These drainage lines are both strictly ephemeral and without any wetland conditions being present. Soils within these drainage lines consist of light coloured, sandy soils, with high calcrete gravel content which is devoid of wetland conditions with a grey matrix and mottling being absent. This is also substantiated by the vegetation along the drainage lines which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. These drainage lines contain very small, but clearly defined channels and clearly still form watercourses. Significant infestation by invasive *Prosopis glandulosa* is also present, also as a result of increased disturbance in this area.

Dominant plant species:
**Prosopis glandulosa, Senegalia mellifera* subsp. *detinens, Gnidia podocephala, Cenchrus ciliaris, Lycium cinerium, Geigeria pectidea, Vachellia karroo.*

Protected plant species:
None observed.

Soil sample:

View of the drainage lines (Yellow), draining from ridges to the south, being crossed by the existing road (Red). Note the surrounding urban settlement which does result in significant aditional disturbances.

View of one of the drainage lines, where a channel is quite prominent (Red). Note also quite heavy infestation by invasive *Prosopis glandulosa*.

The existing road crosses over the drainage lines by means of box culverts clearly contributing toward flow obstruction.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#3 Small depression wetlands – within Ga-Sese, close proximity to Kuruman River	S 27.107451°, E 23.064390° S 27.104127°, E 23.068892° S 27.096960°, E 23.097064° S 27.098170°, E 23.097362°	Ephemeral depressions

Description of watercourse:

Very small depressions or pans, situated in close proximity to the existing road. These are all circular or elongated in shape and form very shallow depressions in the landscape. These depressions consist of four small pans which are located to the west and east of the Kuruman River and still within the settlement of Ga-Sese. The pans are not directly affected by the proposed road and located approximately between 30 and 150 metres from the road. They should therefore remain unaffected, as long as construction and any associated activities avoid these small pan systems. These pans will contain any surface water very infrequently and only during years of exceptional rainfall.

These small pans are fairly heavily modified. This is mostly associated with the surrounding urban settlement. Here the impacts associated with overgrazing by domestic livestock, are much higher, with vegetation greatly reduced. Trampling of the pans is also prominent and will further affect their condition.

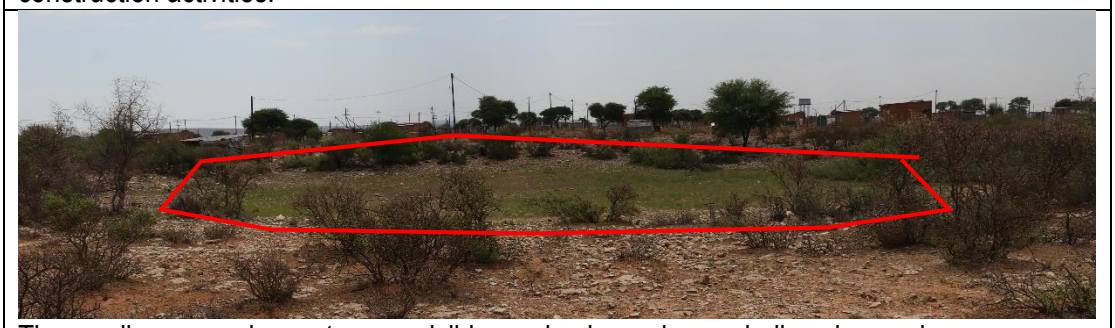
These small pans are all strictly ephemeral and without any wetland conditions being present. Soils within these pans consist of light to reddish sandy soils, with a gravel content which is devoid of wetland conditions with a grey matrix and mottling being absent. This is also substantiated by the vegetation within the depressions which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. These small pans may not always be clearly defined, but should still be avoided by the proposed road construction. Significant infestation by invasive *Prosopis glandulosa* is present, also as a result of increased disturbance in this area.

Dominant plant species:
**Prosopis glandulosa, Geigeria pectidea, Ziziphus mucronata, Pentzia calcarea, Senegalia mellifera* subsp. *detinens, Gnidia podocephala.*

Protected plant species:
None observed.

Soil sample:

Vew of the small pans which are located to the west and east of the Kuruman River. Note that they are situated in close proximity to the existing road, but should be easily avoidable by any construction activities.



The small pans are in most cases visible as circular and very shallow depressions.

These pans can also be quite poorly defined. Note also high levels of trampling by domestic livestock.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#4 Large ephemeral Kuruman River – Within Ga-Sese settlement	S 27.098022°, E 23.074586°	Ephemeral river system

Description of watercourse:

This is the main watercourse in the region, into which all other affected tributaries flow. At this site the river, including its floodplain and -bench, is quite broad but with a narrow main channel. The flood bench is clearly formed by calcrete benches which simplifies the delineation of the riparian zone. The flood bench is dominated by a layer of low shrubs with a sparse grass layer and is quite similar to a Nama Karoo type vegetation, as a result of the calcrete substrate. The flood bench slopes quite steeply toward the lower zone which is dominated by deeper sandy soils and here scattered trees have established. They are also able to establish here due to a higher soil moisture regime and shallow water table. All of the vegetation discussed thus far is mostly dominated by terrestrial species. Along the main channel a very short grass layer (caused by overgrazing) dominates with a few riparian trees also present. A significant species diversity is still present and also indicates a lower level of disturbance. However, a significant infestation by the seriously invasive *Prosopis glandulosa*, still indicates significant disturbance of the riparian vegetation. The river strictly functions as an ephemeral system which flows very infrequently, discharging by means of flash floods during years of exceptional rainfall, which is the only time that connected channel flow might occur.

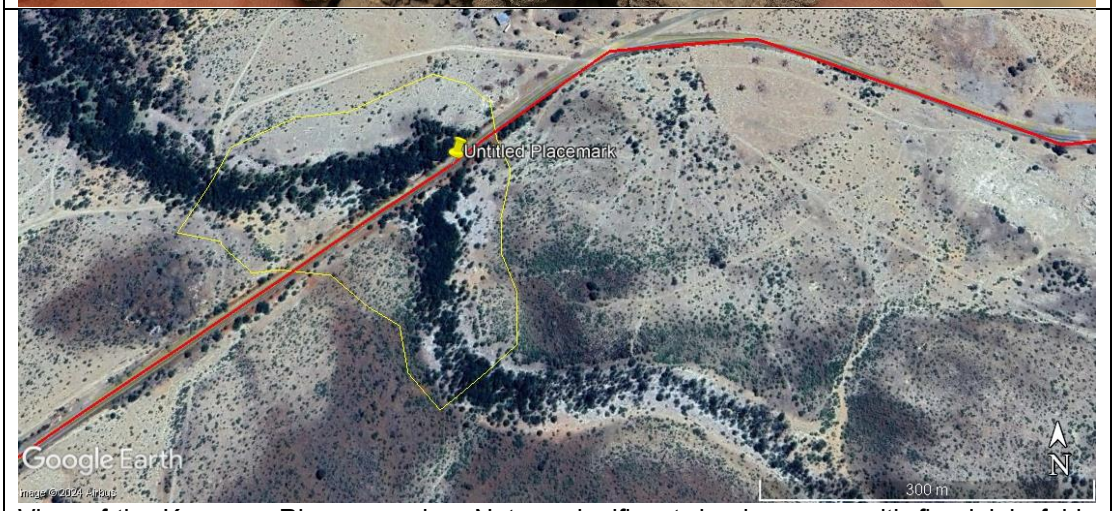
The river is affected here by quite heavy disturbance, which may be localised to the surrounding urban area, though it is likely that a moderate level of modification is still present, given the upstream land uses. Disturbances at the site, are mostly associated with the surrounding urban settlement. Here the impacts associated with overgrazing by domestic livestock, are much higher, with vegetation greatly reduced. Erosion is clearly quite significant, with refuse dumping also being prominent and the river here contains significant levels of disturbance. The river is also being crossed by the existing road and a bridge is already present here, which will also act as a flow barrier.

The river is strictly ephemeral and only flows for short periods during years of high rainfall. However, an elevated moisture regime is still present and localised ponding or areas of longer saturation may form during the rainy season. This is also indicated by the soil samples, which indicate a degree of grey matrix, while scattered obligate wetland sedges also confirm the presence of wetland conditions. These wetland conditions will however be limited to the main channel, while the banks and floodplain are completely devoid of such wetland conditions. Vegetation along the banks is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. Despite being an ephemeral system, this river is highly important, not only in terms of its ecosystem services but also being a vital resource to the local communities. Significant infestation by invasive *Prosopis glandulosa* is present, also as a result of increased disturbance in this area.

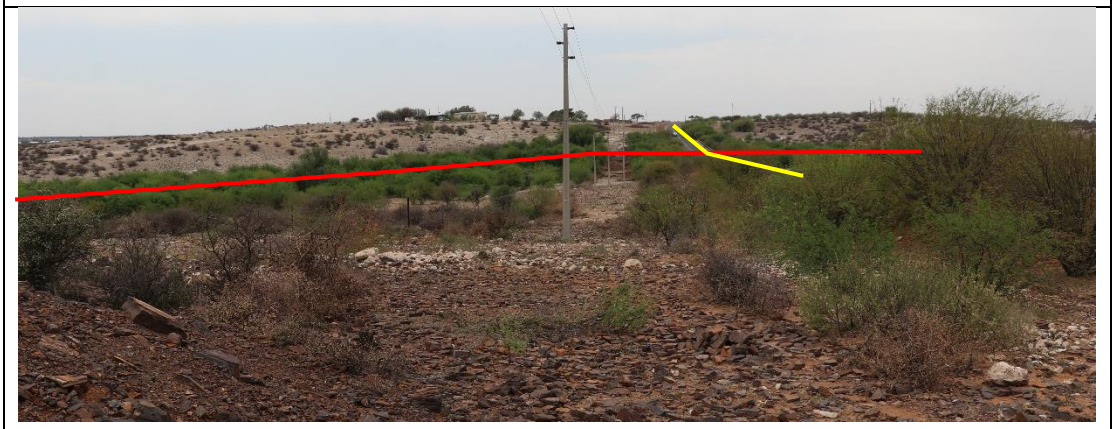
Dominant plant species:
**Prosopis glandulosa, Senegalia mellifera* subsp. *detinens, Kleinia longiflora, Diospyros lycioides, Monechma genistifolium* subsp. *australe, Aristida congesta, Enneapogon sp., Lycium bosciifolium, Sporobolus ioclados* (OW)*, Cynodon dactylon, Vachellia karroo, Gymnosporia buxifolia, Eragrostis echinochloidea, Juncus rigidus* (OW), *Gazania krebsiana.*

Protected plant species:
Euphorbia crassipes.

Soil sample:



View of the Kuruman River crossing. Note a significant riparian zone, with floodplain fairly extensive.



View of the Kuruman River (Red). The existing road is also indicated (Yellow). Note also fairly dense tree layer, dominated by invasive *Prosopis glandulosa*.

View of the main channel (Red), which is fairly narrow, with an extensive infestation by invasive *Prosopis glandulosa* also evident. The bridge structure is also clear.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#5 Small depression wetlands – central section, in natural areas with lower disturbance.	S 27.082349°, E 23.233732° S 27.081896°, E 23.235610°	Ephemeral depressions

Description of watercourse:

Very small depressions or pans, situated in close proximity to the existing road. These are both circular in shape and form very shallow depressions in the landscape. These depressions consist of two small pans which are located to the north of the existing road. The pans are not directly affected by the proposed road and located approximately 15 and 60 metres from the road. They should therefore remain unaffected, as long as construction and any associated activities avoid these small pan systems. These pans will contain any surface water very infrequently and only during years of exceptional rainfall.

These small pans are situated in an area that is more natural, with lower levels of overgrazing. Consequently, they are less modified. Limited impacts affecting them are still moderate levels of overgrazing and trampling by domestic livestock.

These small pans are both strictly ephemeral and without any wetland conditions being present. Soils within these pans consist of light to reddish sandy soils, with a gravel content which is devoid of wetland conditions and a grey matrix and mottling being absent. This is also substantiated by the vegetation within the depressions which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. These small pans may not always be clearly defined, but should still be avoided by the proposed road construction.

Dominant plant species:

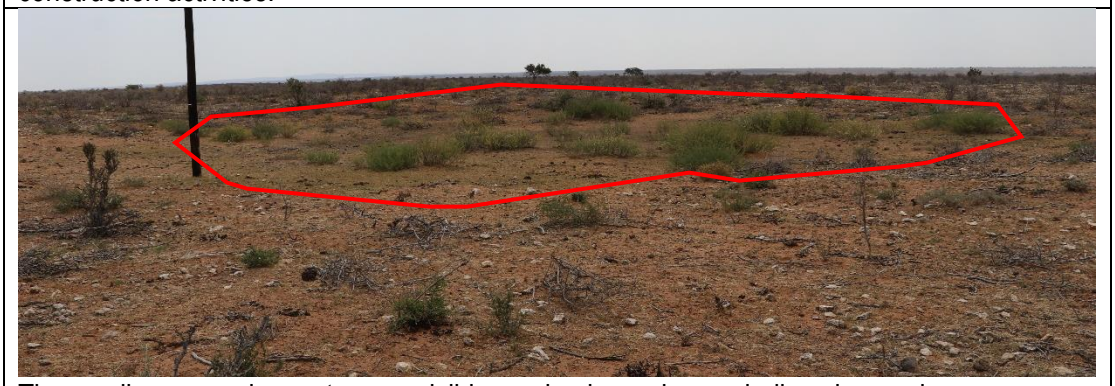
Geigeria pectidea, Senegalia mellifera subsp. *detinens, Gnidia podocephala, Cynodon dactylon, Vachellia hebeclada, Vachellia karroo, Diospyros lycioides, Ledebouria sp., Felicia muricata, Helichrysum argyrosphaerum.*

Protected plant species:

None observed.

Soil sample:

Vew of the small pans which are located to the north of the exising road. Note that they are situated in close proximity to the existing road, but should be easily avoidable by any construction activities.



The small pans are in most cases visible as circular and very shallow depressions.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#6 Small ephemeral stream – tributary of Matlhwaring River	S 27.227679°, E 23.471359°	Ephemeral stream

Description of watercourse:
This is a small but clearly visible stream system which is being crossed by the existing road and which drains directly into the Matlhwaring River, a tributary of the Kuruman River,

approximately 2 km to the north. The stream drains over a large area to the south, which is dominated by fairly flat plains. Flow will therefore be fairly slow, with erosion not being particularly problematic. Instead, sedimentation may be more relevant. Given the arid environment and small size of the stream, it will function as a strictly ephemeral or episodic watercourse whereby continuous flow will only take place during large rainfall events which will flush through the stream system. Flow will also only occur for short periods and only during the rainy season.

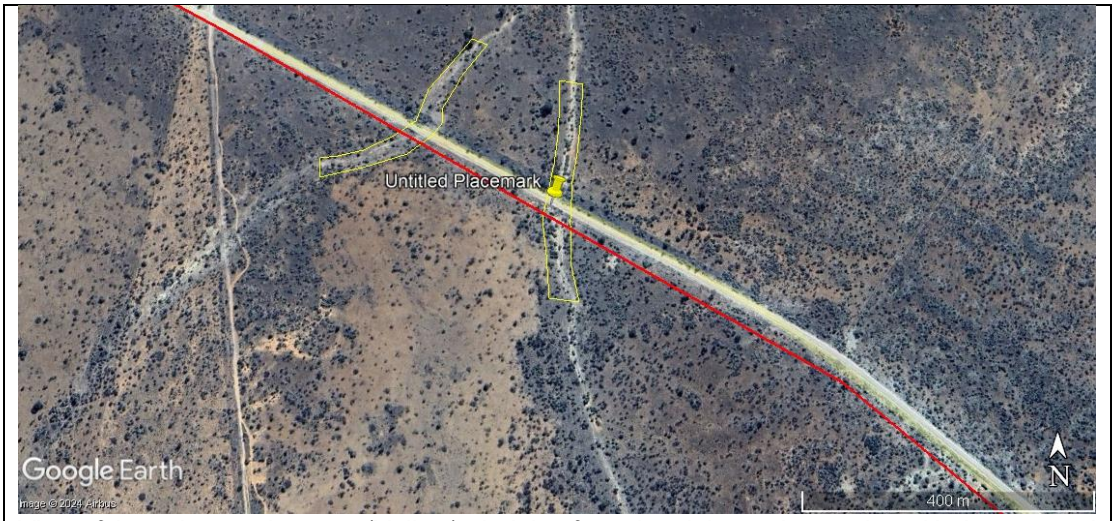
The system is still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover and contributing toward sedimentation of the stream. The existing road also crosses over the stream and forms a prominent obstruction to flow which will also affect its functioning. Significant sediment accumulation and blocking of culverts is also evident and confirms impacts as indicated above.

The stream is strictly ephemeral and without any wetland conditions being present. Soils within the stream consist of light coloured, sandy soils, with high calcrete gravel content which is devoid of wetland conditions with a grey matrix and mottling being absent. This is also substantiated by the vegetation along the stream which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. The stream contains a small but defined channel and clearly still forms a watercourse.

Dominant plant species:
Senegalia mellifera subsp. *detinens, Searsia lancea, Tarchonanthus camphoratus, Sporobolus ioclados* (OW), *Cucumis rigidus, Nolletia sp., Cynodon dactylon, Heteropogon contortus, Themeda triandra.*

Protected plant species:
None observed.

Soil sample:



View of the ephemeral stream (Yellow), draining from the plains to the south and being crossed by the existing road (Red).

The stream is clearly quite small though still containing a clear channel.

The stream is affected by several impacts and sedimentation is clearly problematic. Note how culverts have become almost completely blocked by sediment accumulation.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**

#7 Ephemeral stream – tributary of Matlhwaring River	S 27.261145°, E 23.517617°	Ephemeral stream

Description of watercourse:

This is a small but quite prominent stream which is being crossed by the existing road and which drains directly into the Matlhwaring River, a tributary of the Kuruman River, approximately 5 km to the north. The stream drains over a large area to the south, which is dominated by fairly flat plains. Flow will therefore be fairly slow, with erosion not being particularly problematic. Instead, sedimentation may be more relevant. Given the arid environment and small size of the stream, it will function as a strictly ephemeral or episodic watercourse whereby continuous flow will only take place during large rainfall events which will flush through the stream system. Flow will also only occur for short periods and only during the rainy season.

The system is still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover and contributing toward sedimentation of the stream. The existing road also crosses over the stream and forms a prominent obstruction to flow which will also affect its functioning. Though current culverts still allow for sufficient flow, they will undoubtedly contribute toward the constriction of flow, sedimentation and scouring of the outflow.

The stream is strictly ephemeral, though some wetland conditions occur within the main channel. This indicates that the main channel is likely to become saturated during the rainy season. Keep in mind that although saturation may occur, this is not an indication of flow occurring and still indicates an ephemeral system being present. This is also indicated by the soil samples, which indicate a degree of grey matrix, while scattered obligate wetland sedges also confirm the presence of wetland conditions. These wetland conditions will however be limited to the main channel, while the banks and floodplain are completely devoid of such wetland conditions. Vegetation along the banks is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. The stream contains a small, but prominent and well-defined channel and clearly still forms a watercourse.

Dominant plant species:

Searsia lancea, Tarchonanthus camphoratus, Sporobolus ioclados (OW), *Eragrostis lehmanniana, Vachellia karroo, Polygala hottentotta, Cynodon dactylon, Berkheya spinosissima, Juncus rigidus* (OW), *Lobelia thermalis* (OW), *Scirpoides dioecus* (OW), **Opuntia ficus-indica, Gazania krebsiana, Eragrostis echinochloidea, Sporobolus ioclaodos* (OW), *Microloma armatum, Ruschia calcarea, Cyanella lutea, Aptosimum albomarginatum, Pteronia leucoclada, Anacampseros filamentosa* subsp. *filamentosa, Jamesbrittenia atropurpurea.*

Protected plant species:

Ruschia calcarea, Anacampseros filamentosa subsp. *filamentosa.*

Soil sample:

View of the ephemeral stream (Yellow), draining from the plains to the south and being crossed by the existing road (Red). Note a quite prominent channel is visible.

The stream is still small but quite prominent and with a well-defined channel visible.

The culverts underneath the existing road will enable sufficient flow but will clearly still result in constriction of flow.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#8 Ephemeral stream – tributary of Matlhwaring River	S 27.291375°, E 23.564408°	Ephemeral stream

Description of watercourse:

This is a fairly large stream system which is being crossed by the existing road and which drains directly into the Matlhwaring River, a tributary of the Kuruman River, approximately 6 km to the north. The stream drains over a large area to the south, which is dominated by fairly flat plains. Flow will therefore be fairly slow, with erosion not being particularly problematic. Instead, sedimentation may be more relevant. The origin of the stream is being fed by an artesian fountain system which also significantly increases the hydrology of the stream. However, because the fountain is situated more than 20 km to the south and is not a sustained source, the stream remains a strictly ephemeral or episodic watercourse whereby continuous flow will only take place during large rainfall events which will flush through the stream system. Flow will also only occur for short periods and only during the rainy season.

The system is still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover and contributing toward sedimentation of the stream. The existing road also crosses over the stream and forms a prominent obstruction to flow which will also affect its functioning. The existing crossing contains numerous culverts which will facilitate flow, though a few are clearly obstructed, while the culverts in general will also still contribute toward the constriction of flow, sedimentation and scouring of the outflow.

Given the larger size of the stream and being partially fed by an upstream artesian fountain, it does contain fairly extensive wetland conditions, but remains ephemeral in terms of flow. This indicates that the main channel is likely to become saturated during the rainy season. Keep in mind that although saturation may occur, this is not an indication of flow occurring and still indicates an ephemeral system being present. This is also indicated by the soil samples, which indicate a degree of grey matrix, while an abundance of obligate wetland sedges also confirms the presence of wetland conditions. These wetland conditions will however be limited to the main channel, while the banks and floodplain are completely devoid of such wetland conditions. Vegetation along the banks is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. A prominent floodplain is present, with

some exposed calcrete also being present and these also form a fairly unique habitat, sustaining an abundance of protected plant species, not being common in this area and therefore of high conservation value. Any construction should therefore aim to be limited to the road reserve and should not extend into the more natural areas outside the road reserve.

Dominant plant species:
Vachellia karroo, Cynodon dactylon, Tarchonanthus camphoratus, Vachellia hebeclada, Scirpus dioecus (OW), *Searsia lancea, Diospyros lycioides, Cyperus sp., Juncus rigidus* (OW), *Lobelia thermalis* (OW), *Medicago laciniata, Eragrostis lehmanniana, Eragrostis echinochloidea, Colchicum sp., Ledebouria luteola, Ornithoglossum vulgare, Gymnosporia buxifolia, Vachellia erioloba, Tulbaghia sp., Prepodesma orpenii.*

Protected plant species:
Vachellia erioloba, Prepodesma orpenii.

Soil sample:

View of the ephemeral stream (Yellow), draining from the plains to the south and being crossed by the existing road (Red). Note a prominent channel and fairly extensive floodplain.

The main channel is broad, with an abundance of wetland vegetation being present.

The stream is large, containing a high diversity of habitats. Note also exposed calcrete habitats which sustain several unique species.

The existing crossing contains numerous culverts, though several of these are clearly being obstructed and will influence the flow through the system.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#9 Manyeding River – tributary of Matlhwaring River	S 27.311368°, E 23.600527°	Seasonal river

Description of watercourse:

This is a large system, which can be considered a lowland river and is being crossed by the existing road and which drains directly into the Matlhwaring River, a tributary of the Kuruman River, approximately 6 km to the north. The river drains a large area to the south, which is dominated by fairly flat plains. Flow will therefore be fairly slow, with erosion not being particularly problematic. Instead, sedimentation may be more relevant. The origin of the river is being fed by the Manyeding Eye, which is an artesian fountain providing a consistent flow,

almost throughout the year. The system therefore contains flow for the majority of the year. However, it is likely that flow will cease for periods during the winter season and it is therefore considered a seasonal system rather than perennial. Flow is also dominated by diffuse flow, rather than flooding and it therefore forms a system characterised by extensive wetland conditions, akin to a floodplain wetland system.

The system is still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover and contributing toward sedimentation of the river. The existing road also crosses over the river and forms a prominent obstruction to flow which will also affect its functioning. The existing crossing contains numerous culverts which will facilitate flow, which will still contribute toward the constriction of flow, sedimentation and scouring of the outflow.

Given the larger size of the river, an almost perennial diffuse flow and being fed by an upstream artesian fountain, it contains extensive wetland conditions and forms a vital resource both in terms of services and habitat it provides. The main channel will remain saturated throughout the year, though flow may cease for short periods. This is also confirmed by the soil samples, which contain clear wetland characteristics and indicate a perennial zone of wetness. Obligate wetland vegetation also dominates the main channel. These wetland conditions will however be limited to the main channel, while the banks and floodplain are completely devoid of such wetland conditions. Vegetation along the banks is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present.

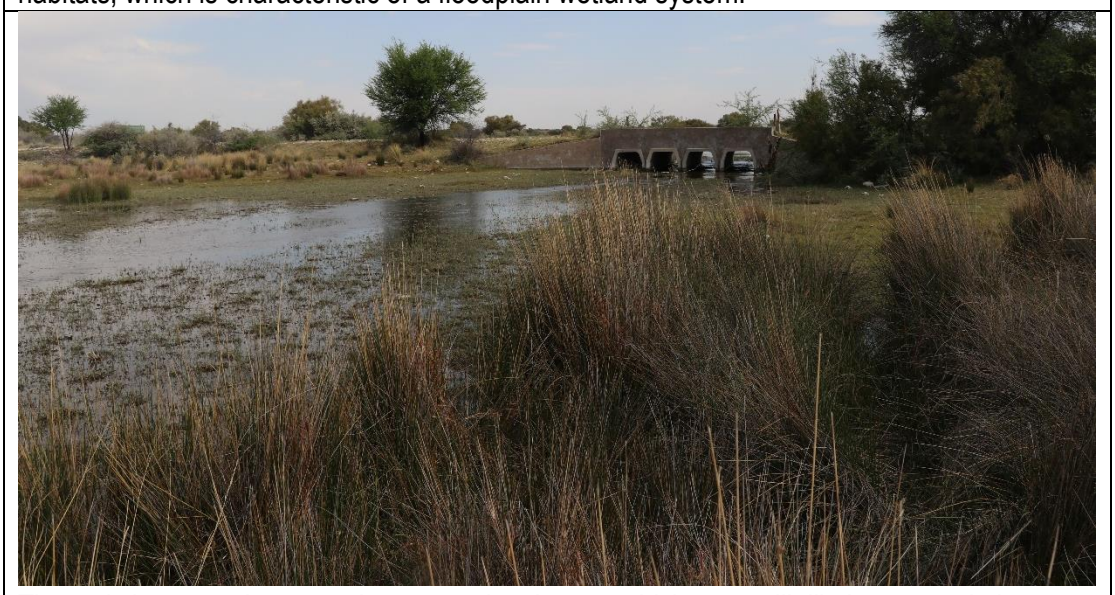
Dominant plant species:
Vachellia karroo, Cynodon dactylon, Tarchonanthus camphoratus, Vachellia hebeclada, Scirpus dioecus (OW), *Searsia lancea, Diospyros lycioides, Eragrostis lehmanniana, Pentzia calcarea, Lobelia thermalis* (OW), *Aristida sp., Gymnosporia buxifolia, Vachellia erioloba, Ziziphus mucronata, Scirpoides dioecus* (OW), *Schoenus nigricans* (OW), *Themeda triandra, Berula erecta* (OW), *Juncus rigidus* (OW), *Isolepis sp.* (OW), *Imperata cylindrica* (OW), *Paspalum distichum* (OW), *Typha capensis* (OW).

Protected plant species:
Vachellia erioloba.

Soil sample:

View of the Manyeding River (Yellow), draining from the plains to the south and being crossed by the existing road (Red). Note a prominent channel and fairly extensive floodplain.

The Manyeding River is extensive, being fed by an artesian eye, containing extensive wetland habitats, which is characteristic of a floodplain wetland system.



The existing crossing contains several culverts, which are still likely to result in some constriction of flow. Note abundance of flow, even at the end of the dry season, which indicates that the system is likely to be almost perennial.

Watercourse name:	**Coordinates of sampling:** S 27.327602°, E 23.660558°	**Flow regime:** Ephemeral drainage line

#10 Small ephemeral drainage line – tributary of Matlhwaring River		

Description of watercourse:

This is a small and not very clearly defined drainage line, which is being crossed by the existing road and which drains directly into the Matlhwaring River, a tributary of the Kuruman River, approximately 2 km to the north. The crossing is situated near the origin of the drainage line, therefore not being well defined and also draining a fairly small catchment. Flow will therefore be fairly slow, with erosion not being particularly problematic. Instead, sedimentation may be more relevant. Given the arid environment and small size of the drainage line, it will function as a strictly ephemeral or episodic watercourse whereby continuous flow will only take place during large rainfall events which will flush through the system. Flow will also only occur for short periods and only during the rainy season.

The system is still relatively natural, though modified to some extent as a result of high levels of overgrazing by domestic livestock, significantly decreasing the vegetation cover and contributing toward sedimentation of the drainage line. The existing road also crosses over the drainage line and forms a prominent obstruction to flow which will also affect its functioning.

The drainage line is strictly ephemeral and without any wetland conditions being present. Soils within the drainage line are light coloured, with high calcrete content which is devoid of wetland conditions with a grey matrix and mottling being absent. This is also substantiated by the vegetation along the drainage lines which is dominated by terrestrial species with only some riparian grasses, trees and dwarf shrubs being present. The drainage line contains a small and poorly defined channel but clearly still forms a watercourse. Prominent exposed calcrete habitats are also present along the drainage line and these also form a fairly unique habitat, sustaining an abundance of protected plant species, not being common in this area and therefore of high conservation value. Any construction should therefore aim to be limited to the road reserve and should not extend into the more natural areas outside the road reserve.

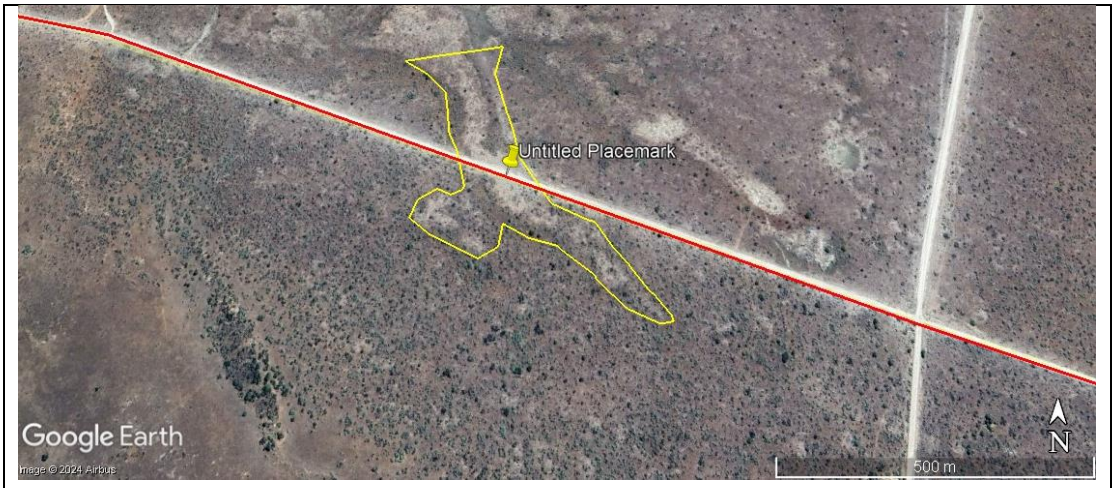
Dominant plant species:

Tarchonanthus camphoratus, Sporobolus ioclados (OW), *Cynodon dactylon, Gymnosporia buxifolia, Nenax microphylla, Pentzia calcarea, Heteropogon contortus, Aristida congesta, Ruschia calcarea, Prepodesma orpenii, Euryops subcarnosus, Euphorbia caterviflora.*

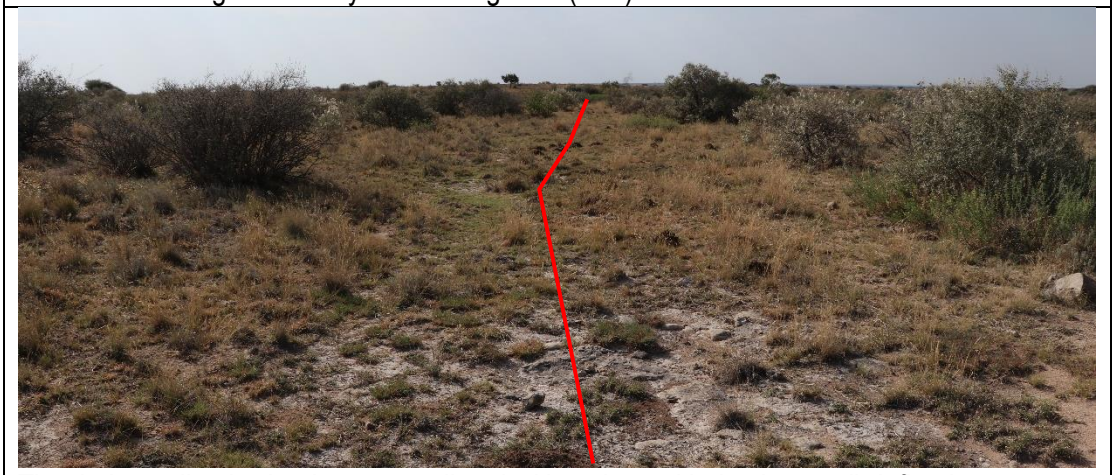
Protected plant species:

Ruschia calcarea, Prepodesma orpenii, Euphorbia caterviflora.

Soil sample:



View of the ephemeral drainage line (Yellow), which is situated near its orgin, being less well-defined and being crossed by the existing road (Red).



The drainage line is clearly very small and with a channel being less well-defined.

The small culvert will still facilitate flow, but will most likely also cause some constriction of flow.

5. Biodiversity Sensitivity Rating (BSR)

Habitat diversity and species richness:
Habitat diversity is considered as moderate. Watercourses and adjacent habitats are often highly diverse, as a result of the variety in geomorphology and moisture regimes, which contribute toward a high habitat diversity. Impacts associated with human induced disturbances, overgrazing by domestic livestock and the existing road reserve decrease the habitat and species diversity. The area does however still form part of the Griqualand West Centre of Endemism and as a result a moderate species diversity is still present. The species diversity associated and supported by these habitats is also considered as moderate.

Presence of rare and endangered species:
Endangered or Red Listed species are absent from the existing road reserve and are considered somewhat unlikely to occur as this area is not known for containing many Red Listed plant species. However, as indicated, several protected plant species do occur along the road (Appendix B & Table 4). These are all relatively widespread but do still retain a significant conservation value. These protected plants include *Vachellia erioloba, Raphionacme velutina, Euhorbia crassipes, Ruschia calcarea, Anacampseros filamentosa subsp. filamentosa, Prepodesma orpenii* and *Euphorbia caterviflora.*

Ecological function:
The ecological function of the area is still fairly intact though some level of modification is present. The area functions as habitat for fauna, sustaining a specific vegetation type, i.e. Kuruman Thornveld, Kathu Bushveld and Kuruman Vaalbosveld and also functions in terms of surface drainage and groundwater recharge (Appendix A: Map 1 & 2). The vegetation along the road section is largely intact though significant disturbance associated with the road reserve does contribute to some modification, at least of the immediate area. Due to this level of modification and the existing road, the habitat provided to mammals will also be modified.

The ecological function of the affected watercourses in the area, despite being ephemeral systems, is considered highly sensitive. Previous discussion (See Section 4.2.6) should also clearly illustrate this. The main drainage system, the Kuruman River of which all watercourses form tributaries and which itself will also be affected by road construction, is also listed as a National Freshwater Ecosystem Priority Area: Upstream system further increasing its sensitivity. The ecological functioning may however be modified to some degree as a result of impacts affecting it (See Section 4.2.5).

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Kuruman Thornveld (SVk 9), Kathu Bushveld (SVk 12) and Kuruman Vaalbosveld (SVk 8) (Appendix A: Map 1). All of these vegetation types cover large areas and are still widespread and currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). As a result, areas of remaining natural vegetation will have a lower conservation value. The survey and desktop resources (National Biodiversity Assessment 2018), indicate that the area is still largely natural, though the existing road and road reserve is degraded from the natural condition. Furthermore, the area is well-known to be heavily affected by overgrazing and -browsing by domestic livestock, which also further decrease the conservation value.

The Northern Cape Critical Biodiversity Areas Plan (2016) indicates that affected watercourses and wetlands are listed as Ecological Support Areas (ESA), which aid in support of these systems and it is therefore important to maintain their integrity. Road construction should therefore not result in any significant modification of the functioning of these systems.

Therefore, overall, the conservation value of the site cannot exceed moderate values. In addition, given the limited footprint of the road construction, it is unlikely to result in a large loss of ecosystem function or vegetation transformation.

Percentage ground cover:
The area is situated in an arid region and a low percentage vegetation cover is therefore natural. However, high levels of sustained overgrazing further decrease the vegetation cover to a significant extent. The current condition is considered to be modified and vegetation cover reduced from the natural condition, at least to a moderate degree.

Vegetation structure:
The area forms part of the Savannah Biome and should therefore naturally contain a well-developed grass layer with an open to closed tree/shrub layer. This is still largely the case for much of the road section though the road reserve and rural settlements do modify this vegetation structure to a moderate degree.

Infestation with exotic weeds and invader plants:
Numerous exotic weeds and invasive species are present on the site (Appendix B). These have not yet formed dominating patches and are in most cases still eradicable and overall infestation is therefore considered as moderate.

Degree of grazing/browsing impact:
The area is being utilised as communal grazing area and as a result of sustained overgrazing and -browsing by domestic livestock this has resulted in high levels of disturbance.

Signs of erosion:
Due to the relatively low slope of the majority of the area and moderate level of impacts affecting it, erosion in the study area is considered as relatively low.

Terrestrial animals:
Tracks and signs of mammals are abundant along the road section and are likely coupled to the largely natural habitat in the surrounding areas. It is however highly likely the existing road will affect the natural mammal population to a significant degree, especially in terms of the occurrence of reclusive and threatened mammal species. The area is also utilised for domestic livestock and the farmers will undoubtedly hunt small carnivores such as Black Backed Jackal (*Canis mesomelas*). The mammal population is therefore anticipated to be modified to some degree. In addition, mammal species which are rare and endangered are often habitat specific, sensitive to habitat change and they avoid areas in close proximity to human activities. Given the proximity of the existing road it is therefore considered unlikely that such species would occur on the site. Overall, the mammal population on the site is considered to be moderately modified.

Table 5: Biodiversity Sensitivity Rating for the proposed road upgrade affecting the watercourses in the study area.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
Ecological function		2	
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover		2	
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion			1
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	3	16	1
Total		20	

6. Biodiversity Sensitivity Rating (BSR) interpretation

Table 6: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Ga-Sese and Washington road section	20	Good condition	2

7. Discussion and conclusions (Appendix A: Map 1 & 2)

The watercourses which will be affected by the proposed road upgrade are considered to be in a good condition but with significant disturbances present (Appendix A: Map 2). This is a result of the systems being situated in a largely natural region and therefore functioning naturally, though significant disturbances are present and include overgrazing by domestic livestock, rural settlements and the existing road and road reserve.

The proposed road upgrade will be undertaken along the gravel road, stretching from the town of Hotazel in the west towards Kuruman in the east. The road is situated along and services numerous small settlements which include, from west to east, Ga-Sese, Tsineng, Ga-Diboye, Ga-Lotlhare, Cottenend, Cardington and Washington. The road section is fairly extensive and has an approximate length of 100 km. The road will require crossing of several small ephemeral watercourses, as well as a few larger watercourses, of which the Manyeding River is fed by an artesian eye and containing perennial flows (Appendix A: Map 1 & 2). The proposed road upgrade is therefore likely to have significant impacts on these systems. Existing impacts on these watercourses are mainly associated with high levels of overgrazing by domestic livestock as well as existing road networks and crossings, low density residential areas and refuse dumping. As a result, these watercourses are already modified to some degree.

The area contains numerous watercourses which range from large systems to fairly small drainage lines (Appendix A: Map 2). Given the flat topography of the region, these amount of watercourses are fairly low, in view of the large section of road proposed for upgrading (approximately 100 km). All watercourses are clearly defined, containing a main channel with active channel banks. Smaller drainage lines may be less prominent, though still containing a clear channel. A few depression wetlands were also observed, and although none of these will be directly affected by the road construction, they will still be included in the assessment, to ensure that they are completely avoided by any construction activities. Almost all of these are clearly ephemeral systems which will only flow for short periods after heavy rainfall events. The only exception being the Manyeding River, which is being fed by the Manyeding Eye, an artesian fountain which ensures a perennial flow. The larger river systems (Kuruman, Matlwaring and Manyeding Rivers) contain a larger channel but also with a wide floodplain where flow slows down. Watercourses vary from containing only riparian conditions, to containing more prominent wetland conditions and longer periods of saturation during the rainy season. All of the affected watercourses form part of the same drainage system, with the Kuruman River forming the main river system, with all other watercourses forming tributaries of it, and draining into it. These watercourses are all largely intact and though functioning naturally, they contain a significant level of disturbances, and are therefore still likely to be affected by the proposed road construction (Appendix A: Map 1 & 2).

As indicated, several watercourses will be affected by road construction and can be summarised as follows:

- The Kuruman River is the main river system with all others draining into it, and which will be crossed by the road upgrade.
- The Manyeding River is the second largest system which is also being fed by an artesian fountain and containing perennial flow.
- Several large, but unnamed tributaries will also be crossed by the proposed road.
- Several smaller drainage lines will also be affected by the road upgrade.

- A few small depression wetlands occur in close proximity to the road and will also be assessed in overview.

As indicated, the affected watercourses are generally intact with their functioning being largely natural. They do however contain varying degrees of disturbances, associated with rural settlements, as well as high levels of overgrazing by domestic livestock. These impacts decrease the vegetation cover, resulting in the modification of the vegetation structure and species composition while infestation by invasive *Prosopis glandulosa* is also prominent. The presence of wetland conditions varies significantly between these watercourses where larger river systems generally contain more prominent wetland conditions, while smaller drainage lines are devoid of wetland conditions. Despite significant levels of disturbance, these watercourses still provide important functions in terms of water transportation and groundwater resources, while their susceptibility to infestation by invasive *Prosopis glandulosa* should also be taken into account.

The larger systems, including the Kuruman- and Manyeding Rivers, have previously been included within the National Wetland Map 5 and the National Freshwater Ecosystem Priority Areas (NFEPA) desktop assessments (Appendix A: Map 1). They are also listed as NFEPA: Upstream systems which will significantly increase their importance and conservation value.

The affected watercourses and their associated wetland and riparian conditions were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C):

- All of the smaller drainage lines are devoid of wetland conditions. However, a distinct channel, with some riparian vegetation and flooding debris does indicate that they must still be regarded as watercourses though being devoid of wetland conditions. These drainage lines are characterised by faster flow and being smaller systems, this also prevents long periods of saturation which in turn prevents the formation of wetland conditions.
- The lower lying, larger watercourses contain at least seasonal wetland conditions. These watercourses are larger and being situated in the lower lying bottomlands, flow slows down allowing for floodplains to form where water resides for longer periods and allows for the formation of seasonal wetland conditions. Irrespective of the presence of wetland conditions or not, all affected watercourses are quite clearly defined with prominent channels and riparian vegetation.
- The Manyeding River is being fed by an artesian fountain, the Manyeding Eye resulting in a near perennial flow within it. Because this enables a continuous diffuse flow to occur, the Manyeding can be regarded a river system but with characteristics of a floodplain wetland. Along this system, wetland conditions are prominent and indicative of a perennial zone of wetness. This is confirmed through both soil samples and wetland vegetation.
- The main system, the Kuruman River system, also contains a large and prominent main channel, which is clearly only activated on an ephemeral basis and will only contain connected main channel flow during years of exceptional rainfall. Nonetheless, wetland conditions are prominent within the main channel.
- A few small depression wetlands occur in close proximity to the proposed road upgrade. These are very small and wetland conditions are not prominent. Both in terms of soil samples and vegetation composition, wetland conditions cannot be considered to be conclusively present. However, the combination of topography (forming a shallow

depression) and vegetation composition which contains some riparian species, confirms that these should nonetheless still be regarded as depression wetlands.

The wetland conditions associated with the larger rivers and watercourses can be characterised as a channel wetland system (SANBI 2009). The wetland conditions are confined to the main channel of these systems which experiences surface flow only intermittently. Here wetland conditions are most prominent along the main channel and decrease in distance from the channel. Due to the ephemeral nature of these watercourses, the floodplains are devoid of wetland conditions.

The Manyeding River is fed by a perennial artesian fountain and therefore contains extensive wetland conditions, most characteristic of a floodplain wetland system (SANBI 2009). The survey site along the river, is clearly situated within an extensive and quite flat plain and therefore meets the main criterion for a floodplain wetland, as opposed to a valley-bottom system. Floodplain and channelled valley-bottom wetlands are easily confused and do look similar but can mainly be differentiated by a floodplain wetland being associated with a lowland watercourse, while channelled valley-bottom systems are associated with the upper reaches where hills and valley-bottoms are present.

The wetland conditions associated with a few very small pans near the road construction can be characterised as depression wetlands (SANBI 2009). They are circular to elongated, but with closed contours, and forming shallow but clearly discernible depressions in the landscape (Appendix A: Map 2). These pans are all endorheic (without outflow).

As indicated, the Kuruman River forms the main system within the study area, with all other tributaries flowing into it. Several of these tributaries are also substantial watercourses, especially the Manyeding River. They are also listed as National Freshwater Ecosystem Priority Areas (NFEPA): Upstream systems which have a very high conservation value and sensitivity (Appendix A: Map 2). It is clear that the river system still provides vital services, including water transportation, storm water management, flood dissipation, riparian habitat and groundwater recharge. The entire system should therefore still be considered as sensitive and the proposed development should not lead to altering it any further.

The Kuruman River and all tributaries which will be affected by the road construction are situated within quaternary catchment D41L. The Kuruman River and tributaries which will be affected by the proposed road construction are considered to be affected by several significant impacts with the most prominent being over-utilisation by domestic stock. An Index of Habitat Integrity (IHI) was conducted for the main Kuruman River system to serve as representative of the other smaller watercourses (Appendix D). The results of the IHI indicated that the system has an Instream IHI of Category C: Moderately Modified and Riparian IHI of category C: Moderately Modified. In order to further improve the accuracy of this determination, an additional WET-Health assessment was conducted for the floodplain wetland system associated with the Manyeding River and the results indicate a PES of Category C: Moderately Modified (Appendix D). This is mostly associated with the impacts of overgrazing, coupled with erosion and higher sediment inputs, but is also associated with the existing road crossings, which clearly act as barriers to the natural flow regime.

The EI&S of the affected watercourse systems has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains/wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. The survey has indicated that the

floodplain and affected watercourses can be fairly large, containing important ecosystems and being fed by artesian fountains, also being a vital resource for the ecosystem and region. All affected watercourses are also listed as NFEPA: Upstream systems, which also significantly increases their importance and sensitivity.

8. Recommendations

- After construction of the road section, the area must be rehabilitated. This includes removal of all construction material. Excavated rock may not be left in heaps and must be removed and disposed of at a registered facility. Compacted areas must be ripped. Construction roads not being utilised must afterwards be rehabilitated.

- Problematic weeds must be eradicated where these establish on the proposed road section (Appendix B). The affected watercourses should particularly be monitored for establishment of weeds particularly the invasive *Prosopis glandulosa* (Mesquite) which is highly problematic in this region.

- Adequate monitoring of weed establishment and its continued eradication must be maintained (Appendix B). Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

- No littering must be allowed and all litter must be removed from the site.

- The following mitigation should also be implemented where the road construction will cross over any of the affected watercourses (Table 4) (Appendix A: Map 2):
    - The timeframe for construction through the watercourses should be kept to a minimum.
    - Any disturbance and removal of vegetation within these watercourses should be kept to a minimum.
    - Construction should be limited to the existing road reserve and should not encroach into the adjacent natural areas.
    - The disturbance caused by construction will also cause susceptible conditions for further establishment of exotics. It is therefore recommended that weed eradication be initiated at the construction site prior to construction and continued until rehabilitation of the road reserve has been completed (Appendix B).
    - When excavating through any of the watercourses, the upper 30 cm, or topsoil, should be removed together with the vegetation and stored as sods on the site. These should then be replaced when rehabilitating the construction area.
    - Where topsoil is perceived to be absent, a seedbank will still be present, even if this may only be a few centimetres thick and should still be retained, as this will greatly aid in successful rehabilitation.
    - Subsoil should be used as backfilling and not as top dressing. Only removed sods and topsoil should be utilised to rehabilitate the soil surface.
    - The construction site must be inspected for erosion. This is particularly relevant for the banks and steep slopes of affected watercourses. Where erosion is evident this must be remedied.

- Where steep banks occur and erosion is evidently problematic it is recommended that geotextiles be utilised to stabilise soils. Available options include contouring, berms, gabions and geotextile netting.
- The soil surface should be re-instated to the virgin soil level and not depressed or elevated as this will promote erosion and cause flow barriers. After rehabilitation any excess soil or material should be removed and disposed of at a registered disposal facility.
- The watercourse bed and bank morphology should also be re-instated as far as possible, which will also speed up the stabilisation of the bed and banks.
- Where concrete is utilised the detrimental impacts of uncured cement on watercourses must be taken into consideration.
- Construction within any of the watercourses should preferably be undertaken during the winter months (June to September) when flooding will be unlikely.
- Currently, the extent to which watercourses will be affected by the road construction is not yet known but may include simple maintenance and clearing of culverts, replacing or installation of additional culverts and construction of associated structures (erosion and wingwalls). Once specific designs for each affected watercourse (Table 4, Appendix A: Map 2) have been determined, a Risk Assessment Matrix should be conducted to assess the relevant risk and anticipated impacts associated with the proposed construction activities.

- Monitoring of construction and compliance with recommended mitigation measures must take place.

- The necessary authorisations must be acquired from Department of Water and Sanitation (DWS) for the construction of the water pipeline network that will affect the watercourses in the area (Table 4) (Appendix A: Map 2).

9. References

Bromilow, C. 1995. Problem Plants of South Africa. Briza Publications CC, Cape Town.

Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications CC, Cape Town.

Coates-Palgrave, M. 2002. Keith Coates-Palgrave Trees of Southern Africa, ed. 3, imp. 4. Random House Struik (Pty.) Ltd., Cape Town.

Collins, N.B. 2005. Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.

Conservation of Agricultural Resources Act, 1983 (ACT No. 43 OF 1983) Department of Agriculture.

Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.

Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M. Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. 2015. Identification guide to the Southern African grasses. An identification manual with keys, descriptions and distributions. *Strelitzia* 36. South African National Biodiversity Institute, Pretoria.

Gerber, A., Cilliers, C.J., Van Ginkel, C. & Glen, R. 2004. Easy identification of aquatic plants. Department of Water Affairs, Pretoria.

Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

Germishuizen, G. & Meyer, N.L. (eds) 2003. Plants of Southern Africa: an annotated checklist. *Strelitzia* 14. National Botanical Institute, Pretoria.

Gerber, A., Cilliers, C.J., Van Ginkel, C. & Glen, R. 2004. Easy identification of aquatic plants. Department of Water Affairs, Pretoria.

Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M. & Dallwitz, M.J. 1990. Grasses of Southern Africa. Memoirs of the Botanical Survey of South Africa No. 58. Botanical Research Institute, South Africa.

Griffiths, C., Day, J. & Picker, M. 2015. Freshwater Life: A field guide to the plants and animals of Southern Africa. Penguin Random House South Africa (Pty) Ltd., Cape Town.

Kleynhans, C.J. 2000. Desktop estimates of the ecological importance and sensitivity categories (EISC), default ecological management classes (DEMC), present ecological status categories (PESC), present attainable ecological management classes (present AEMC), and best attainable ecological management class (best AEMC) for quaternary catchments in South Africa. DWAF report, Institute for Water Quality Studies, Pretoria, South Africa.

Kleynhans, C.J. & Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 329/08.

Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical Manual). Joint Water Research Commission and Department of Water Affairs and Forestry Report. WRC Report No. TT 377-08.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L., Nel, J.L., Maherry, A. and Witthüser, K. (2018) Identification, Delineation and Importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater. Report No. TT 743/1/18, Water Research Commission, Pretoria.

Manning, J. 2009. Field Guide to Wild Flowers. Struik Nature, Cape Town.

Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

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

National Environmental Management: Biodiversity Act (10/2004): National list of ecosystems that are threatened and in need of protection. Government Notice 1002 of 2011, Department of Environmental Affairs.

National Environmental Management: Biodiversity Act (10/2004): Publication of lists of critically endangered, endangered, vulnerable and protected species. Government Notice 151 of 2007, Department of Environmental Affairs.

National Water Act (Act No. 36 of 1998). Republic of South Africa.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

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

Raymondo, D. Van Staden, L. Foden, W. Victor, J.E. Helme, N.A. Turner, R.C. Kamundi, D.A. Manyama, P.A. (eds.) 2009. Red List of South African Plants. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.

Roberts, B.R. & Fourie, J.H. 1975. Common grasses of the Northern Cape. Northern Cape Livestock Co-Operative Limited, Vryburg.

SANBI. 2009. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Shearing, D. & Van Heerden, K. 2008. Karoo: South African wild flower guide 6. Botanical Society of South Africa, Cape Town.

South African National Biodiversity Institute (SANBI). 2019. National Biodiversity Assessment 2018: The status of South Africa's ecosystems and biodiversity. Synthesis Report. South African National Biodiversity Institute, an entity of the Department of Environment, Forestry and Fisheries, Pretoria. pp. 1–214.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 2, released on 2018/11/06. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

Van Ginkel, C.E. & Cilliers, C.J. 2020. Aquatic and wetland plants of Southern Africa. Briza Publications, Pretoria.

Van Ginkel, C.E., Glen, R.P., Gordon-Grey, K.D., Cilliers, C.J., Musaya, M. & Van Deventer, P.P. 2011. Easy Identification of some South African Wetland Plants. WRC Report No. TT 479/10.

Van Oudtshoorn, F. 2004. Gids tot Grasse van Suider-Afrika. Briza Publications, Pretoria.

Van Rooyen, N. 2001. Flowering plants of the Kalahari dunes. Ekotrust CC, Lynnwood.

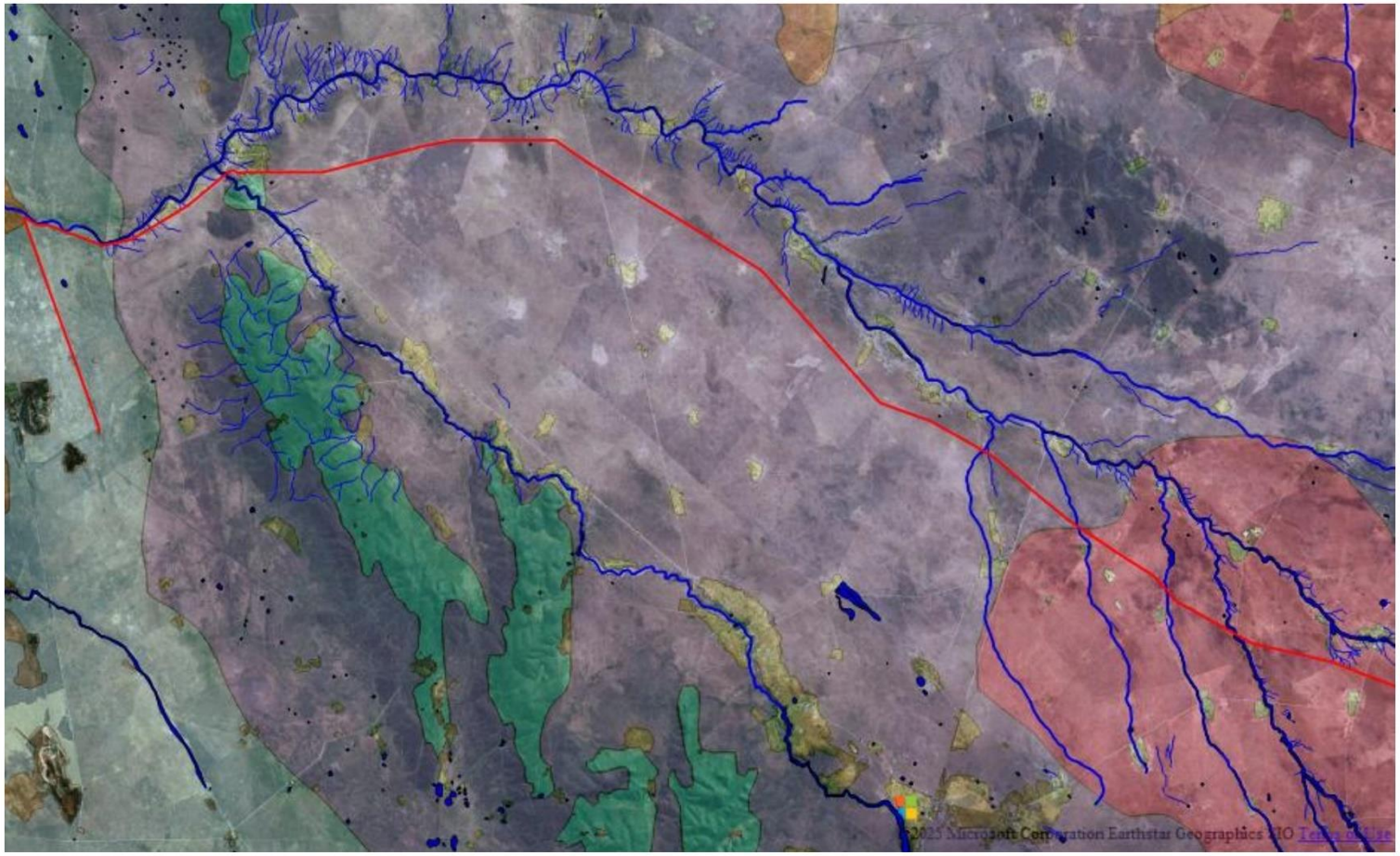
Van Rooyen, N. & Van Rooyen, G. 2019. Flowering plants of the Southern Kalahari. Published by the authors, Somerset West.

Van Wyk, B. & Malan, S. 1998. Field guide to the wild flowers of the Highveld. Struik Publishers, Cape Town.

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

Annexure A: Maps

General ecology map for the proposed upgrading of the road between Ga-Sese and Washington, situated north of Kuruman, Northern Cape Province.



Prepared for:
Environmental Management Group
P.O. Box 28242
Danhof
9310

Legend:

- Road section
- Watercourses
- Wetlands and impoundments
- Kathu Bushveld
- Kuruman Thornveld
- Kuruman Vaalbosveld

Map Information

Spheroid: WGS 84

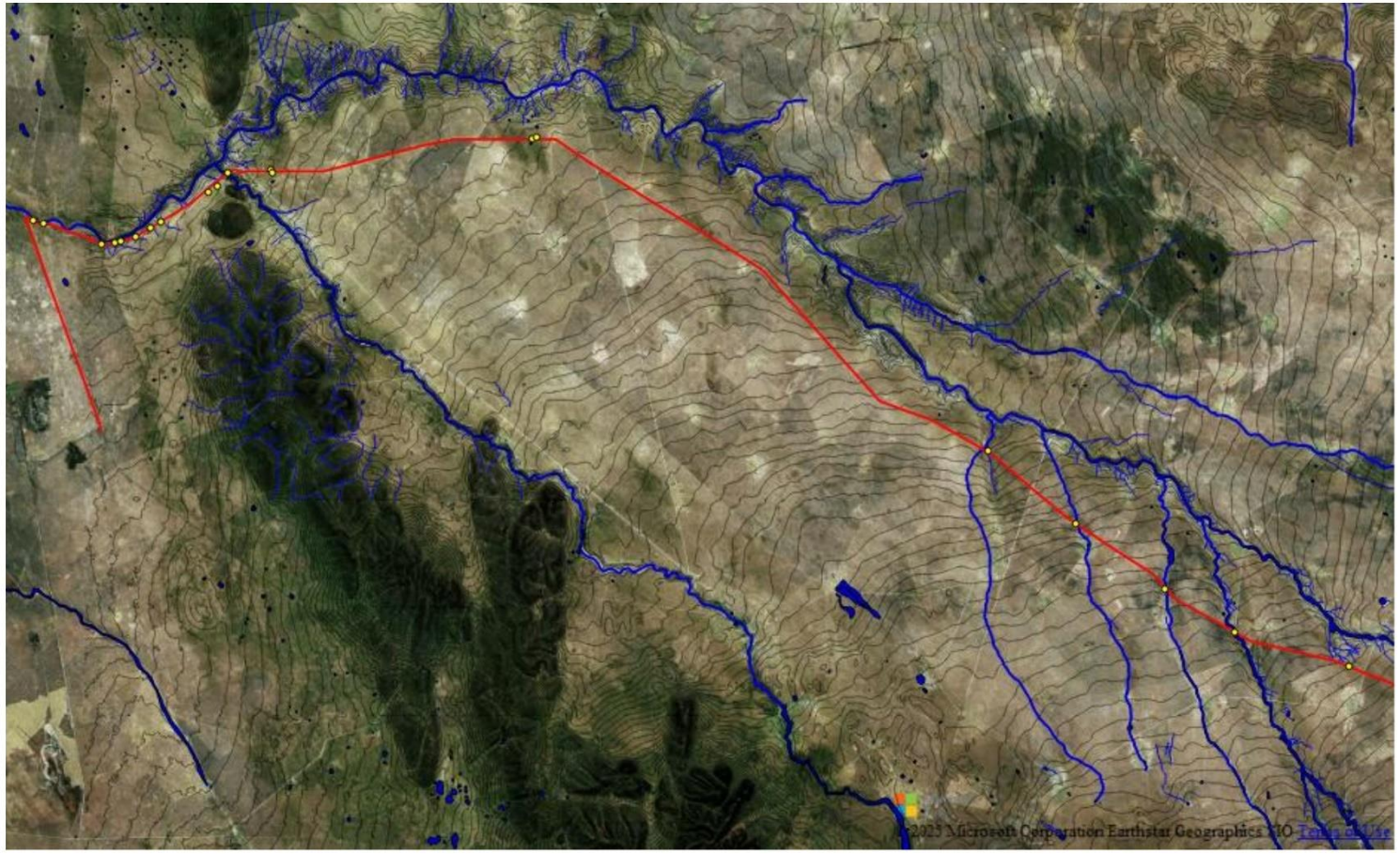
Quantum GIS

Scale: 1:330 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 1: General ecology map of the proposed upgrading of the road section between Ga-Sese and Washington. Portions of remaining natural vegetation is indicated (NBA 2018) and the area is clearly still largely natural. The remaining natural vegetation is however affected by high levels of overgrazing by domestic livestock. The location of watercourses and wetlands along this section are also indicated (NFEPA, NWM 5) which indicates the occurrence of only a few larger watercourses draining from south to north. Due to the flat topography only a limited number of watercourses are present in this area. On-site confirmation and delineation of these watercourses was also undertaken (Map 3).

Watercourse and wetland delineation map for the proposed upgrading of the road between Ga-Sese and Washington, situated north of Kuruman, Northern Cape Province.



Prepared for:
Environmental Management Group
P.O. Box 28242
Danhof
9310

Legend:

- Road section
- Surface contours
- Watercourses and wetlands
- Watercourse crossing point

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:330 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 2: Delineation map of the proposed upgrading of the road section between Ga-Sese and Washington. Due to the flat topography, a few larger watercourses occur that will be affected by the road construction. The Kuruman River forms the main system in this region and it is evident that all affected watercourses form tributaries of it, with the river itself also being crossed in the western section of the road. Other prominent watercourses include the Manyeding and other streams in the eastern section which will also be crossed by the road.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Opuntia ficus-indica*	Succulent
**Prosopis glandulosa*	Tree
Anacampseros filamentosa subsp. *filamentosa*	Succulent
Aptosimum albomarginatum	Dwarf shrub
Aristida congesta	Grass
Aristida sp.	Grass
Berkheya spinosissima	Herb
Berula erecta	Herb
Cenchrus ciliaris	Grass
Colchisum sp.	Geophyte
Cucumis rigidus	Herb
Cyanella lutea	Geophyte
Cynodon dactylon	Grass
Cyperus sp.	Sedge
Diospyros lycioides	Shrub
Enneapogon sp.	Grass
Eragrostis echinochloidea	Grass
Eragrostis lehmanniana	Grass
Euphorbia caterviflora	Succulent
Euphorbia crassipes	Succulent
Euryops subcarnosus	Dwarf shrub
Felicia muricata	Dwarf shrub
Gazania krebsiana	Herb
Geigeria pectidea	Herb
Gnidia polycephala	Dwarf shrub
Grewia flava	Shrub
Gymnosporia buxifolia	Shrub
Helichrysum argyrosphaerum	Herb
Heteropogon contortus	Grass
Imperata cylindrica	Grass
Isolepis sp.	Sedge
Jamesbrittenia atropurpurea	Dwarf shrub
Juncus rigidus	Rush
Kleinia longiflora	Succulent
Ledebouria luteola	Geophyte
Ledebouria sp.	Geophyte
Lobelia thermalis	Herb
Lycium bosciifolium	Shrub
Lycium cinerium	Shrub

Madicago lacinata	Herb
Microloma armatum	Dwarf shrub
Monechma genistifolium subsp. *australe*	Dwarf shrub
Nenax microphylla	Dwarf shrub
Nolletia sp.	Dwarf shrub
Ornithoglossum vulgare	Geophyte
Paspalum distichum	Grass
Pentzia calcarea	Dwarf shrub
Polygala hottentotta	Herb
Prepodesma orpenii	Succulent
Pteronia leucoclada	Dwarf shrub
Ruschia calcarea	Succulent
Salsola sp.	Dwarf shrub
Schoenus nigricans	Sedge
Scirpoides dioecus	Sedge
Searsia lancea	Tree
Senegalia mellifera subsp. *detinens*	Tree
Setaria verticilliata	Grass
Sporobolus ioclados	Grass
Tarchonanthus camphoratus	Shrub
Themeda triandra	Grass
Tulbaghia sp.	Geophyte
Typha capensis	Bulrush
Vachellia erioloba	Tree
Vachellia hebeclada	Shrub
Vachellia karroo	Tree
Ziziphus mucronata	Tree

Appendix C: Soil Samples Methodology

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions in the study area. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result, available oxygen is consumed by microbes and plant roots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions, and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen, they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced, the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components is often the most diagnostic indicator of hydromorphic soils. The colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours in the soil matrix will become.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell). According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Appendix D: Index of Habitat Integrity (IHI)/WET-Health Summary

For the complete IHI/WET-Health results please contact the author of this report.

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Kuruman Road Upgrade
UPPER LATITUDE	S 27.121804°
UPPER LONGITUDE	E 22.975770°
UPPER ALTITUDE	1017 m
LOWER LATITUDE	S 27.338022°
LOWER LONGITUDE	E 23.688924°
LOWER ALTITUDE	1357 m
SURVEY SITE (if applicable)	
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Lower Vaal
QUATERNARY	D41L
ECOREGION 2	29_1
DATE	09/10/2024
RIVER	Kuruman River
TRIBUTARY	Manyeding River
PERENNIAL (Y/N)	**N**
GEOMORPH ZONE	**LOWLAND**
WIDTH (m)	**>15**

	MRU
INSTREAM IHI	
Base Flows	-0.5
Zero Flows	0.0
Floods	-1.0
HYDROLOGY RATING	**0.6**
pH	1.0
Salts	1.0
Nutrients	2.0
Water Temperature	0.0
Water clarity	2.0
Oxygen	1.0
Toxics	1.0
PC RATING	**1.1**
Sediment	2.0
Benthic Growth	1.5
BED RATING	**1.7**
Marginal	1.5
Non-marginal	1.5
BANK RATING	**1.5**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.5**
INSTREAM IHI %	**76.1**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**2.8**

	MRU
RIPARIAN IHI	
Base Flows	-0.5
Zero Flows	0.0
Moderate Floods	-1.0
Large Floods	-1.0
HYDROLOGY RATING	**0.8**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	2.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	1.0
Physico-Chemical (non-marginal)	1.0
Marginal	2.0
Non-marginal	2.0
BANK STRUCTURE RATING	**2.0**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.5**
RIPARIAN IHI %	**70.5**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.7**

Wetland Attributes

The information in this sheet must be captured before continuing with any other aspects of the assessment. Not capturing all the information required will lead to errors in the spreadsheet calculations, which will prevent a final outcome being obtained.

Wetland Name	Manyeding Floodplain
Assessment Unit Name / No.	1
Assessor	DP van Rensburg
Date of Assessment	09/10/2024
HGM Type (Basic)	Floodplain wetland
	FP
HGM Type (Refined)	Floodplain wetland
	FP
Conceptual model	Water and sediment inputs from the topographically defined catchment are assumed to emanate primarily from the catchment upstream of the wetland, with limited lateral inputs. A weighting of 90% is therefore allocated to the assessment of hydrological, geomorphic and water quality impacts in the upstream catchment whereas impacts associated with lateral inputs only contribute 10% to final catchment impact scores.
Wetland size (Ha)	48
Upslope catchment size (Ha)	5560
Quaternary Catchment[1]	D41L
MAR (Mm3)	2.6
MAR per unit area (m3/Ha)	10.0
MAP (mm)	305
PET (mm)	2399
MAP:PET ratio	0.1
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Other
Connectivity of wetland to a regional aquifer	Connected to the regional aquifer, but other sources appear to be dominant
Change in groundwater levels in the regional aquifer	Minor lowering of the water table in the regional aquifer which slightly reduces its contact with the rooting zone in the wetland
Water quality of regional aquifer	Unknown
Channel characteristics (if present)	Poorly deinfed channel with extensive floodplain fed by an artesian fountain, the Manyeding Eye.
Natural wetness regimes	Dominated by permanently saturated soils
Broad vegetation attributes	Dense wetland vegetation, being sustained by a pereniial fountain system. Significant overgrazing is also present due to communal grazing by domestic livestock.
Number of dams in the catchment	0
Average surface area of dams (m2)	0
Perimeter of wetland (m)	6550
Perimeter-to-area ratio (m/ha)	136.5
Down-slope length of wetland (m)	2800
Elevation change over length (m)	14
Longitudinal Slope (%)	0.5%
Propensity to erode (Category)[3]	Low
Propensity to erode (Score)	0.9
Dominant sediment accumulation process	Clastic

WET-Health Level 2 assessment: PES Summary

This worksheet provides an overall summary of the WET-Health Assessment that can be used for reporting purposes

	Wetland PES Summary			
Wetland name	Manyeding Floodplain			
Assessment Unit	1			
HGM type	Floodplain wetland			
Areal extent (Ha)	48.0 Ha			
Unadjusted (modelled) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	5.0	1.4	0.4	4.0
PES Score (%)	50%	86%	96%	60%
Ecological Category	D	B	A	D
Combined Impact Score	3.0			
Combined PES Score (%)	70%			
Combined Ecological Category	C			
Hectare Equivalents	33.8 Ha			
Confidence (modelled results)	tion to regional aquifer but missing information on the degree of connectitivity, the			
Final (adjusted) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	5.0	1.4	0.4	4.0
PES Score (%)	50%	86%	96%	60%
Ecological Category	D	B	A	D
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	3.0			
Combined PES Score (%)	70%			
Combined Ecological Category	C			
Hectare Equivalents	33.8 Ha			

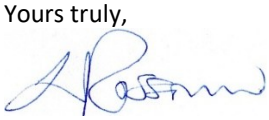
PHASE 1 HERITAGE IMPACT ASSESSMENT FOR A PROPOSED ROAD UPGRADE BETWEEN HOTAZEL, TSINENG AND WASHINGTON TOWNSHIP NEAR KURUMAN, NORTHERN CAPE PROVINCE.

Report prepared for
Environmental Management Group (PTY) Ltd.
15 New Market Road
Bloemfontein, 9301

Report prepared by
L Rossouw BA Hons (US) MSc (Wits) PhD (UFS)
Paleo Field Services
CC Registration Number: 2011/097199/23
12 Piet du Plooy Street
Langenhovenpark, Bloemfontein, 9301
Cell: 0842505992
Email: lloyd@paleofs.co.za
ASAPA Registration No. 122
#rossouwlloyd
www.linkedin.com/in/lloyd-rossouw-33507b69

Specialist Info
Lloyd Rossouw previously led the Archaeology and Florisbad Quaternary Research Departments at the National Museum in Bloemfontein and has more than 30 years of fieldwork experience in South African archaeology and Quaternary palaeontology. He earned a BA degree in Archaeology, completed an Honours programme in Stone Age Archaeology at the University of Stellenbosch, and received training in osteology and Quaternary palaeontology for his MSc at the Bernard Price Institute of Palaeontology (Wits). He also undertook instruction in human anatomy at Duke University in Durham, North Carolina, USA. For his PhD at the University of the Free State, he developed a palaeobotanical method that uses plant silica remains to reconstruct past environmental conditions. His fieldwork includes participation in various excavations and surveys, such as historical built environments and farmsteads (including Keerweder, Zomerlust, Boekenhoutskloof, Bien Donne, Sterhuis, Fredericksberg, Aurora), rock art surveys (Ceres, Vanrhynsdorp, Clanwilliam, Piketberg), industrial projects (coastal section for Mossgas Pipeline Project, Molenaars River crossing for Du Toitskloof Pass Tunnel Project), Stone Age sites (Hoedjiespunt, Klasies River Mouth, Erfkroon, Damvlei, Thyspunt, Sunnyside, Baden Baden, Florisbad, Cornelia), and palaeontological localities (Langebaanweg, Zwartklip, Besaansklip, Boesmansfontein, Spitskop, Cango Valley, Braamhoek, Gladysvale, Taung). He has surveyed and mapped multiple open sites in the central interior region, including the northern Karoo, lower Orange, Vaal, Modder, Vet and Sand River basins as well as the central Makgadikgadi basin.

Declaration of Independence
Paleo Field Services remains financially independent, with no vested interest in project activities or outcomes except for professional fees. Its sole remuneration comes from agreed-upon services for each project. Paleo Field Services accepts client-provided information as accurate.
Yours truly,



February 2025

SUMMARY

A Phase 1 Heritage Impact Assessment was carried out for the proposed upgrade of a ~100 km-long section of partially paved and unpaved road between Hotazel and the Washington township located east of Kuruman, Northern Cape Province. Upgrades, restricted to within ~10 m wide road reserves, are planned for the ~100 km long road section, that starts at the R31 provincial road about 5km east of Hotazel, transecting the Kuruman River, and passing through Ga-Sese and Tsineng to connect with the N14 national road at the Washington township located ~31 km east-northeast of Kuruman. Decades of routine road maintenance—particularly repeated grading and mechanical scraping—have severely degraded the gravel road surface and extensive sections of the associated road reserves. Any archaeological or palaeontological traces that may once have existed within the road or its 10 m-wide lateral reserves have been substantially disturbed or destroyed. Given this extensive prior disturbance, the potential for negative palaeontological impacts on surface limestones, or the thin mantle of geologically recent aeolian sands is assessed as low and does not warrant further mitigation. A palaeontological Chance Find Protocol is included as a precautionary measure for any Quaternary vertebrate fossils that may occur within calcrete or surface limestone deposits at depth. As far as archaeological heritage is concerned, the footprint no longer retains intact archaeological context, and the anticipated impact will have negligible negative effects on heritage resources. The footprint is rated Generally Protected C and the proposed development may proceed provided that all construction activities are restricted to within the boundaries of the demarcated road corridor.

CONTENTS

INTRODUCTION

A Phase 1 Heritage Impact Assessment was carried out for the proposed upgrade of a ~100 km long section of partially paved and unpaved road between Hotazel and the Washington township east of Kuruman, Northern Cape Province (**Fig. 1**). The assessment is required as a prerequisite for new development in terms of the National Heritage Resources Act (NHRA) 25 of 1999. The NHRA identifies what is defined as a heritage resource, the criteria for establishing its significance and lists specific activities for which a heritage specialist study may be required. In this case, the proposed development triggered Section 38(1) of the Act where proposed development includes *(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length.*

DISCLAIMER, ASSUMPTIONS AND LIMITATIONS

Information provided by the Client and/or Environmental Assessment Practitioner (EAP) was assumed to be accurate and complete for the purposes of this assessment. Observations presented in this report are based solely on aboveground visibility of features and outcrops as encountered during field survey. The reliability and completeness of these observations are subject to several inherent limitations:

- Fossiliferous outcrops are often limited to exposed lithologies and may be obscured by colluvium, vegetation, rubble or soil mantling; the degree of weathering affects the preservation and visibility of fossil material, with heavily weathered surfaces

potentially masking fossil content or fragmenting specimens; stratigraphic context is inferred from visible lithologies only; subsurface fossil-bearing horizons may remain undetected without trenching or coring.

- The surface visibility of archaeological remains is variable and may be significantly reduced by vegetation cover, soil accumulation, or recent land disturbance (e.g., ploughing, erosion, construction); subsurface archaeological remains (e.g., buried structures, features, or artefact scatters) may not be detectable without excavation or remote sensing.

METHODOLOGY

Site assessment was conducted in accordance with the National Heritage Resources Act (NHRA) (No 25 of 1999) and SAHRA Minimum Standards for Archaeological and Palaeontological components of Impact Assessment Reports. The site was rated using existing field data, database information and published literature. This was followed by personal observation via foot surveys with access by motor vehicle. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera were used for recording purposes.

Terms of Reference

- Identify and map heritage sites and occurrences using published and database resources.
- Conduct site assessment to determine and assess impacts of the proposed development on heritage resources.
- Recommend mitigation measures to minimize potential impacts associated with the proposed development, if any.

LOCALITY DATA

Map Reference: 1:50 000 topographical maps 2722 BB Hotazel, 2723 AA Tsineng, 2723 AB Matlhwaring and 2723 BC Logaganeng.

1:250 000 geological map 2722 Kuruman.

Section Coordinates (**Fig. 2**):

A) 27°13'3.95"S 23° 0'27.97"E
B) 27° 7'7.16"S 22°58'6.73"E
C) 27° 4'58.56"S 23°14'41.64"E
D) 27°12'14.10"S 23°24'51.82"E
E) 27°17'5.11"S 23°33'29.94"E
F) 27°21'56.81"S 23°43'58.44"E

Upgrades, restricted to within ~10 m wide road reserves, are planned for the ~100 km long road section, that starts at the R31 provincial road about 5km east of Hotazel, transecting the Kuruman River, and passing through Ga-Sese and Tsineng to connect with the N14 national road at the Washington township located ~31 km east-northeast of Kuruman. (**Fig. 2 - 4**).

BACKGROUND

The footprint lies within an outcrop area of Ghaap Group carbonate rocks, consisting of stromatolite-bearing dolomite, dolomitic limestone and chert members that were formed by the precipitation of carbonate rocks when colonies of stromatolites thrived in shallow, tropical marine environments towards the end of the Archaean Eon, around 2.6 billion years ago (*Vgd,* **Fig. 5**) These rocks are capped on places by surface calcretes and Quaternary windblown sand (*Tl, Qs*).

Rock shelters, dolomite terraces and exposed valley floors along the Kuruman River valley, occasionally yield intact and open (surface) Stone Age archaeological assemblages and are also at places decorated with rock engravings that reflect colonial and LSA/Iron Age frontier interaction (**Fig. 6**). Heritage sites found north and west of Kuruman, include Marupeng, Batlharo, Mahakane (rock art) and Ga-Mohana Hill (Stone Age deposits and rock art). Stone wall enclosures in the region include 15th century structures, possibly related to sedentary Khoi groups, and early 19th century BaTlaping stone-walled settlements (e.g. BaTlaping capital at Dithakong, and enclosures at Mothibi).

FIELD ASSESSMENT

The existing road and road reserves are primarily mantled by intact to severely degraded surface limestone and calcretes as well as loose sandy residual soils (windblown sand) resulting from the construction and grading of the existing road (**Fig. 7**). Previous road-building activities have progressively stripped the original gravel horizon, displaced surface gravels laterally into the shoulders and reserve areas which resulted in the reworking of original upper loose sediments and calcrete profiles within the footprint corridor.

There are no indications of *in situ* Stone Age archaeological material, capped or distributed as surface scatters on the landscape. There are also no indications of rock art (engravings), stone-walled structures, graves or historically significant buildings older than 60 years within the boundaries of the footprint corridor (**Fig. 8**).

IMPACT STATEMENT & RECOMMENDATIONS

Potential negative palaeontological impact on Ghaap Group carbonate rocks, surface calcretes and geologically recent windblown sandy overburden is considered low and will require no mitigation (**Table 1**). As far as archaeological heritage is concerned, anticipated impact will have negligible negative effects on archaeological resources and will require no mitigation (**Table 1**). The footprint is rated Generally Protected C (**Table 2**) and the proposed

development may proceed provided that all construction activities are restricted to within the boundaries of the demarcated road corridor.

REFERENCES

Altermann, W. & Schopf, J.W. 1995. Microfossils from the Neoarchaean Campbell Group, Griqualand West Sequence of the Transvaal Group, and their palaeoenvironmental and evolutionary implications. *Precambrian Research* 75: 65-90.

Beukes, N.J. 1983. Stratigrafie en litofasies van die Campbellrand-Subgroep van die proterofitiese Ghaap-Groep, Noord-Kaapland. *Transactions of the Geological Society of South Africa* 83: 141-170.

Beaumont, P.B., 1990. Kathu Pan. In: Beaumont P.B., Morris D. (Eds.). *Guide to the Archaeological Sites in the Northern Cape, McGregor Museum, Kimberley*, pp. 101-134.

Beaumont, P.B., Vogel, J.C., 2006. On a timescale for the past million years of human history in central South Africa. South African Journal of Science 102, 217-228.

Chazan, M., et al. 2012. The Oldowan horizon in Wonderwerk Cave (South Africa): archaeological, geological, paleontological and paleoclimatic evidence. Journal of Human Evolution 63(6):859-66.

Eriksson, P.G., Altermann, W. & Hartzer, F.J. 2006. The Transvaal Supergroup and its precursors. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) *The geology of South Africa*, pp. 237-260. Geological Society of South Africa, Marshalltown.

Helgren, D.M. 1978. Acheulian settlement along the lower Vaal River, *SA. Journal of Archaeological Science* 5: 39 – 60.

Humphreys, A.J.B. 1978. The re-excavation of Powerhouse Cave and an assessment of Frank Peabody's work on Holocene Deposits in the Taung area. *Ann. of the Cape Prov. Museums* (nat. Hist) 2 (12): 217 – 244.

Kuman, K. 2001. An Acheulean factory site with prepared core technology near Taung, SA. *South African Archaeological Bulletin* 56(173&174): 8 – 22.

Maingard, L.F. 1933. The Brikwa and the ethnic origins of the BaTlaping. *South African Journal of Science* 30, 597 – 602.

Morris, D. 1990 Dithakong. In: Beaumont P.B., Morris D. (Eds.). *Guide to the Archaeological Sites in the Northern Cape*, McGregor Museum, Kimberley.

TABLES & FIGURES

Table 1. Impact rating table summarizing potential impacts on a scale of 1 to 4. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude = 6-28 (Low), 29-50 (Moderate), 51-73 (High) and 74-96 (Very High).

Points	Impact significance rating	Description

6 to 28	Low impact	The anticipated impact will have negligible negative effects and will require no mitigation.
29 to 50	Moderate impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
51 to 73	High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of extenuation.
74 to 96	Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".

Context	**Rating Palaeontology**	**Rating Archaeology**
Extent	Site = 1 The impact will only affect the site.	Site = 1 The impact will only affect the site.
Probability of Occurrence	Unlikely = 1 The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).	Unlikely = 1 The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
Duration	Permanent = 4 Mitigation either by man or natural process will not occur in such a way or such a time span prompting an impact that can be considered indefinite.	Permanent = 4 Mitigation either by man or natural process will not occur in such a way or such a time span prompting an impact that can be considered indefinite.
Magnitude	Low = 1 Impact affects the quality and integrity of the resource in a way that is barely perceptible.	Low = 1 Impact affects the quality and integrity of the resource in a way that is barely perceptible.
Reversibility	Completely reversible = 1 Impact is neutral.	Completely reversible = 1 Impact is neutral.
Irreplaceable loss of resources	No loss of resource = 1 The impact will not result in the loss of any resources.	No loss of resource = 1 The impact will not result in the loss of any resources.

Cumulative Impacts	Negligible = 1 The impact would result in negligible to no cumulative effects on resource.	Negligible = 1 The impact would result in negligible to no cumulative effects on resource.
Significance	**Low = 9** The anticipated impact will have negligible negative effects on the resource.	**Low = 9** The anticipated impact will have negligible negative effects on the resource.

Table 2. Description of Field Rating categories as prescribed by SAHRA.

Field Rating	**Grade (NHRA No. 25 of 1999, Section 7)**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation: national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation: provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation: mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A (GP.A)	-	High/medium significance	Mitigation before destruction
Generally Protected B (GP.B)	-	Medium significance	Recording before destruction
Generally Protected C (GP.C)	-	Low significance	Destruction

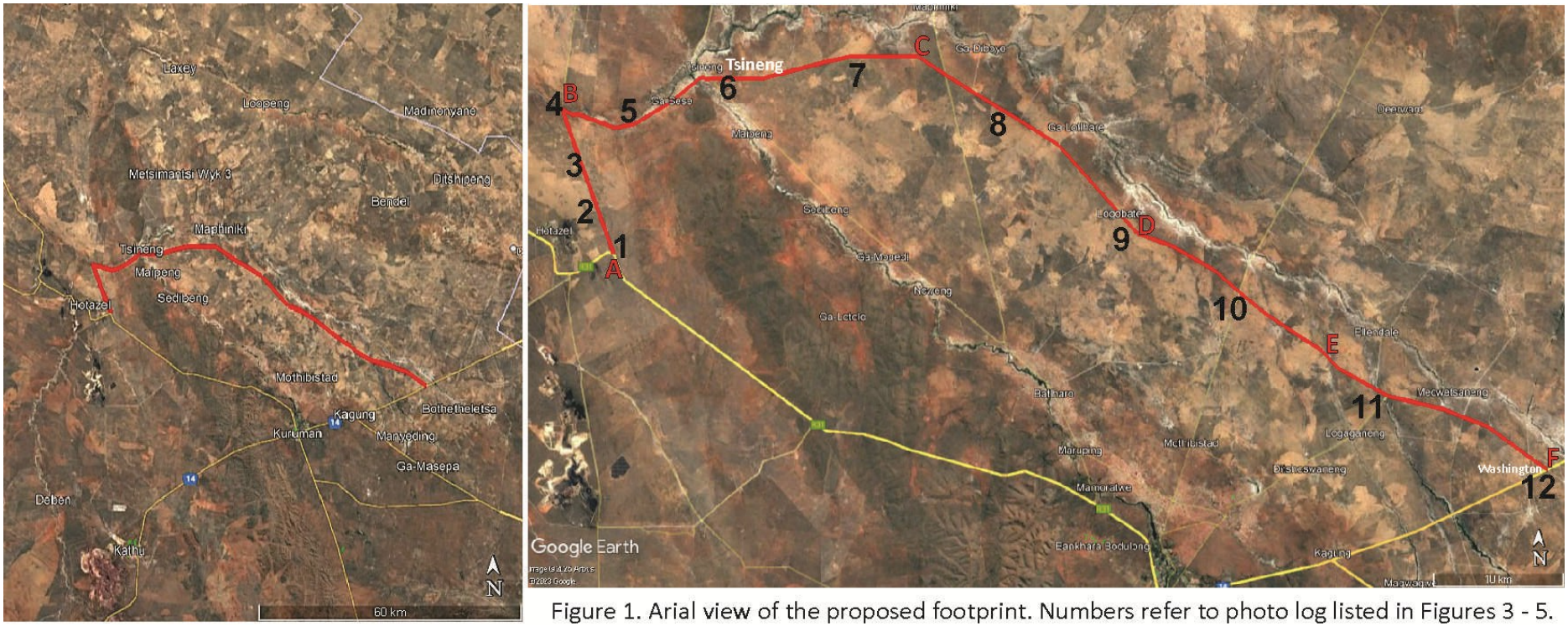


Figure 1. Arial view of the proposed footprint. Numbers refer to photo log listed in Figures 3 - 5.

Figure 2. General view of the start of the section (top) to the Tsineng turn-off (bottom). Site numbers marked on map in Figure 1.

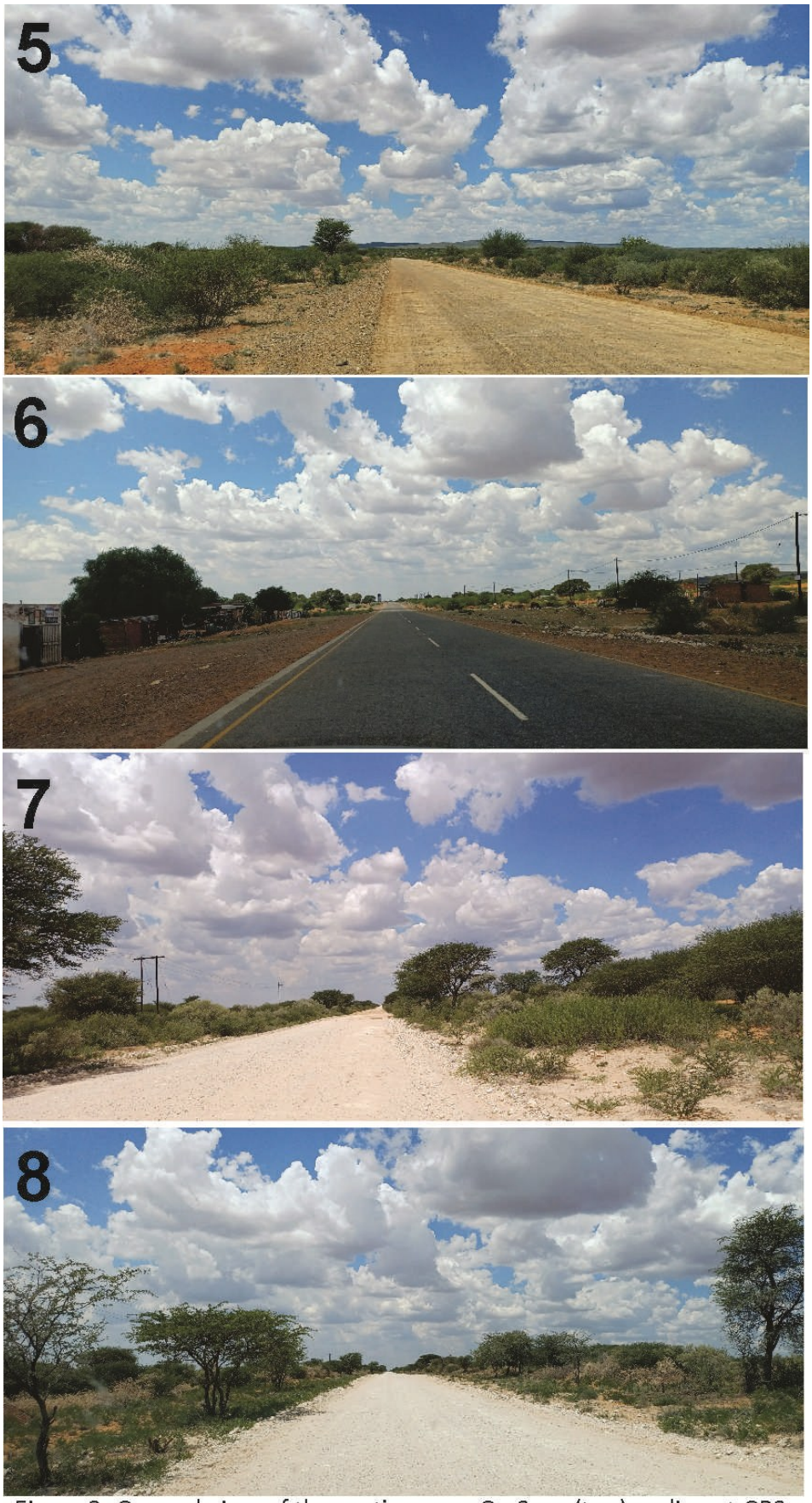


Figure 3. General view of the section near Ga-Sese (top) ending at GPS coordinates 27° 7'5.04"S 23°18'27.63"E (bottom). Site numbers marked on map in Figure 1.

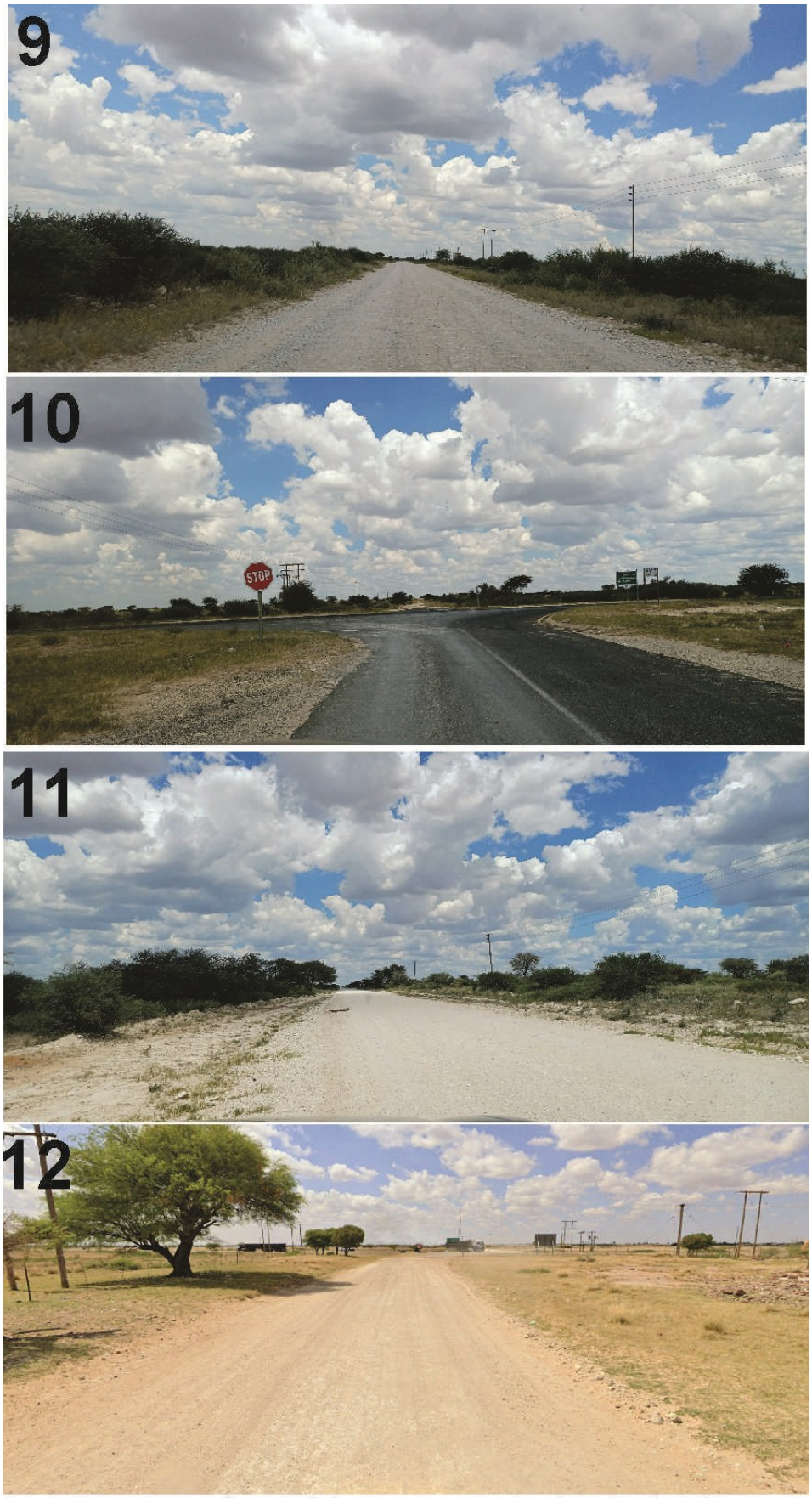
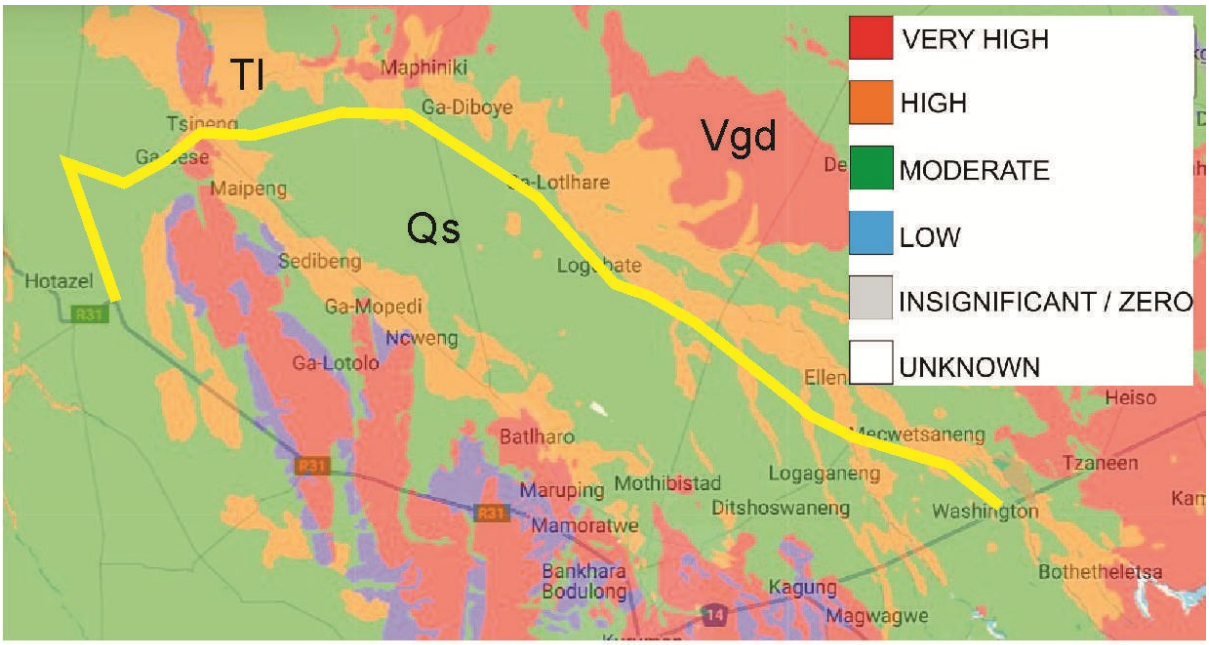


Figure 4. General view of the section near Logobate (top) ending at the Washington township (bottom). Site numbers marked on map in Figure 1.



Symbol	Group/Formation/Period	Lithology
Qs	Quaternary Period	Red to red brown aeolian sand
Tl	Tertiary Period	Surface limestone
Vgd	Vaalian Stage Ghaap Group, Campbell Rand Subgroup	Stromatolite-bearing, dolomitic limestone, interbedded chert

Figure 5. Portion of SHARIS palaeosensitivity map, based on 1:250 000 scale geological map 2722 Kuruman. The proposed development footprint (existing road and road reserves) are primarily capped by severely degraded surface limestone rubble (*Tl*) and residual soils (*Qs*, windblown sand).

Figure 6. Distribution of previously recorded heritage features/sites located between Kuruman and the proposed development footprint (yellow icons).

Figure 7. The road reserves are capped by severely degraded surface limestone rubble and residual soils (windblown sand) resulting from the construction of the existing road

Figure 8. Modern man-made structures situated near or within the vicinity of the road reserves.

APPENDIX 1: PALAEONTOLOGICAL CHANCE FIND PROTOCOL FOR DEVELOPER

Identification of anomalous / irregular shapes or forms within rocks at the site is a first step in recognizing potential fossil remains in the field.

Figure 9. Quaternary vertebrate fossils to look out for in surface limestones / calcretes may resemble cylindrical and elongated, stone-like objects with odd-looking patterns, shapes and surfaces (below).

- Fossil remnants to look out for if excavations are to be conducted into subsurface Quaternary calcretes and surface limestones may resemble modern-looking long bones, horn cores, and teeth (**Fig. 9**).
- If material is significant, a palaeontologist must be able to confirm the finds as soon as possible.
- Newly excavated fossil remains must be stored in a safe place if it is portable. The material should not be washed or cleaned in any way.
- Intact remains must be kept in place and protected from further damage by covering it with a light but rigid object like a box, bucket, or metal sheet if possible and the

area must be avoided by implementing a no-go buffer zone until further confirmation by a palaeontologist.

If material proves to be significant, a Phase 2 rescue operation may be required subject to permits issued by SAHRA. In this case it is advised that the developer should, subject to SAHRA permit approval appoint a professional palaeontologist to remove and transport the fossil material and assist the palaeontologist with the removal of the fossil material.

TERRESTRIAL ECOLOGICAL ASSESSMENT FOR THE PROPOSED UPGRADE OF D3342 NEAR GASESE AND N14 NEAR WASHINGTON, KURUMAN DISTRICT, NORTHERN CAPE PROVINCE

Prepared by: Ms. E Ferreira and Mr. R Nel
E- emma@envmgp.com

E- rnel@envmgp.com
15 New Market Street, Groenvlei, Bloemfontein

Environmental Management Group

February 2025

Specialist investigator: Ms EL Ferreira

BSc. Honours majoring in Botany (Vegetation Ecology and Plant Taxonomy) – University of the Free State (2019)

BSc. Majoring in Botany and Zoology – University of the Free State (2018)

Declaration of independence:

I, the above-mentioned specialist investigator responsible for conducting this particular specialist ecological study, declare that

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report, I did not have any interest, hidden or otherwise, in the proposed development, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part of;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse the proposed development, but aim to present facts, findings and recommendations based on relevant professional experience, and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I have the necessary qualifications and guidance from professional experts (registered Pr. Nat. Sci.) in conducting specialist reports relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity
- This document and all information contained herein are and will remain the intellectual property of Environmental Management Group. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the respective specialist investigator.

Emma Ferreira

Specialist investigator Co-author: Mr R Nel

South African Council for Natural Scientific Professions (SACNASP) in Ecological Science (Cand. Sci. Nat. 144943)

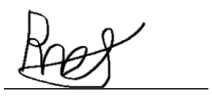
BSc. Honours majoring in Botany (Vegetation Ecology) – University of the Free State (2020)

BSc. Majoring in Botany and Zoology – University of the Free State (2019)

Declaration of independence:

I, the above-mentioned specialist investigator responsible for conducting this particular specialist ecological study, declare that

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse the proposed development, but aim to present facts, findings and recommendations based on relevant professional experience, and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I have the necessary qualifications and guidance from professional experts (registered Pr. Nat. Sci.) in conducting specialist reports relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity
- This document and all information contained herein are and will remain the intellectual property of Environmental Management Group. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the respective specialist investigator.



Ricus Nel

Report Details

Ecological report prepared by:	Emma Ferreira
Report prepared for:	
Locality	Kuruman, Northern Cape, South Africa

Specialist Details/ CV:

Employment date:	2022-Present
Company:	Environmental Management Group (PTY) Ltd.

List of specialist work:

- R. Nel., E.L. Ferreira, 2022. ALIEN INVASIVE VEGETATION ASSESSMENT AND MANAGEMENT PLAN COMPILED FOR SOUTH AFRICAN ROLL COMPANY ON ERF 112, VANDERBIJLPARK NW 7, GAUTENG PROVINCE
- E.L. Ferreira, 2022. ECOLOGICAL ASSESSMENT FOR THE LOGISTICS HUB DEVELOPMENT NEAR KIMBERLEY
- E.L. Ferreira, 2022. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE ENVIRONMENTAL AUTHORISATION FOR A MINING PERMIT REGISTRATION OF A BORROW PIT OUTSIDE STELLA, NORTH WEST
- E.L. Ferreira, R. Nel, 2022. ORANGE RIVER SOLAR FACILITY –ECOLOGICAL ASSESSMENT FOR THE 50 MW PV ORANGE RIVER SOLAR FACILITY
- E.L. Ferreira, R. Nel, 2022. ORANGE RIVER SOLAR FACILITY – ECOLOGICAL ASSESSMENT FOR THE 132 KV TRANSMISSION LINE DEVELOPMENT
- E.L. Ferreira, R. Nel, 2022. TREE HEALTH RISK ASSESSMENT FOR THE PROPOSED ADVENTURE COURSE FOR BOOMRITS ADVENTURES
- E.L. Ferreira, R. Nel, 2022. ALIEN INVASIVE VEGETATION ASSESSMENT AND MANAGEMENT PLAN COMPILED FOR SEVEN DAMS CONSERVANCY, BLOEMFONTEIN, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED TOWNSHIP ESTABLISHMENT ON PORTION 1 OF HOLDING'S 4, 46 AND 47, VYFHOEK AGRICULTURAL HOLDINGS, POTCHEFSTROOM, NORTH WEST PROVINCE
- E.L. Ferreira, 2023. GRASSLAND VEGETATION ASSESSMENT AND MANAGEMENT RECOMMENDATIONS
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM BEERSHEBA RE 13/2, FREE STATE PROVINCE
- E.L. Ferreira, 2024. AMENDED SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM BEERSHEBA RE 13/2, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM JACHTERSFONTEIN RE 61/2, FREE STATE PROVINCE

- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM ROODEKOPJES RE 1050/0, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM ROODEKOPJES RE 1050/1, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM ROODEKRAAL RE 249, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED REGISTERED BORROW PIT ON FARM WAAIPLAATS RE 1048, FREE STATE PROVINCE
- E.L. Ferreira, 2023. SOETVELDE- SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED EXPANSION OF CATTLE FEEDLOT ON RE KLIPPLAATDRIFT 224, VENTERSDORP, NORTH WEST PROVINCE
- E.L. Ferreira, 2023. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED DEVELOPMENT ON FARM SCHMIDTSDRIFT RE 459, NORTHERN CAPE PROVINCE
- E.L. Ferreira, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED EXPANSION OF CATTLE FEEDLOT ON RE HELENA A NO 1385, DENEYSVILLE, FREE STATE PROVINCE
- E.L. Ferreira, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED MINING AREA ON FARM TRIANGLE RE 384, CLOCOLAN, FREE STATE PROVINCE
- E.L. Ferreira, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED MINING AREA ON FARM DE RUST RE 300, SENEKAL, FREE STATE PROVINCE
- E.L. Ferreira, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY VERIFICATION REPORT COMPILED FOR THE PROPOSED FUEL STATION ON ERF 7749, KROONSTAD, FREE STATE PROVINCE
- E.L. Ferreira and R. Nel, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED CATTLE FEEDLOT ON RE DOORNKOP NO 148, PARYS, FREE STATE PROVINCE
- E.L. Ferreira and R. Nel, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED ROAD UPGRADE BETWEEN GA-HOHUWE AND DITHAKONG, NORTHERN CAPE PROVINCE
- E.L. Ferreira and R. Nel, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED ROAD UPGRADE BETWEEN ELLENDALE AND KOKFONTEIN, NORTHERN CAPE PROVINCE
- E.L. Ferreira and R. Nel, 2024. ECOLOGICAL ASSESSMENT FOR THE 132KV TRANSMISSION LINE DEVELOPMENT BETWEEN ORSF 1 (GROBLERSHOOP) AND GARONA SUBSTATION.
- E.L. Ferreira and R. Nel, 2024. SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT COMPILED FOR THE PROPOSED WATER RETICULATION DEVELOPMENT PROJECT, MODUTUNG, NORTH WEST PROVINCE
- E.L. Ferreira and R. Nel 2024. TERRESTRIAL ECOLOGICAL ASSESSMENT FOR THE PROPOSED NEW LANDFILL SITE ON A PORTION OF ERF 1, DIBENG, DEBEN, GAMAGARA LOCAL MUNICIPAL AREA.

Table of contents:

EMG

List of figures:

List of tables:

EMG

1 Executive summary:

The proposed road upgrading is expected to affect roughly 400ha of land directly affected by and directly adjacent to the existing road, D3342 near Ga-Sese and N14 near Washington Northern Cape.

As a linear development, the proposed development passes through the Gordonia Duneveld, Kathu Bushveld, Kuruman Mountain Thornveld, and Kuruman Vaalbosveld vegetation types and their remaining extent.

An ecological survey was performed as part of a Botanical Impact Assessment. The topography of the study area is relatively uniform plains with some undulating hillsides. The vegetation is prominent features of the study area.

The site consists of four vegetation units with varying overall vegetation layer characteristics. Overall, the tree layer is moderately developed in certain areas, while absent in others. The shrub layer is well developed throughout the site. Poor to moderately developed graminoid and herbaceous layers are consistent throughout the study area. The overall vegetation, are good representatives of the vegetation types in which they are located or an ecotone (mix) of adjacent vegetation types (Mucina and Rutherford, 2006; SANBI, 2006-2018; Skowno et al., 2018).

The DFFE screening tool has indicated the floral theme to be of low sensitivity. The known occurrence of one floral SCC (*Drimia sanguinea*) and numerous provincially protected flora in the surrounding vegetation is better associated with a medium floral sensitivity theme. Although this species was found directly within this ecological report's study area the inclusion of this, the supporting evidence has been excluded in the report. Overall the site sensitivity is considered medium.

Anticipated environmental impact evaluation has overall indicated that the development would have a very low anticipated ecological impact. A very low environmental impact was greatly influenced by the proposed developments overall ecological condition and associated disturbances. As per the EIA species guidelines, minimisation mitigation alternatives should be implemented.

2 Introduction:

Ecological infrastructure refers to the natural functioning ecosystems which provide essential services to people. An ecosystem functions as a collective of components, living and non-living, interacting with one another (Wohlitz, 2016). Humans benefit from healthy functioning ecosystems in the utilisation of the services they provide. Ecosystem services include provisioning services (food, raw materials, freshwater), regulating services (climate and air quality, carbon sequestration, water purification), supporting services (habitats and genetic diversity), and cultural services (recreation, tourism and spiritual) (Costanza et al., 1997; Fy et al., 2015; Wohlitz, 2016). Ecosystems can't provide these services when in a poorly functioning, unhealthy state. An ecosystem's health is largely threatened by anthropogenic influences such as habitat fragmentation, pollution and unsustainable harvesting. These anthropogenic activities destabilise ecosystems and will ultimately result in an ecological breakdown, which ultimately raises the costs of living. In terms of biological diversity, South Africa ranks third globally with a high level of endemism (found only in South Africa) (Hoveka et al., 2020). Because of this, South Africa's vegetation is highly localised and experiences a greater threat of extinction. Thus, it is our responsibility to protect South Africa's rich biodiversity.

Despite the seeming homogeneity and low diversity of vegetation, an area may contain endangered and rare species. Red data species presence may make the development unfeasible at that specific location. If this occurs, the project should be moved to an alternative location or cease immediately. Development is a necessity, especially for a developing country such as South Africa. New developments create job opportunities, increase capital growth, and overall create a better country. However, these developments should not come at the cost of pristine ecosystems as they produce invaluable services humans reap for free. For this reason, sustainable development practices should balance the need for development and the conservation of natural resources (Wohlitz, 2016). In a developing country, development is closely linked to electricity generation, transmission and utilization (Akinbami et al., 2021). Renewable energy generation provides the same benefits of sustainable development to the economy (Lekavicius et al., 2019; Akinbami et al., 2021).

2.1 Project Background

The proposed development is located North of Kuruman, from the R31 close to Hotazel, following through to Ga-Sese of the Northern Cape Province. From Ga-Sese the proposed development continues to Washington on the N14. Overall, the proposed development is expected to have a distance of just under 100km and potentially affect 20m on either side of the road's central line. Thus, the study area is 40m wide by 100 km long. In total, the proposed development has an estimated area of 400 ha. However, a fair portion of the area is to be converted to a road reserve and will unlikely be affected by total vegetation clearance. Thus, the proposed development will likely have an expected indigenous vegetation clearance significantly less than the potential 400 ha.

Surveying was performed on two days (26 and 27 November 2025) totalling roughly 12.5hrs in late spring. Surveying thus took place early in the rainy season, which is within the optimal season to perform vegetation surveying

Despite this, the overall species richness observed was low. As a result, the majority of species observed on site are perennial. The diversity of perennial species observed underrepresents the potential diversity of annual and geophytic species which could occur on site. Thus, the number of species observed is an underestimate of the potential number of species that could occur on site.

This report forms part of the Environmental Authorisation Process for the proposed development and will discuss the various potential impacts that could arise given the approved authorisation of the development. The recommendations and mitigation measures generated in this report should be used to minimise the impact of the proposed development.

3 Scope and limitations of the study:

- Evaluating the present ecological functioning of the area within which the proposed development will take place.
- Identifying and assessing possible environmental impacts that the proposed development could generate.

3.1 Scope:

Vegetation-related topics to be investigated include:

- Vegetation type within which the proposed development lies and the importance thereof.
- Assessing the overall ecosystem health in terms of its vegetation with emphasis on the level of disturbance (grazing- and anthropological impacts).
- Identification of the area's species composition with emphasis on dominant-, rare-, threatened[1]- and protected species[2]
- Environmental impacts on terrestrial plant species assessment in terms of site sensitivity verification and terrestrial plant species specialist assessment.

3.2 Assumptions and limitations:

- Not all plants have the same growth and/or flowering period, and thus it is likely that the survey could have occurred outside of the growth and/or flowering period of a specific species.
    - Thus, species diversity and growth form may be skewed towards perennial species.

[1] Any species classified as Critically Endangered, Possibly Extinct (CR PE), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), indicated by the South African Red List categories.
[2] Protected species is any species listed as protected in terms of *Section 56 (1)(d)* of the Biodiversity Act.

    - Thus, true species diversity and richness are assumed to be underestimated.
- Some geophytic and succulent plants have specialised in mimicking their surrounding habitat. Thus, some of these plants might have been overlooked due to their cryptic nature.
- Species of conservation concern (SCC) are generally uncommon and/or localised.
    - Thus, locating such species can be challenging when attempts to locate such species occur outside the SCC's flowering season.
- With ecology being vast, dynamic, and highly complex, some aspects may have been overlooked. However, most floral communities have been accurately assessed and considered. Therefore, the information within this report is considered sufficient to allow informed decision-making to take place.
- Most plant species found in central South Africa experience summer rainfall, which allows for spring growth periods and summer-spring flowering season.
    - Thus, late spring is within the optimal season in which to perform vegetation surveying for this study region.

4 Methodology:

4.1 Literature used for additional information:

- Red Data List (Raimondo et al. 2009).
- Vegetation types (Mucina and Rutherford, 2006; SANBI, 2006-2018).
- Field guides used for species identification (van Wyk and Malan, 1998; Botha, 2001; van Rooyen et al., 2001; Bromilow, 2010; van Wyk and van Wyk, 2013; van Oudtshoorn, 2014; Manning, 2019).

4.2 Survey:

Before visiting the site, a desktop study commenced where the following information was determined:

- Vegetation type.
- Climatic conditions.
- Probable rare- endemic- and protected species[3].
- Relatively homogenous vegetation units in which surveying will commence.
- Probable environmental impacts of the proposed development.
- The iNaturalist website was also consulted to obtain probable species presence as identified by the general public and other specialists.

The survey was performed by means of transects traversed on foot. The use of an unmanned aerial vehicle (UAV) flying at a maximum altitude of 80 m was used to aid the delineation of relatively homogenous vegetation units. Plant species observed

[3] SANBI was consulted prior to the site visit to attain the species names of Rare, threatened and or protected floral species as identified through the DFFE Screening Tool.

were recorded with particular emphasis on rare-, endemic-, protected- and dominant species. Attention was given to the current state of the environment regarding grazing impacts, anthropogenic disturbances, erosion and the presence of alien or invasive species. Observed animal species and evidence of their existence (dung, habitat requirements, excavations, animal tracks, burrows, and nests) were recorded.

4.3 Assessment criteria:

4.3.1 Unit sensitivity assessment

As per the SANBI (2020) Species Environmental Assessment Guidelines, site ecological importance (SEI) was calculated. The fulfilling criteria of the conservation importance, functional integrity and resilience is not an exhaustive list, and the guidelines allow for adding additional, conditional aspects which were not included in the fulfilling criteria. Where the addition of additional, conditional aspects was required, the reasoning for the applicable addition was required to be stipulated.

Conservation importance (CI) concerns the sites' ability to support biodiversity features or species of conservation concern through largely natural processes. CI was calculated using internationally acceptable, recognized and established biodiversity value determination principles and criteria utilized in evaluating conservation importance (IUCN KBA, 2016; SANBI, 2020), as shown in the table below.

Table 1: Criteria that fulfil the requirements for the ratings of conservation importance (CI)

Conservation importance (CI) rating	Fulfilling criteria
Very high	Confirmed or high likelihood of occurrence of SCC with an EOO of <10km^2. and/or Any environment featuring characteristics of a natural habitat of a CR vegetation type or a large area (>0.1% of total vegetation type extent) of natural habitat of an EN vegetation type. and/or Natural habitat featuring a unique combination of biophysical characteristics rarely seen in the surrounding environment. and/or Unusually high occurrence frequency of protected/ endemic species.
High	Confirmed or highly likely occurrence of SCC species with an EOO of >10km^2. SCC must be listed under any criterion other than A. Species with reported occurrences of <10 localities or < 10 000 individuals and/or Small area (>0.01% but <0.1% of total vegetation type extent) of natural habitat of an EN vegetation type or a large area of natural habitat of a VU vegetation type. and/or

	Natural habitat featuring a unique combination of biophysical characteristics and may also occur in the surrounding environment. and/or Any area hosting a unique combination of protected species not occurring in the surrounding environment.
Medium	Confirmed or high likely occurrence of SCC which have been observed in more than 10 locations or more than 10 000 reported mature individuals. and/or Any area of natural habitat of a VU vegetation type. and/or Confirmed species which exhibits a restricted range. and/or >50% of the unit contains natural habitat with potential to support SCC. and/or A fairly high species richness of naturally occurring species. Some protected species may also occur.
Low	No confirmed observations of, or low probability of SCC occurrence. and/or No confirmed observations of, or low probability of species with a restricted range. and/or <50% of unit contains natural habitat with a limited potential to support SCC. and/or Poor to moderate species richness. Some alien and invasive species may occur.
Very low	No confirmed observations of, or very low probability of SCC occurrence. and/or No confirmed observations of, or very low probability of species with a restricted range. and/or Very little to no natural habitat remaining.

Functional integrity refers to the site's ecological condition, where it's able to maintain its structure and functionality with regard to habitat connectivity and pristineness. The

EMG

ecological condition of the vegetation units was determined by considering the remaining functional area, habitat connectivity and level of disturbance which influences the ecological processes of the site.

The ecological functioning of a large, uninterrupted, undisturbed natural area is considered intact and functional with high functional integrity. On the other hand, a small, fragmented, poorly connected, very disturbed site is inhibited and has a very low functional integrity.

Site functional integrity was determined using the fulfilling criteria as tabulated below in Table 2.

Table 2: Criteria that fulfil the requirements for the ratings of functional integrity (FI)

Functional integrity (FI)	Fulfilling criteria
Very high	Very large (>100 ha) intact habitat and/or High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches. and/or No or minimal current negative ecological impacts with no signs of major past disturbance
High	Large (>20 ha but <100 ha) intact area for any conservation status of vegetation type or > 10 ha for EN vegetation type. and/or Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches and/or Only minor current negative ecological impacts (e.g., few livestock utilising area) with no signs of major past disturbance (e.g. ploughing) and good rehabilitation potential.
Medium	Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of vegetation type or > 20 ha for VU vegetation type. and/or Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches. and/or Mostly minor current negative ecological impacts with some major impacts (e.g., established population of alien and invasive flora) and a few signs of minor past disturbance. Moderate rehabilitation potential.
Low	Small (> 1 ha but < 5 ha) area

	and/or Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area. Low rehabilitation potential. and/or Several minor and major current negative ecological impacts.
Very low	Very small (< 1 ha) area. and/or No habitat connectivity except for flying species or flora with wind-dispersed seeds. and/or Several major current negative ecological impacts.

Biodiversity importance concerns the site's ability to support biodiversity features or species of conservation concern with its current ecological condition in terms of functional size, connectivity and level of disturbance. Using the determined conservation importance and functional integrity of the vegetation units, biodiversity importance was determined using the following simple matrix (SANBI, 2020), as seen in table 3 below.

Table 3: Matrix in calculating biodiversity importance (BI) using conservation importance and functional integrity.

Biodiversity importance		**Conservation importance (CI)**				
		Very high	High	Medium	Low	Very low
Functional integrity	Very high	Very high	Very high	High	Medium	Low
	High	Very high	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very low
	Low	Medium	Medium	Low	Low	Very low
	Very low	Medium	Low	Very low	Very low	Very low

Site resilience is the site's natural ability to overcome or recover from negative influences of disturbance without human intervention. A site's recovery to a specified level of restoration with respect to the site's original ecological functionality in an estimated time is the baseline evaluation criteria. Justification of the resilience rating with respect to estimated recovery time was required. Particular disturbances and impacts, as well as the time of year these impacts are expected to occur, are often associated with resilience and were considered (SANBI, 2020).

Site resilience was determined using the fulfilling criteria as indicated below (Table 4).

Table 4: Criteria that fulfil the requirements for the ratings for resilience (R)

Resilience category	Fulfilling criteria
Very high	Habitat that can recover rapidly (~ less than five years) to restore > 75% of the original species composition and functionality of the receptor functionality or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed.
High	Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality or species that have a high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a high likelihood of returning to a site once the disturbance or impact has been removed.
Medium	Will recover slowly (~ more than 1ten years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed.
Low	Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~ less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a low likelihood of returning to a site once the disturbance or impact has been removed.
Very low	Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed.

Site ecological importance (SEI) concerns the site's biodiversity importance in its ability to support biodiversity features or SCC and its natural resilience ability to recover from negative influences.

SEI for each vegetation unit was determined through the simple matrix (SANBI, 2020) below (Table 5) by using the vegetation units' biodiversity importance (CI x FI) and resilience. SEI was determined for each relatively homogenous vegetation unit (VU) and should be used to inform sustainable development practices.

Table 5: Matrix for determining site ecological importance (SEI) using biodiversity importance and resilience

Site ecological importance		Biodiversity importance				
		Very high	High	Medium	Low	Very low
Receptor resilience	Very high	Very high	Very high	High	Medium	Low
	High	Very high	Very high	High	Medium	Very low
	Medium	Very high	High	Medium	Low	Very low
	Low	High	Medium	Low	Very low	Very low
	Very low	Medium	Low	Very low	Very low	Very low

Site ecological importance is specific to the proposed development activities and is not comparable to different proposed development activities (SANBI, 2020). Interpretation of the ratings of site ecological importance in relation to the activities associated with the proposed development is indicated in Table 6 below.

Table 6: Interpretation of the ratings of site ecological importance in relation to proposed development activities

Site ecological importance	Interpretation in relation to proposed development activities
Very high	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation is not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/ unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high-impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact are acceptable, followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact are acceptable, followed by appropriate restoration activities.
Very low	Minimisation mitigation – development activities of medium to high impact are acceptable, and restoration activities may not be required.

EMG

4.3.2 Anticipated environmental impact assessment

Anticipated impacts (section 10) of the proposed development on the receiving environment at the proposed location were determined using the impact assessment and significance evaluation forms which are available in Appendix 1 and 2.

Anticipated environmental impacts of the proposed development on each SCC (section 10.1) were determined as above. Anticipated environmental impacts of the proposed development on the receiving environment were determined for the following components: habitat, indigenous floral and faunal, floral SCC and provincially protected flora.

5 Study area:

The proposed development area is located North of Kuruman, from the R31 close to Hotazel, following through to Ga-Sese of the Northern Cape Province. From Ga-Sese the proposed development continues to Washington on the N14. Overall, the proposed development is located within a 60km radius of North of Kuruman. As the crow flies, the proposed development's starting point is located roughly 50.1 km North West of Kuruman and approximately 5 km South East of Hotazel. As the crow flies, the proposed development's end point is lacted roughly 31.7km North East of Kuruman. As the development is roughly 100km long, the proposed development is expected to influence less than 400 ha of indigenous vegetation.

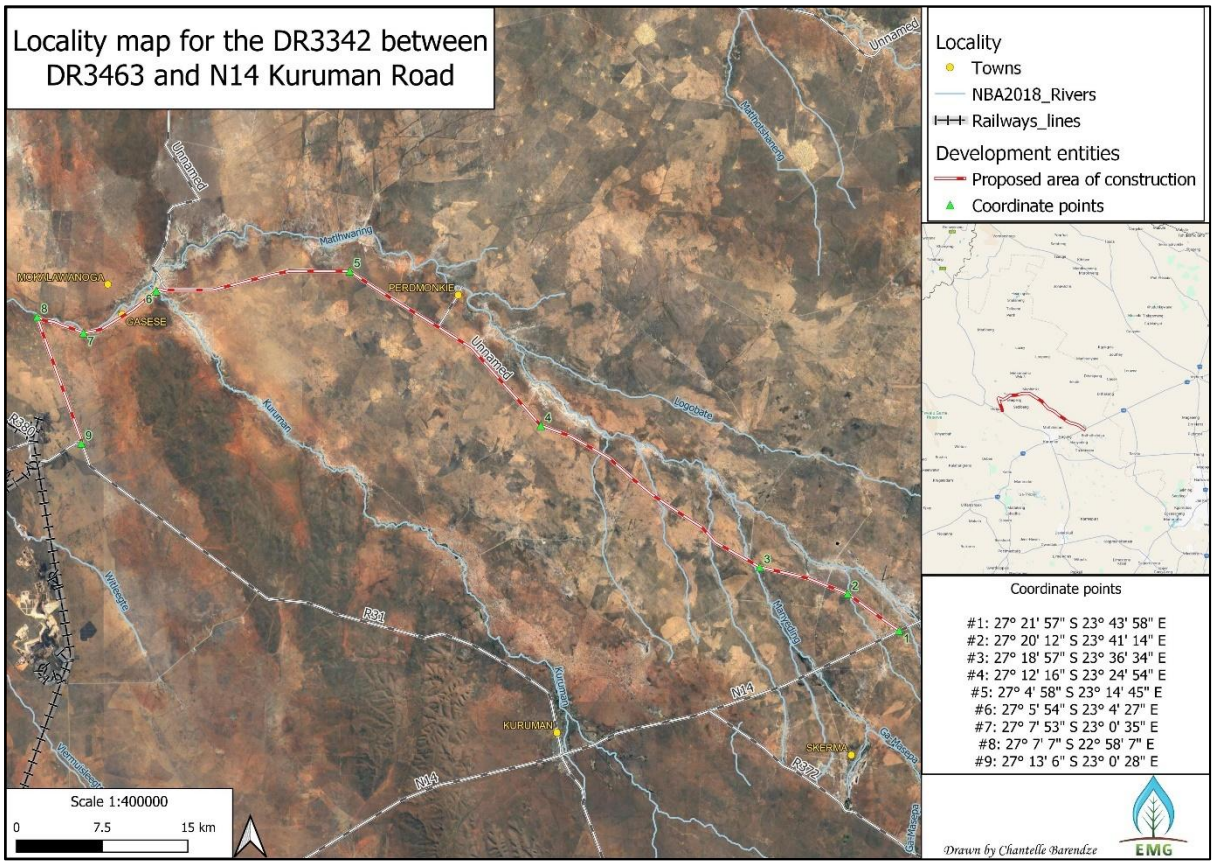


Figure 1: Map indicating the proposed transmission line development site locality which is situated West of Deben.

5.1 The physical environment:

The topography of the study area is fairly uniform plains to undulating hillsides. Over most of the study area, the vegetation is the most prominent features of the landscape.

Altitudes of the different vegetation types through which the proposed development passes range from 800 m a.m.s.l to1800 m a.m.s.l (Mucina and Rutherford, 2006). Overall, the topography of the study area range from 1 010 m a.m.s.l to 1 389 m a.m.s.l. Thus, the altitude of the proposed development is within the overall altitude limits of the regional vegetation types through which the proposed development crosses.

Thus, the physical characteristics of the proposed development is in agreement with that of the various vegetation types.

5.2 Regional vegetation:

The proposed development area is located within the Eastern Kalahari Bushveld bioregion of the Savanna biome. Regional vegetation which the proposed development is located within is the Kuruman Vaalbosveld (SVk8), Kuruman Thornveld (SVK 9), Kuruman Mountain Bushveld (SVk 10), Kathu Bushveld (SVk 12) and the Gordonia Duneveld (SVkd1) vegetation types (Mucina and Rutherford, 2006).

Representative of 32.8% of South Africa's terrestrial vegetation, the savanna biome is the most widely distributed biome within South Africa. The biome is distinctly variable as the herbaceous layer being dominated by graminoids with irregular tree cover. This distinction governed the commonly used term 'bushveld' as the woody component of the savanna often does not form a continuous canopy layer rather forming irregular groupings of vegetation. Six bioregions distinguish the vegetation of the Savanna. These are the (1) Central Bushveld, (2) Mopane, (3) Lowveld, (4) Sub-escarpment Savanna, (5) Eastern Kalahari Bushveld and (6) Kalahari Duneveld. Gordonia Duneveld is described under the Kalahari Duneveld bioregion (Mucina and Rutherford, 2006).

The savanna biome in terms of macroclimate is widely variable, likely due to its widespread nature, the biome does however experience two major climate traits. These traits are seasonal precipitation (wet summers and dry winters) and no (or low) frost occurrences due to its (sub)tropical thermal regime. These traits occur across the savanna biome with variation in the above-mentioned bioregions due to variable such as distance to equator, isotherms effects along coastlines and the thermal continentality effect within the Kalahari region.

The seasonal precipitation of the biome is strongly represented by the wet spring-summers being considered strong rainfalls and the dry winters receiving less than 5 mm of rain per month. When compared to the surrounding grassland the savanna receives relatively less hail and flash density of lightning with variable intensities of surface winds (Mucina & Rutherford, 2006).

Kuruman Vaalbosveld (SVk 8)

The SVk 8 vegetation type occurs between 1 300-1 500 m. The vegetation type experiences a mean annual precipitation (MAP) of 422 mm, majority of which occurs in the late summer-autumn months (January to April) (Mucina & Rutherford, 2006).

The SVk 8 occurs on flat, rocky, sandy plains allowing the vegetation to be a prominent feature. The flat plains are due to the shallow red aeolian sands with underlying rocks forming flat and rocky plains (Mucina & Rutherford, 2006).

The SVk 8 vegetation type is characterized by its open tree layer dominated by *Vachellia erioloba* (Tall tree)*, V.karoo, Searsia lancea* and *Ziziphus murcronata* (Small tree). The shrub and grass layer is poorly developed resulting in many bare patches of soil with interspersed shrubs. These shrubs include *Grewia flava* and

Tarchonanthus camphoratus (dominant tall shrub). The grass layer is dominated by *Anthephora pubescens, Aristida meridionalis, Eragrostis lehmanniana* and *Stipagrostis uniplumis*.

Kuruman Thornveld (SVk 9)

The SVk 9 vegetation type occurs between 1 100-1 500 m. The MAP (Summer and Autumn rainfall) is between 300-450 mm.

The vegetation type occurs on rocky, wind swept, shallow sand which forms rocky pavements in places. The flat rocky plains mean the well-developed shrub and tree layers are prominent features with some sloping hills.

The vegetation consists of a well-developed open tree stratum and closed shrub layer with the former being dominated largely by *Vachellia erioloba*. The small tree is dominated by *Senegalia mellifera* subsp. *detinens* and *Boscia albitrunca*. The tall and low shrubs are dominated by *Grewia flava, Lycium hirsutum, Tarchonanthus camphoratus* and *Vachellia hebeclada* subsp. *hebeclada, Pogonospermum divaricatum* respectively. The grass cover is dominated by *Aristida meridionalis, A. stipitata* subsp. *stipitata* and *Eragrostis lehmanniana.*

Kuruman Mountain Bushveld (SVk 10)

SVk 10 occurs with the altitude of 1 100- 1 800 m and a MAP of 371 mm. The vegetation type receives most of its rain in Summer and Autumn and also receives frequent frost.

The characteristic landforms of SVk 10 are rolling hills which consist of gentle to moderate slopes. These hills contain open shrubveld dominated by *Lebeckia macrantha* and a well-developed grass layer. The vegetation occurs on sandy, shallow soils.

The vegetation consists of open shrubland dominated by the low shrub *Searsia ciliata* and is characterized by *Lebeckia macrantha.* The grass layer is dominated by *Andropogon chinensis, A. schirensis, Anthphora pubescens, Aristida congesta, Digitaria eriantha* subsp. *eriantha, Themeda triandra* and *Triraphis andropogonoides*.

Kathu Bushveld (SVk 12)

The SVk 12 vegetation type occurs between 960-1 300 m. The MAP for the SVk 12 is 300 mm, with the majority of rainfall occurring in late summer-autumn (January to April). Rainfall varies from year to year, but rain occurs distinctly in the wet season, which is from late spring to early Autumn.

Plains are typical landscape features of the SVk 12 vegetation type, which allows the vegetation to be the prominent features of the physical environment. Deep aeolian red sand and surface calcrete soils form the plains which are typical landscape features.

The vegetation consists of medium to tall trees in a mostly open tree layer. The mostly open tree layer consists of tall to medium *Vachellia erioloba* and *Boscia albitrunca* trees. *Senegalia mellifera detinens* dominates the small tree and tall shrub layer along with *Diospyros lyciodes* and *Lycium hirsutum* in the latter. Grass cover is variable, with

Aristida meridionalis, Brachiaria nigropedata, Centropodia glauca, Eragrostis lehmanniana, Schmidtia pappophoroides and *Stipagrostis ciliata* dominating the grass layer.

Gordonia Duneveld (SVkd1)

The SVkd 1 vegetation type occurs between the altitudes of 800- 1 200 m with a mean annual temperature of 18.6°C and a MAP of 120-260 mm. The vegetation type experiences these rains in Summer and Autumn and experiences fairly frequent frost in winter.

The vegetation type occurs on parallel dunes which sit 3-8 m above the plains and is characterized by open shrubland with some occurrences of grassland along the ridges. The dune crests are characterized by *Stipagrostis amabilis* and the dunes slopes are dominated by *Vachellia haematoxylon* with *Senegalia mellifera* occurring on the lower slopes and *Rhigozum trichotomum* in the interdune. The small tree layer is dominated by *Senegalia mellifera* subsp. *detinens* with the tall shrub layer being dominated by *Grewia flava* and *Rhigozum trichotomum.* The grassland is dominated by *Schmidtia kalahariensis* with the herbaceous layer including a dominant *Hermbstaedtia fleckii.*

All the vegetation types through which the proposed development passes, SVkd1, SVK8, Svk9, SVk10 and SVk 12 have conservation statuses of Least Concern (LC).

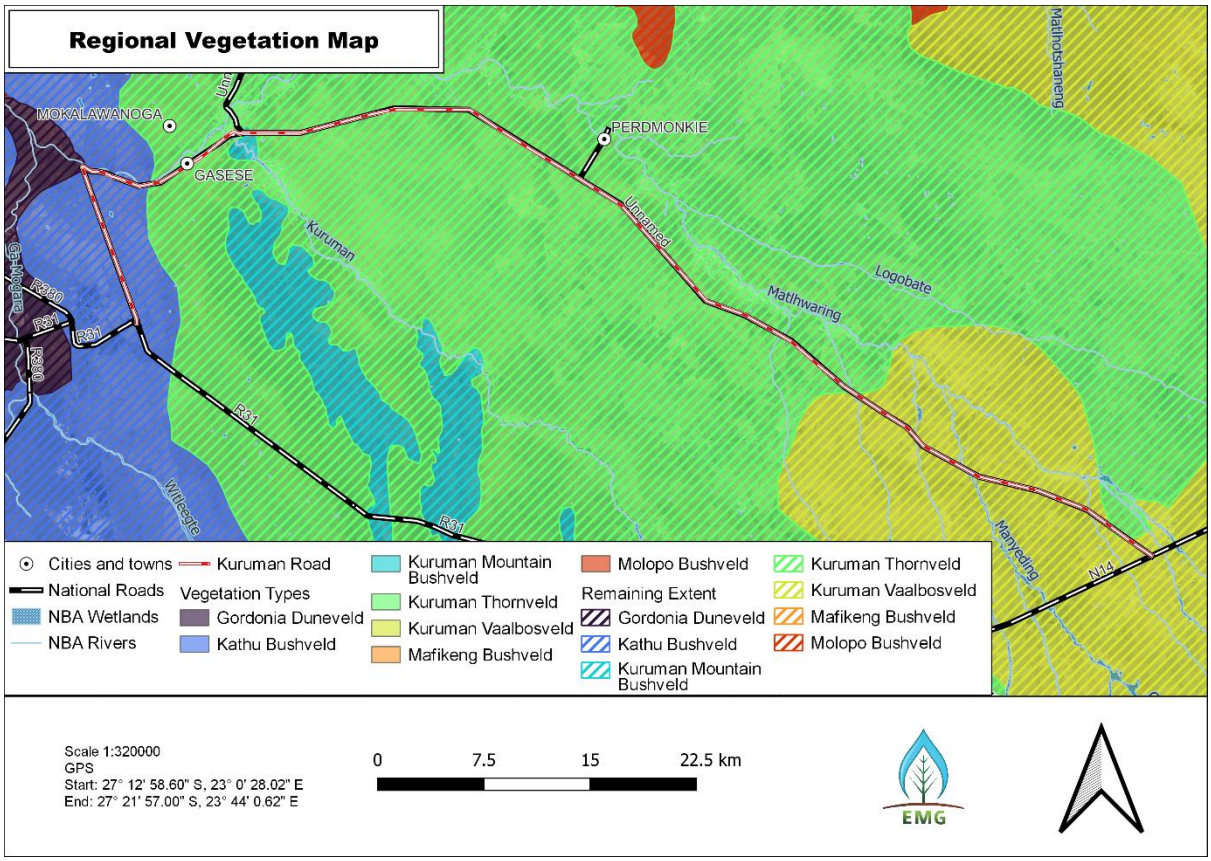


Figure 2: Regional vegetation indicating the site's locality within the Gordonia Duneveld (SVkd1), Kathu Bushveld (SVk 12) Kuruman Mountain Bushveld (SVk10), Kuruman Thornveld (SVk9) and Kuruman Vaalbosveld (SVk8) vegetation type (SANBI, 2006-2018) and the remaining extent thereof.

The study area is located largely in areas classified as Other Natural Areas (ONA's) and Ecological Support Areas (ESA's) and minorly in areas classified as Critical Biodiversity Area 2's (CBA 2's).

Ecological Support Areas (ESA) are areas which are in good, fair or modified ecological condition that serve in ecological functioning. These areas must retain its ecological processing and therefore must maintain at least a fair ecological condition or worsening the current ecological state of the area. Other Natural Areas (ONA) are areas which are in good of fair ecological condition that do not have specific management objectives (SANBI, 2017).

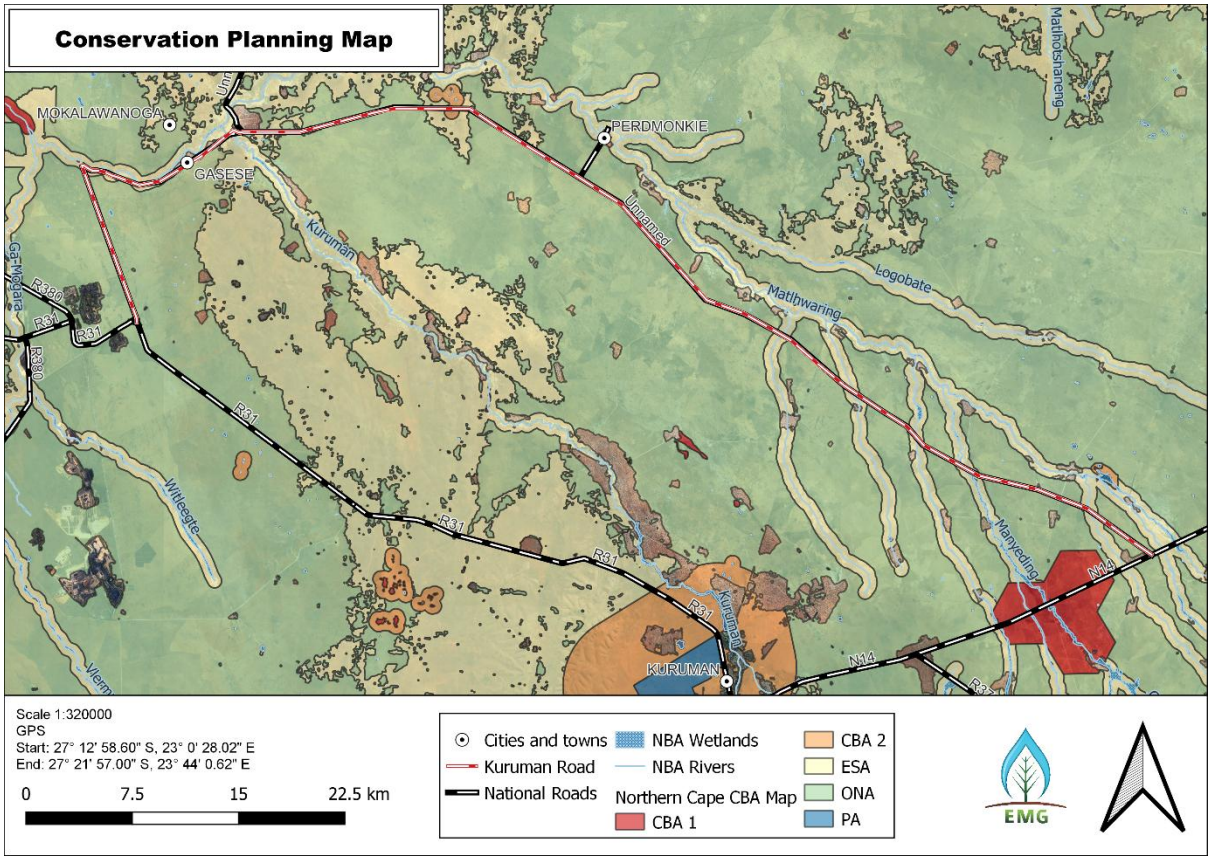


Figure 3: The study area is majorly found in an ONA and ESA area with minor intrusions of CBA 2 areas according to the Northern Cape spatial biodiversity plan (SANBI, 2017).

6 Results:

A comprehensive floral species list is available in Table 16.

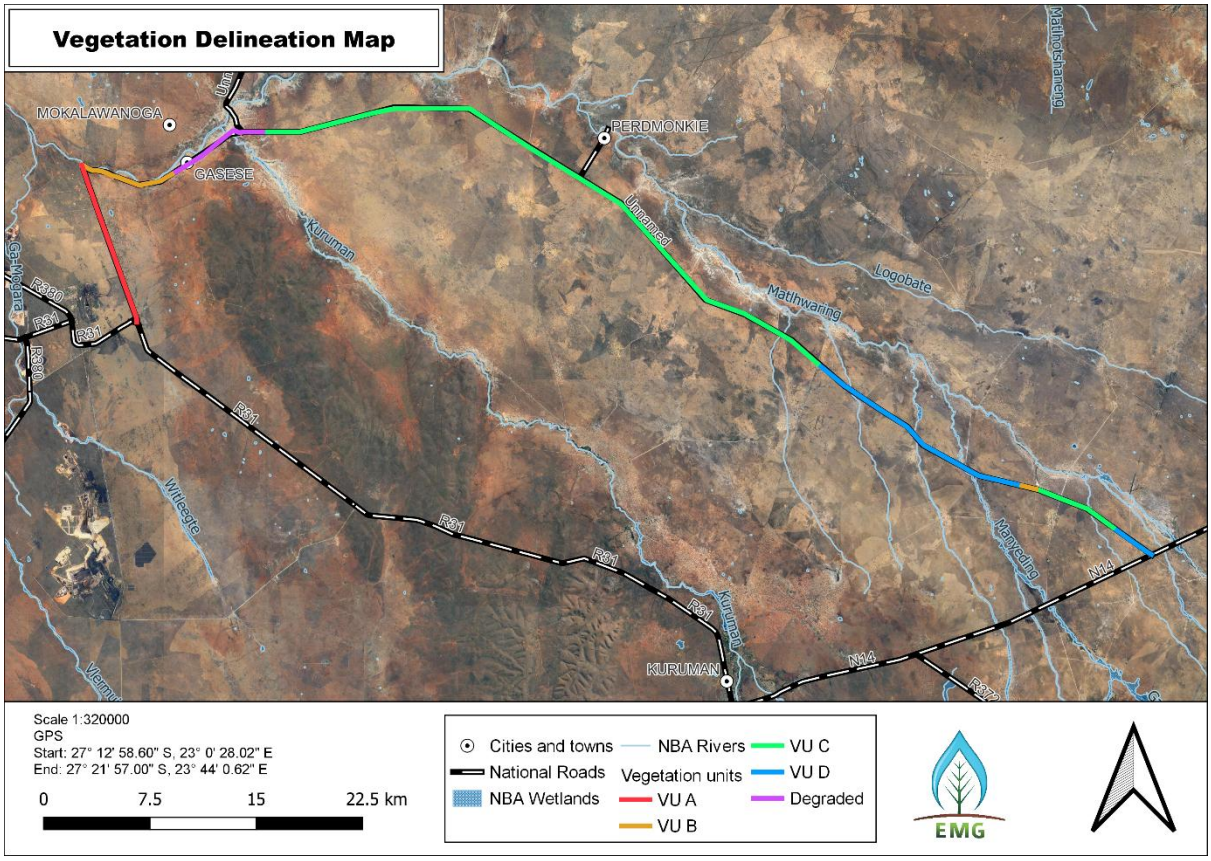


Figure 4 Map indicating the spatial distribution of the homogenous vegetation units (VU's) within the study area. A total of four distinguishable vegetation units can be found within the study area with one degraded area.

As the proposed development traverses nearly 100 km, the vegetation delineation map has been split into 5 for better scale visuals.

6.1 Floral survey:

Overall

Four homogeneous vegetation units were identified within the study area. The vegetation unit delimitation was based on floral homogeneity, vegetation composition distinctiveness and influences of anthropogenic disturbances. Broadly, the study area's vegetation resembles that of an open Kalahari bushveld.

Bare ground and dead vegetation are prominent, patchy features in various areas of the study area. For the majority of the study area, vegetation coverage is fair, with vegetation coverage lower in some areas, while in others, vegetation coverage is high with almost complete canopy cover. Overall, the tree layer is moderately developed in certain areas, while nearly absent in others. The shrub layer is poorly to moderately developed throughout the site. Poor to moderately developed graminoid and herbaceous layers are consistent throughout the study area. Overall the vegetation resembles a dry savanna shrubland. Overall, the different vegetation units align with the vegetation types or ecotones of the vegetation types in which they are found. Some areas are more structurally similar to a vegetation type than compositionally and vice versa.

For all provincially and nationally protected species, the appropriate authority must be contacted with regard to the feasibility of obtaining removal permits for any protected species which would require such a permit should the development be approved. Removal permits for all protected species which will be affected by the development must be obtained before development commences.

6.1.1 VU - A

Vegetation Unit A is found closest to Hotazel, from the R31 along the road to Severn. This vegetation unit resembles the Kathu Bushveld vegetation type (Mucina and Rutherford, 2006).

This vegetations tree layer is well developed and contains many *Vachellia erioloba* and *V. haematoxylon* individuals which form part of the tall tree layer. The tall shrub layer is well developed and dense. The tall shrub layer is dominated by *Senegalia mellifera detinens, Grewia flava, Rhigozum obovatum* and *Neltuma velutina*. The sub-shrub layer is poorly developed with *Senegalia hebeclada*, *Entada elaphantina, Asparagus cf. suaveolens* and *Melolobium candicans* dominated. The herbaceous layer is fairly developed, with *Senna italica, Lasiosiphon polycephalus, Citrullus naudinianus, Cleome angustifolia* dominating. Other herbs observed include *Harpagophyllum sp, Melhannia rehmannii, Helichrysum sp, Pavonia burchellii* and Jamesbrittenia atropurpurea. The grass layer is poorly developed, but scarcely distributed. Dominating graminoids include Stipagrostis cilliata, Enneapogon desvauxii, Aristida congesta, Stipagrostis uniplumis and Eragrostis lehmanniana.

Besides the largely existing tarred road, and existing partial gravel road (previous infrastructure development), several disturbances were noted in this vegetation unit. Cut-stumping of trees and tall shrubs were noticeable. Several illegal dump sites were

recorded. Some illegal dumping of hazardous material (Asbestos) and building rubble also occurring. Grazing goats were encountered. Many tall shrub individuals were dead in certain areas – indicating that the health of the tall shrub layer is negatively influenced by something in the environment. Thus, the ecological functioning of this vegetation unit is likely negatively influenced as well. However, the current ecological functioning of this vegetation unit is considered good. The majority of this vegetation unit is in a natural ecological condition.

Figure 5: A ground view of VU A. The tall shrub layer is well developed and dense. The tree layer is well developed but scattered while the herbaceous layer is fairly to poorly developed.

6.1.2 VU B

This vegetation unit is located east of VU A along the road from VU A to Ga-Sese. VU B is not a good representative of either vegetation types which this VU crosses. However, VU B resembles the Kuruman Mountain Bushveld vegetation type in structure whilst shares more compositional characterisitcs with the Kuruman Thornveld vegetation type.

The tree layer is poorly developed, with few individuals of *Boscia albitrunca* occurring. *Tapinanthus oleifolius* was found as a parasite on the host tree species. The shrub layer is fairly developed, With *Senegalia mellifera detinens, Rhigozum obovatum, Neltuma velutina* and an *Asparagus* sp. dominating. The sub-shrub layer is fairly developed, with *Aptosimum albomarginatum, Pogonospermum australe* and *Caryoxylon aphyllum* dominating. The grass layer is moderately developed, with grasses such as *Stipagrostis uniplumis* and *Stipagrostis cilliata* dominating. The forb layer is poorly developed, with *Barleria rigida, Melhania rehmannii* and *Felecia hirsuta* being dominant. Three succulent species were found in this vegetation unit, *Kleinia longiflora, Aloe hereoensis* and *Opuntia ficus-indica* (spineless).

The ground is scattered with medium-large sized gravel/stones. Where stones lessen, bare ground becomes more prominent. Despite the existing gravel road (previous infrastructure development), few other ecological disturbances were visible. Minor amounts of litter was noticed, with one area having been exposed to illegal dumping of Asbestos products (presumably ceilings). Grazing by horses was observed. Several smaller gravel roads intersect with this vegetation unit. Despite these ecological disturbances, this vegetation unit has good ecological functioning, with a natural to near-natural ecological condition.

Figure 6: Ground View of VU B which has an open tall shrub layer and prominent sub-shrub layer.

6.1.3 VU C

This vegetation unit covers a rather long section of the proposed development. It is found from East of Tsineng to West of Cottonend, where the road turns into a four way which travels North East to Cardington.

This vegetation Unit resembles the Kuruman Thornveld vegetation type.

The tree layer is moderately developed and open, with *Vachellia Erioloba* dominating. Few individuals of *Vachellia haematoxylon, Boscia albitrunca, Searsia lancea* and *Terminalia sericea* were observed in this vegetation unit. The tall shrub layer was well developed, relatively dense with few open spaces. Dominated by *Tarchonanthus camphoratus, Gymnosporia buxifolia* and *Senegalia mellifera detinens*. The sub-shrub layer was poorly developed, with *Rhigozum obovatum* being dominant. The herbaceous layer was moderately developed, with *Senna italica, Hermannia linnaeoides, Pegolettia retrofracta, Felecia hirsuta* and *Helichrysum cerastioides* dominating. *Sansevieria aethiopica, Dicoma macrocephala* and *Melhania rehmannii* were infrequently observed herbs. The grass layer consists of *Eragrostis lehmanniana, Cymbopogon pospischillii, Stipagrostis uniplumis* and *Cynodon dactylon*. Four succulent species were observed infrequently in this vegetation unit, *Kleinia longiflora, Aloe greatheadii*, *Aloe hereroensis* and *Trichocereus spachianus* (NEM:BA category 1b listed AIS).

Vegetation removal was occurring within 10m on either side of the existing gravel road at the time of the survey. Woody and shrubby elements were being removed. The forbs and grasses were left remaining. However, this removal resulted in heaps of vegetative waste. Additionally, dumping was observed frequently in parts of this vegetation unit. Litter was frequently observed throughout this vegetation unit. Some areas of this vegetation unit were affected by agriculture, where grazing of domesticated animals was observed. Erosion was observed in more calcareous areas.

Due to these ecological disturbances observed, the ecological functioning is likely negatively influenced. The ecological functioning is considered fair, with an ecological condition of near-natural to semi-natural.

Figure 7: A ground view of VU C which resembles the Kuruman Thornveld vegetation type.

6.1.4 VU D

This vegetation unit is located South East of VU C, on the Eastern side of the crossways which travels North to Cardington, until 4.1 km west of the Manyeding River. Then again, for the last 3.3 km of the proposed development that starts at Washington (N14).

This vegetation unit structurally resembles an open savannah. Compositionally, this vegetation unit resembles a mix of the Kuruman Vaalbosveld and Kuruman Thornveld vegetation types.

The tree layer is fairly developed, open and sparse. *Vachellia karoo, Vachellia erioloba, Searsia lancea, Ziziphus mucronata, Diospyros lycoides* dominate the tree layer. *Olea europaea africana* is found rarely within the tree layer. The shrub layer is well developed and open. *Tarchonanthus camphoratus, Grewia flava, Ziziphus zeyheriana, Diospyros austro-africana* dominate the shrub layer. Other shrub species observed include *Entada elephantina* and *Gynmosporia polyacantha*. The herb layer is well developed. *Vahlia capense, Nolletia cilliaris, Jamesbrittenia aurantiaca, Helichrysum cerastiodes* dominate the herbaceous layer. Other herbs observed include *Rhynchosia holosericea, Lobelia thermalis, Scabiosa columbaria, Lactuca inermis, Ipomoea bathycolpos, Gazania* sp and *Convolvulus sagittatus.* One succulent species was observed, *Euphorbia inaequilatera*. Four geophytic species were observed, *Boophone disticha, Albuca setosa, Drimia* cf sanguinea (NT) and *Trachyandra* sp. The grass layer is well developed and relatively dense in most areas. *Cynodon dactylon, Stipagrostis uniplumis, Eragrostis lehmanniana, E. trichophora, E. echinocloidea, E. annulata* and *Themeda triandra* dominate the grass layer. Other grasses observed include *Aristida stipitata, Brachiaria serrata*, *Cymbopogon caesius* and *Stipagrostis ciliata*. One sedge species was found, *Afroscirpoides dioeca*.

Despite the existing gravel road, a number of ecological disturbances were recorded in this vegetation unit. Litter and dumping were minimal. Grazing goats and horses were observed. Some infrastructure development (housing) was observed within and near this vegetation unit, influencing the surrounding area through day-to-day anthropogenic movements. Some areas surrounding trees and feeding/watering troughs showed signs of soil compaction and trampling. Some chickens and chicks were observed within close range to the housing. A graveyard was present, bordering slightly within the study area. Some erosion was observed in areas where calcrete was observed. With all these current and ongoing ecological disturbances, the ecosystem functioning is likely negatively influenced. However, the current ecological functioning of this vegetation unit allows for the occurrence of SCC species (*Drimia sanguinea* (NT)). The ecological functioning is considered poor to fair, with an ecological condition of semi-natural.

Figure 8: A ground view of VU D which is structurally an open savanna which is compositionally similar to the Kuruman Vaalbosveld and Kuruman thornveld vegetation types.

7 Sensitivity assessment

Unit sensitivity is calculated according to SANBI's (2020) Species Environmental Assessment Guidelines for site ecological importance (SEI). Unit sensitivity is calculated using resilience (R) and. biodiversity importance (BI), which is calculated as the sum of conservation importance (CI) and functional integrity (FI).

Table 7: Ratings determining the Unit sensitivities for the vegetation units found within the study areas

Vegetation unit	Conservation importance	Functional integrity	Biodiversity importance	Resilience category	UNIT SENSITIVITY
VU A	Medium	Medium	Medium	Medium	Medium
VU B	Medium	High	Medium	Medium	Medium
VU C	Medium	Medium	Medium	Medium	Medium
VU D	Medium	Medium	Medium	Medium	Medium

7.1 Vegetation unit sensitivity

7.1.1 VU A

Was given a low conservation importance rating due to approximately half of the vegetation unit being in a natural ecological condition, with few current and past disturbances. Furthermore, there was no confirmed sighting of SCC and a low likelihood of occurrence. The functional integrity rating of medium was given, as there were few signs of past disturbances such as the gravel/dirt road development and the occurrence of transmission lines and few minor current disturbances such as grazing and illegal dumping. Thus, the biodiversity importance rating is medium. There is a moderate likeliness that species will return to a site post-disturbance due to the large, intact broadscale habitat that allows for migration. Thus, the resilience rating of this vegetation unit was given a resilience rating of medium. Together, the biodiversity importance rating of medium and receptor resilience rating of medium results in a unit sensitivity rating of medium. The proposed development is expected to negatively influence a small area of this vegetation unit.

7.1.2 VU B

Was given a medium conservation importance rating due to the majority of the vegetation unit being in a natural to near natural ecological condition, with few disturbances. Functional integrity rating of high was given, as there were few signs of past disturbances such as the gravel/dirt road development and the occurrence of transmission lines and few minor current disturbances such as grazing and illegal dumping. Thus, the biodiversity importance rating is medium. There is a moderate likeliness that species will return to a site post-disturbance due to the large, intact

broadscale habitat that allows for migration. Thus, the resilience rating of this vegetation unit was given a resilience rating of medium. Together, the biodiversity importance rating of medium and receptor resilience rating of medium results in a unit sensitivity rating of medium. The proposed development is expected to negatively influence a relatively small area of this vegetation unit.

7.1.3 VU C

Was given a medium conservation importance rating due to the vegetation unit having more than 50% natural vegetation remaining. The functional integrity rating of medium was given, as the habitat is good habitat connectivity, but has a busy road network between habitat patches. Furthermore, there were few signs of past disturbances such as the existing gravel/dirt road, infrastructure development and few minor current disturbances such as grazing. Thus, the biodiversity importance is medium. There is a moderate likeliness that species will return to a site post-disturbance due to the large, intact broadscale habitat that allows for migration. Thus, the resilience rating of this vegetation unit was given a resilience rating of medium. Together, the biodiversity importance rating of medium and receptor resilience rating of low results in a unit sensitivity rating of medium. The proposed development is expected to negatively influence a relatively small area of this vegetation unit.

7.1.4 VU D

Was given a medium conservation importance rating due to the confirmed occurrence of a Near Threatened species in a habitat which has more than 50% remaining of the natural vegetation which has shown to be able to support SCC. Functional integrity was given a medium rating due to good habitat connectivity and a busy road network intersecting the habitat patches, as well as the several minor ecological impacts such as grazing and illegal dumping. Thus, the biodiversity importance is medium. The receptor resilience or recovery of this vegetation unit is likely to be medium due to the species composition favouring species with a moderate likelihood to remain during or return post disturbance. Together, the biodiversity importance rating of medium and receptor resilience rating of medium results in a unit sensitivity rating of medium. The proposed development is expected to negatively influence a relatively small area of this vegetation unit.

See the ecological sensitivity map in Figure 9 below.

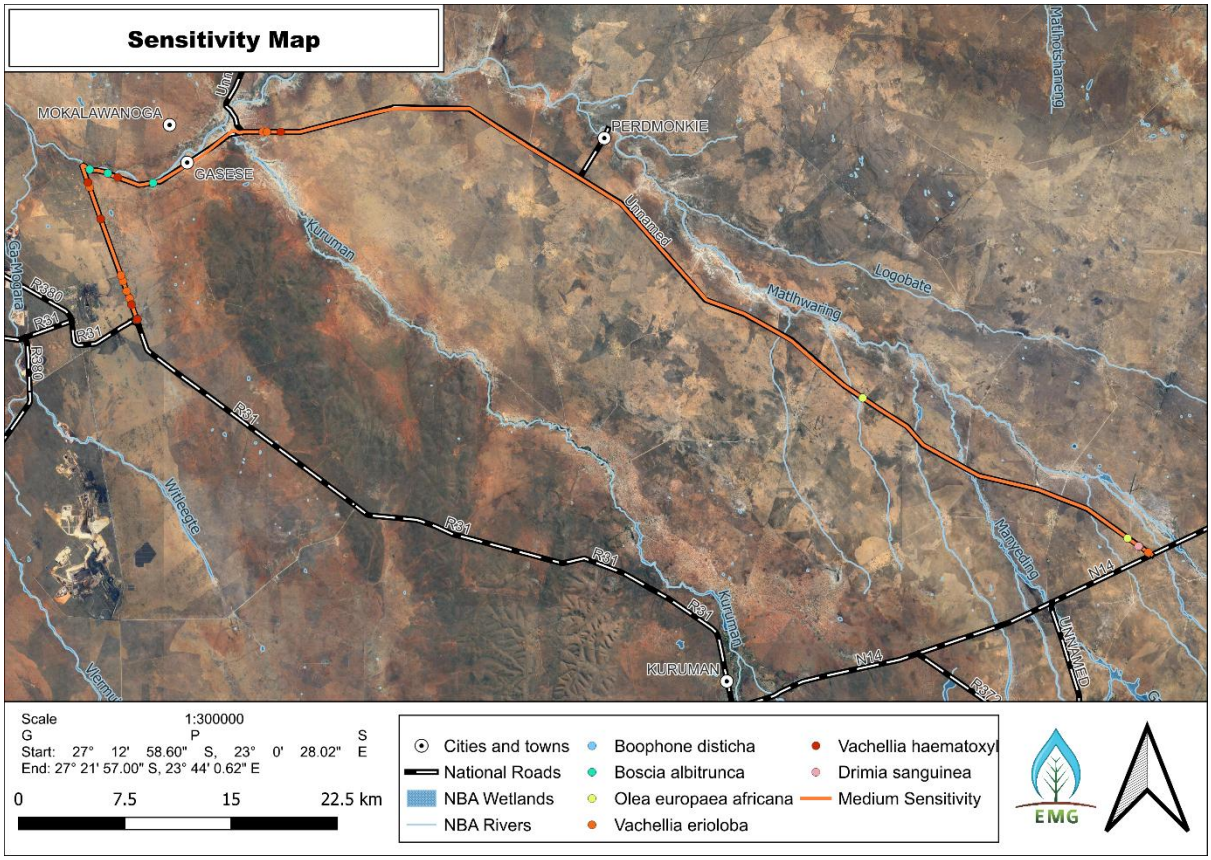


Figure 9: A map of the proposed developments ecological sensitivities.

8 Anticipated impacts:

Overall, the proposed development will directly impact a linear area over four distinguishable vegetation units. Overall, the proposed development is expected to influence less than the potential 400 ha indicated by the size of the road reserve. The following section provides a breakdown of the impacts imposed on the receiving environment due to the development and operation of the proposed development.

Table 8 Summary of anticipated impacts associated with the proposed development. It's important to note that this table is not all-inclusive, but merely provides perspective concerning the types of activities that contribute to the deuteriation of concerned ecological aspects.

Concerned aspect	Activities directly contributing to the concerned aspect	Secondary activities which may contribute to the concerned aspect
Habitat loss	• Physical clearance of vegetation • Habitat fragmentation leading to edge effects • Trampling • Accidental events such as fire • Loss of protected species	• Introduction of alien and invasive species • Soil compaction reducing re-establishment success • Soil erosion • Reduced biodiversity

		• Disrupted general animal behaviour
Loss of CBA and ESA's	• Physical clearance of vegetation • Loss of protected species • Habitat fragmentation • Accidental events such as fire • Increased anthropogenic movement	• Introduction of alien and invasive species • Soil compaction reducing re-establishment success • Soil erosion • Thinning of local genetic diversity • Increased ecological disturbance
Loss of indigenous floral and faunal diversity	• Physical clearance of vegetation • Loss of protected species • Trampling • Habitat fragmentation • Accidental events such as fire, oil spills etc • Unlawful harvesting of plants • Unlawful hunting/ poaching of animals • Road mortalities	• Introduction of unnatural competitors, i.e. alien and invasive species • Reduced fecundity through reduced reproductive ability and success • Reduced survivability • Disrupted general animal behaviour • Disrupted circadian rhythms • Noise pollution (construction phase) •
Loss of floral and faunal species of conservation concern	• Clearance of vegetation • Loss of protected species • Habitat fragmentation • Poaching, unlawful hunting and gathering of plants and animals • Careless and reckless behaviour • Trampling • Accidental road mortalities • Accidental events such as fire	• Thinning of local genetic diversity • Reduced fecundity through reduced reproductive ability and success • Disrupted circadian rhythms • Interruption of lifecycle patterns due to noise pollution.

8.1 Concerned terrestrial ecological aspects:

8.1.1 Habitat loss

Habitat loss and fragmentation is the leading cause of the global biodiversity crisis. The removal of crucial environmental units will lead to the destabilisation of the entire ecosystem and, eventually, ecological breakdown.

This project will result in an overall loss of biodiversity through habitat destruction and reduction of species diversity. Site location across multiple vegetation types, the Kuruman Vaalbosveld (SVk8), Kuruman Thornveld (SVK 9), Kuruman Mountain Bushveld (SVk 10), Kathu Bushveld (SVk 12) and the Gordonia Duneveld (SVkd 1) vegetation types, all of which are of Least Conservation Concern (Mucina and

Rutherford, 2006; SANBI 2006-2018; Government Gazette no. 34809, 2011; Department of Environmental Affairs, 2016). The study area consists of several vegetation units with varying, sparse-moderate overall vegetation layer characteristics.

Relatively large areas of the overall area has experienced direct disturbances in the past. Direct disturbances as a result of the development of the existing gravel/dirt road, daily anthropogenic movements, agricultural activities, infrastructure developments (powerlines etc), illegal dumping of various waste types, alien invasion and few agriculturally based infrastructure developments can be reported. Despite this, a large proportion of the proposed development area has experienced little to no disturbance besides grazing.

Overall, the expected disturbance is expected to influence a relatively small area considering the existing gravel/dirt road requiring little expansion and the upgrading requiring localised areas for equipment and material storage. The expected level of disturbance caused by the proposed development is relatively low, resulting in slight vegetation and habitat transformation within the terrestrial area of the study area. This development will cause loss of habitat with the overall impact thereof on the receiving environment being low. However, the expected low levels of disturbance will only be for if all appropriate mitigation measures are met. The receiving environment's overall landscape is not considered unique regarding vegetation type and broadscale vegetation structure.

The impacts associated with habitat loss are evaluated to be of low significance since the proposed road upgrade is a linear development, which is occurring on existing gravel/dirt roads. Medium to High-intensity developmental practices are recommended and should form a critical part of the Environmental Management Plan. The efficient implementation of the proposed mitigation measures will lower the impact significance on habitat loss. However, **minimisation mitigation** must be implemented (SANBI, 2020).

Table 9 The anticipated impact on habitat loss for fauna and flora during the construction phase. Post-mitigation significance is also indicated.

Construction phase			
Concerned aspect:	**Impact characteristic**	**Pre mitigation**	**Post mitigation**
Habitat loss	Geographical extend	2	1
	Probability	2	1
	Duration	2	2
	Reversibility	2	1
	Cumulative impacts	2	1
	Intensity	2	1

	TOTAL	**20**	**6**
Significance rating		Low	Very Low
General mitigation: • Removal of indigenous flora should be kept at a minimum. • No collection of plants other than for holding for use in rehabilitation is allowed. • Disturbance-related activities may only occur in the authorised area. • Vehicle movement should strictly be kept on designated dirt/gravel roads and/or bypasses. • Soil erosion mitigation measures need to be implemented. • Post-development open/barren areas should be revegetated and kept free of exotic plant species. • Vehicles may only move within the demarcated space of the development area. • Any other relevant recommendations listed in this report should be implemented.			
Operation phase			
Not applicable due to loss of definitive characteristics of habitats in the construction phase. Additionally, no greater impact during operation can occur than those impacts occurring during construction.			

8.1.2 Loss of CBA and ESA areas

According to the Technical Guidelines for CBA Maps, CBA's are areas which must remain largely in a natural ecological condition whilst ESA's require at least semi-natural ecological condition (SANBI, 2017). However, the proposed site does not fully fulfil the requirements of either ESA's or CBA's in terms of ecological condition due to the existing gravel/dirt road.

The loss of CBA and ESA areas for the proposed development is closely associated with the presence of (ephemeral) watercourses, which should be discussed in the Aquatic Specialists report. The proposed development runs adjacent to or crosses these waterbodies. Considering the proposed development's occurrence on top of existing gravel/dirt roads and bordering spaces, the majority of the area to be influenced has previously been negatively affected. As such, the proposed development is likely to have a significantly lessened negative effect of loss of CBA and ESA areas.

Due to this, the anticipated impact on this aspect without mitigation is considered low. Mitigation is necessary and would be easily achieved. After mitigation measures are implemented, the anticipated impact on the loss of CBA and ESA areas is very low.

Table 10: The anticipated impact on Critical Biodiversity Areas and Ecological Support areas during the construction phase. Post-mitigation significance is also indicated.

Construction phase			
Concerned aspect:	Impact characteristic	Pre mitigation score	Post mitigation score
Loss of CBA and ESA areas	Geographical extend	3	1
	Probability	2	1
	Duration	2	1
	Reversibility	2	1
	Cumulative impacts	2	1
	Intensity	2	1
	TOTAL	**22**	**5**
Significance rating:		**Low**	**Very Low**
Recommended mitigation measures:			
General Mitigation: • Limit the removal of vegetation in theseCBA/ESA areas. • Low impact transplanting techniques must be utilised. • Vegetation and topsoil must be kept for use in rehabilitation. • Holding areas for plants must be demarcated and utilised. • Topsoil storage must be prevented from contamination and invasion by alien and invasive species. • General works should, where possible, take place from the edge of the existing road to the side opposite a watercourse. In cases where the watercourses intersect the road, care must be taken to limit the distance across affected by construction activities. • No heavy machinery or material storage should occur on the side closest to a water course or within 100m of a watercourse. • A comprehensive fire management plan needs to be drafted prior to construction • Removal of indigenous flora should be kept at a minimum. • Disturbance related activities may only occur in the authorised area. • No unnecessary clearance of vegetation or topsoil may take place outside of the development area. • No other activity than that authorised may be taken within the authorised area. • Where possible, indigenous vegetation removed from the development area must be transplanted in other neighbouring areas to try and improve or re-establish ecological functioning. • Post-development open areas should be revegetated and kept free of exotic plant species. • Vehicles may only move within the demarcated space of the development area. • Any other relevant recommendations listed in this report should be implemented			
Operation phase			
Not applicable due to loss of definitive characteristics of CBA or ESA areas in the construction phase. Additionally, no greater impact during operation can occur than those impacts occurring during construction.			

8.1.3 Loss of indigenous floral and faunal diversity

Indigenous vegetation has a far greater conservation value compared to exotic species. Indigenous species have adapted to the surrounding environment and have established many stable networks of energy transfer. The removal of indigenous species disrupts this balance that has formed over many years.

Some alien and invasive species were recorded within the study area; however, their occurrences were restricted. The receiving environment's structure and species composition are primarily natural despite the existing gravel/dirt road, with most areas showing signs of few to significant habitat disturbance. Therefore, the construction phase of the proposed development will result in the localized removal of mostly indigenous vegetation and the loss of local floral diversity. During the construction phase of the proposed development, faunal elements will likely migrate to lesser disturbed spaces (broadly available in the area). Due to this, the anticipated impact on this aspect without mitigation is considered very low. Mitigation is necessary and would be easily achieved. After mitigation measures are implemented, the anticipated impact on the loss of floral and faunal diversity is very low.

During the construction and operational phases, the anticipated impact on the loss of indigenous floral and faunal diversity will be of very low significance whether or not mitigation measures are implemented. However, the implementation of mitigation measures is required for minimisation mitigation.

Table 11 The anticipated impact on the loss of indigenous floral and faunal diversity. The impacts were calculated for both the construction and operational phases. Post-mitigation significance is also indicated.

Construction phase			
Concerned aspect:	**Impact characteristic**	**Pre mitigation**	**Post mitigation**
Loss of Indigenous floral and faunal diversity	Geographical extend	2	1
	Probability	2	1
	Duration	2	1
	Reversibility	2	1
	Cumulative impacts	3	1
	Intensity	1	1
	TOTAL	**11**	**5**
Significance rating		Very Low	Very Low
General mitigation: • Development may only occur within the clearly demarked area.			

- Monitoring for the emergence of exotic species should be conducted.
- An alien invasive species management plan must be drafted if the need for such management emerges.
- Vehicle movement should remain within the authorised boundary.
- A comprehensive rehabilitation plan must be adhered to.
- No unnecessary destruction or removal of vegetation is allowed.
- Wildlife elements such as nests and burrows should be carefully inspected, and animals responsibly removed by a relevant specialist.
- Post-development open areas should be revegetated and kept free of exotic plant species.
- Any other relevant recommendations listed in this report should be implemented.

Operational phase

Concerned aspect:	**Impact characteristic**	**Pre mitigation**	**Post mitigation**
Loss of indigenous floral and faunal diversity	Geographical extend	2	1
	Probability	1	1
	Duration	2	1
	Reversibility	2	1
	Cumulative impacts	3	2
	Intensity	1	1
	TOTAL	**10**	**6**
Significance rating		Very Low	Very Low

General mitigation:

- Ensure all construction residue has been removed at the end of the construction phase.
- Ensure the sloping towards the road is smooth/to an acceptable angle.
- An alien and invasive management plan (AIMP) should be developed to avoid the possibility of invasions and supply eradication techniques should they arise in the development area.
- Quarterly alien and invasive species monitoring should take place according to the AIMP.

8.1.4 Loss of floral species of conservation concern

The loss of rare, threatened and or protected species should always evoke a conservative approach regarding land use management. These species have been declared as species of conservation concern due to various population declining factors such as urban expansion, the loss of species-specific symbiotic relationships, innate small population sizes, habitat loss, etc. The further loss of these species should be prevented at all costs.

The proposed development will affect few provincially or nationally protected flora. Certain provincially protected species can be granted a permit for removal or transplant. The DAERL should be consulted on the feasibility of transplanting protected flora. Based on the recommendations of the DAERL, removal or transplant permit applications for all provincially protected flora must be submitted to DAERL.

Boscia albitrunca, *Vachellia erioloba* and *Vachellia haematoxylon*, nationally and provincially protected trees listed as species of least conservation concern, are respectively sparsely distributed and localised in the development area. Removal of this species should be avoided in areas where it has a high density. DFFE removal permits are necessary for the selective removal of this species.

Anticipated environmental impacts on the loss of floral SCC during the construction phase and operational phase is expected to be low. After the efficient implementation of mitigation measures during the construction phase the anticipated impact on the loss of floral SCC is expected to be very Low. Strict mitigation measures are required to lower the overall impact.

Table 12 The anticipated impact on the loss of floral SCC. The impacts were calculated for both the construction and operational phases. Post-mitigation significance is also indicated.

Construction phase			
Concerned aspect:	**Impact characteristic**	**Pre mitigation**	**Post mitigation**
Loss of floral species of conservation concern	Geographical extend	2	1
	Probability	1	1
	Duration	2	1
	Reversibility	4	4
	Cumulative impacts	2	1
	Intensity	2	1
	TOTAL	**22**	**8**
Significance rating		Low	Very Low
General mitigation: Prior to development • A thorough walk-through of the study area by a qualified botanist should occur to locate any potential SCC/protected species. • All staff should be trained on SCC/protected species, observations of SCC/protected species and the reporting procedure. • On-site environmental and health and safety officers must report any observations of SCC/protected species to a qualified botanist and apply the recommended buffer area for that SCC/protected species. • Protected plant species should be located and demarcated.			

- Removal or relocation of the SCC are prohibited without the appropriate permits.
- DAERL should be consulted with regard to the feasibility of transplanting or removing provincially protected species.
- Removal or transplant permits from DAERL must be obtained for all provincially protected flora.
- If DAERL indicates transplant or relocation of some of the provincially protected flora, a formal relocation management plan should be drafted and implemented.

Construction

- The relocation plan should be strictly supervised by a qualified botanist.
- All construction staff should be informed on SCC and protected species or species of special conservation concern.
- A relevant specialist should be notified when any of the mentioned SCC and protected flora are observed during construction.
- All disturbance-related activities must be restricted to the authorised development boundary.
- No illegal harvesting of plant material is allowed.
- Any other relevant recommendations listed in this report should be implemented

Operational phase

Concerned aspect:	**Impact characteristic**	**Pre mitigation**	**Post mitigation**
Loss of floral species of conservation concern	Geographical extend	2	1
	Probability	1	1
	Duration	2	1
	Reversibility	4	3
	Cumulative impacts	2	1
	Intensity	2	1
	TOTAL	**22**	**7**
Significance rating		Low	Very Low

General mitigation:

- Staff should immediately inform the on-site environmental representative and a relevant specialist if any SCC are observed.
- In the case of SCC observations, a GPS co-ordinate and photo must be recorded by the onsite environmental officer and supplied to the associated qualified botanist.
- Vehicle movement should strictly be contained on designated roads. No off-roading must be allowed.
- No harvesting of plant material allowed.
- All damage-causing activities should strictly be restricted to the authorised development area.
- The presence of alien and invasive species needs to be monitored quarterly.
- Any other relevant recommendations listed in this report should be implemented

8.1.5 Overall anticipated environmental impacts

The anticipated environmental impact evaluation indicated that the proposed development's construction phase would have an overall very low impact on the receiving environment. The anticipated environmental impact generated through the

facility's operational phase will have a low impact. Any deviation from the proposed development plan will significantly influence this score. The developer and the appointed contractor should remain mindful of low-impact developmental practices. The recommended mitigation measures should be strongly enforced.

Table 13 Overall anticipated environmental impact pre- and post-mitigation.

Concerned aspect	Score pre-mitigation	Rating pre-mitigation		Score post-mitigation	Rating post-mitigation
Construction phase					
Habitat loss	20	Low		6	Very Low
Loss of CBA and ESA areas	22	Low		5	Very Low
Loss of indigenous floral and faunal diversity	11	Very low		5	Very low
Loss of floral species of special conservation concern	22	Low		8	Very Low
Overall impact:	**18.75**			**6**	
Significance rating:	Very Low			Very low	
Operation phase					
Loss of indigenous floral and faunal diversity	10	Very Low		6	Very Low
Loss of floral species of special conservation concern	22	Low		7	Very Low
Overall impact:	**21**			**6.5**	
Significance rating:	Low			Very Low	

9 Recommendations:

- Limit the removal of vegetation in theseCBA/ESA areas.
- Low impact transplanting techniques must be utilised.
- Vegetation and topsoil must be kept for use in rehabilitation.
- Holding areas for plants must be demarcated and utilised.
- Topsoil storage must be prevented from contamination and invasion by alien and invasive species.
- General works should, where possible, take place from the edge of the existing road to the side opposite a watercourse. In cases where the watercourses intersect the road, care must be taken to limit the distance across affected by construction activities.

- No heavy machinery or material storage should occur on the side closest to a water course or within 100m of a watercourse.
- Prior to development, a thorough walk-through of the study area by a qualified botanist should occur to locate any potential SCC/protected species.
- Protected plant species should be located and demarcated prior to development.
- Removal or relocation of the SCC/protected species are prohibited without the appropriate permits.
- No protected flora may be removed or harmed without the necessary permits.
    - Prior to development, DAERL should be consulted with regard to the feasibility of transplanting or removing provincially protected species.
    - Removal or transplant permits from DAERL must be obtained for all provincially protected flora prior to development.
    - If DAERL indicates transplant or relocation of some of the provincially protected flora, a formal relocation management plan should be drafted and implemented prior to development.
- Notice boards should be erected informing construction workers on floral special of conservation concern and or protected species. A relevant specialist should be notified when any of these species are observed during the construction
- All staff should be trained on SCC/protected species, observations of SCC/protected species and the reporting procedure.
- On-site environmental and health and safety officers must report any observations of SCC/protected species to a qualified botanist and apply the recommended buffer area for that SCC/protected species.
- During development, care should be taken to not unnecessarily clear or destroy indigenous vegetation.
- An alien invasive management plan is a recommended requirement for monitoring the invasion of alien and invasive species found in areas affected by disturbance. Early detection of alien invasion is recommended to lower the development's environmental impact as well as overall project costs.
    - The presence of alien and invasive species needs to be monitored quarterly.
- Vehicle movement should be restricted to the authorised site boundary.
- Excavated topsoil should be kept clean of exotic vegetation.
- Should any fauna become trapped in excavations, a qualified individual must be responsible for their safe relocation and release.
- A designated construction waste/debris area should be placed on site and located as far as possible from sensitive habitats.
- Waste should be removed from the site on a regular basis and not allowed to pile up to start polluting the environment.
- All construction-related waste/material should be appropriately disposed of after the construction has ceased.
- A comprehensive fire management plan should be implemented to prevent any fire outbreaks.

10 Discussion and conclusion:

The site consists of four vegetation units with varying overall vegetation layer characteristics. Overall, the tree layer is moderately developed in certain areas, while absent in others. The shrub layer is well developed throughout the site. Poor to moderately developed graminoid and herbaceous layers are consistent throughout the study area. The overall vegetation, are good representatives of the vegetation types in which they are located or an ecotone (mix) of adjacent vegetation types (Mucina and Rutherford, 2006; SANBI, 2006-2018; Skowno et al., 2018).

The DFFE screening tool has indicated the floral theme to be of low sensitivity. The known occurrence of one floral SCC (Drimia sanguinea) and numerous provincially protected flora in the surrounding vegetation is better associated with a medium floral sensitivity theme. Although this species was found directly within this ecological report's study area the inclusion of this, the supporting evidence has been excluded in the report. Overall the site sensitivity is considered medium.

Anticipated environmental impact evaluation has overall indicated that the development would have a very low anticipated environmental impact. A very low environmental impact was greatly influenced by the proposed developments overall ecological condition and associated disturbances. As per the EIA species guidelines, minimisation mitigation alternatives should be implemented.

11 References:

Bartholomew, J. 1885. Sketch map of South Africa showing British Possessions. Edinburg.

Botha, C.,2001., *Common weeds of crops and gardens in southern Africa*. Potchefstroom, Suid-Afrika: ARC-Grain Crops Institute.

Bromilow, C., 2010. *Problem plants and alien weeds of South Africa*. Briza Publications CC, Cape Town.

Costanza, R., d' Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V.,Paruelo, J., Raskin, R.G., Sutton, P., van den Belt,M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253-260.

Department of Agriculture, Forestry and Fisheries. 1998. National Forest Act., (Act no. 84 of 1998). Government Gazette no 19408 of 30 October 1998.

Department of Forestry, Fisheries and the Environment., 2021. The South Africa protected areas database. South Africa.

Gbif.org. 2022. Global Biodversity Information Facility. Last Accessed on 26/08/2022 at https://www.gbif.org/

Fy, B., Zhang, L., Xu, Z., Zhao, Y., Wei, Y., Skinner, D., 2015. Ecosystem services in changing land use. *Journal of soils and sediments* 15, 833-843.

Hoveka, L.N., van der Bank, M., Bezeng, B.S., Jonathan davies T., 2020. Identifying biodiversity knowledge gaps for conserving South Africa's endemic flora. *Biodiversity and conservation* 29, 2803-2819

IUCN. (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

Manning, J., 2019. *Field Guide to Wild Flowers of South Africa*. Struik Nature, Cape Town.

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

National Environmental Management: Biodiversity Act., 2016. Alien and invasive species list (Act No 10 of 2004). Government Gazette no 40166 of 29 July 2016.

National Environmental Management: Biodiversity Act., 2020. Alien and Invasive species lists, 2020. Government Gazette np 43726 of 18 September 2020.

National Forest Act., 2014. Notice of the list of Protected Tree species under the National Forest Act, 1998 (Act No.84 of 1998). Government Gazette no 38215 of 21 November 2014.

Raimondo, D., Van Staden, L,. Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A., Manyama, P.A., (Eds.), 2009. Red List of South African Plants. Strelitzia 25. South African National Biodiversity Institute, Pretoria..

Skowno, A.L., Raimondo, D.C., Poole, C.J., Fizzotti, B., Slingsby, J.A. 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 1: Terrestrial Realm. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6370

South African National Biodiversity Institute (SANBI).,2006-2018. Vegetation map of South Africa, Lesotho and Swaziland, Mucina L., Rutherford, M.C., Powrie, L.W (Eds), Online, http://bgis.sanbi.org/Projects/Detail/186, Version 2018.

South African National Biodiversity Institute (SANBI), 2010-12. National Red List Categories. Accessed on 2022/07/01 at http://redlist.sanbi.org/redcat.php

South African National Biodiversity Institute (SANBI)., 2017. Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning. First Edition (Beta Version). *South African National Biodiversity Institute*, Pretoria

South African National Biodiversity Institute (SANBI)., 2018. Using CBA Maps to support land-use planning and decision-making. SANBI Factsheet Series. *South African National Biodiversity Institute*, Pretoria.

South African National Biodiversity Institute (SANBI), 2022. Southern African plant names and floristic details. Botanical Database of Southern Africa (BODATSA) [dataset]. doi: to be assigned. Accessed on 2022/09/26 at http://posa.sanbi.org/

Turpie, J., Botha, P., Coldrey, K., Forsythe, K., Knowles, T., Letley, G., Allen, J. and de Wet, R. 2019. Towards a policy on indigenous bush encroachment in South Africa (2019), Department of Environmental Affairs, Pretoria, South Africa

van Oudtshoorn, F. 2014. *Guide to grasses of southern Africa*. Briza publishers, Pretoria.

van Rooyen, N., Bezuidenhout, H., de Kock, E., 2001. *Blomplante van die Kalahari-duineveld*. South African National Biodiversity Institute, Pretoria.

van Wyk, B., Malan, S., 1998. *Field guide to the wild flowers of the Highveld*. Struik Publishers, Cape Town.

van Wyk, B., van Wyk, P., 2013. *Field Guide to Trees of Southern Africa*. Struik Publishers, Cape Town.

Wohlitz, E. 2016. *Bring Nature back to the city: How to conduct urban nature conservation*. Briza publications, Pretoria.

12 Appendices:

12.1 Appendix 1: Impact assessment evaluation form

Table 14 description of the rating system used to evaluate the possible impacts concerned with the proposed development.

Geographical extent: This describes the spatial reach an impact might have.		
Score		
1	Site specific	The impacts will only affect the specific site.
2	Local	The impacts will affect the local area or district.
3	Provincial	The impacts will be recognised across most of the province.
4	International/ national	Will affect the entire country or other countries.
Probability: This describes the probability that a specific environmental impact will occur.		
1	Unlikely	Less than 25% chance of occurrence.
2	Possible	Between 25-50% chance of occurrence.
3	Most likely	50-75% chance of occurrence.
4	Definite	Greater than 75% chance of occurrence.
Duration: This describes the amount of time an environment will be affected by the impact.		
1	Short term	The impact will disappear very quickly, either through mitigation or through natural processes. The impact should have disappeared within 1 year.
2	Medium term	The impact will endure for a short while after the construction processes and will be mitigated by either human intervention or natural processes. The impact should have disappeared between 2-10 years. .
3	Long term	The impact will persist through the construction phase and disappear by either human intervention or natural processes in 10-30 years.
4	Permanent	Mitigation either by man or natural processes is highly unlikely. The impact will have permanently affected the environment.
Reversibility: Describes the potential of an impact to be entirely reversed after development.		
1	Entirely reversable	The impact is entirely reversible and can be achieved with minor mitigation measures.
2	Possibly reversable	The impact might be reversible. Suitable mitigation measures will increase the chances of reversibility and should be considered.
3	Barely reversible	It is unlikely that the impact will be reversed. Extreme mitigation measures might increase the chances of successful reversibility.
4	Irreversible	The impact is irreversible. No mitigation measures can reverse the effects on the environment.
Cumulative impacts: Describes the cumulative impacts of the proposed development, i.t.o. the development process and all activities emanating from the operation of the facility.		

1	Very low cumulative impact	The impact will result in no or minimal cumulative effects.
2	Low cumulative impact	The impact will result in an overall low cumulative effect.
3	Moderate cumulative impact	The cumulative impacts will have moderate levels of impact.
4	High cumulative impact	The cumulative impact will result in high to very high environmental effects.
Intensity: Describes the severity of the impact on the environment		
1	Low	The impact's effect on the system will be hardly noticeable, if at all. Rehabilitation measures have to be in place if required.
2	Medium	The impact will have a recognisable effect on the environment. However, system functionality will still be present with negligible effects on ecosystem integrity. Rehabilitation measures have to be in place.
3	High	The impact will severely affect ecosystem integrity and function. Rehabilitation will be costly, and extreme mitigation measures have to be in place.
4	Very high	The impact will result in the entire ecological breakdown of the system or components thereof. Rehabilitation will be costly with minimal chances of success. Extreme mitigation measures must be in place.

12.2 Appendix 2: Impact significance on the environment

12.2.1 Appendix 2A: Impact significance evaluation:

Impact significance describes the overall environmental impact resulting from the cumulation of impact characteristics. Significance gives a judgement of the effect a development will have on the environment. Significance is calculated as the total score for each criterion (geographical extend + probability + duration + reversibility + cumulative impacts) multiplied by the intensity. A greater significance score results in an overall greater environmental impact and should be avoided or allowed with extreme mitigation measures in place. A lower significance score results in an overall lesser environmental impact and may be allowed with very little or no mitigation measures needed.

Table 15 impact significance evaluation form

Score	Impact significance rating	Description
5-19	Very low	Impact significance is of a very low order. Development is acceptable
20-34	Low	Impact significance is of a low order, and development is acceptable.
35-49	Moderate	The impact will be recognisable and may pose a problem to the development.
50-64	High	The impact is substantial and will significantly affect the environment. Development is unacceptable.
65-80	Very high	The impact is of the highest possible order and will cause irrefutable damage to the environment. Development unacceptable.

Appendix 3: Species list

12.3 Appendix 3A: Plant species

Provincially protected species are coloured orange and species listed as nationally protected species are indicated in red. Specially protected species (NCCA schedule 1) are indicated in pink. The appropriate authority must be contacted with regards to the feasibility of obtaining removal or relocation permits for these species should they be influenced by the development. Based on the appropriate authorities' recommendations, the applicable permits for these species must be obtained prior to any developmental activity. Alien species are indicated in blue.

Table 16 Plant species recorded during the field survey

Family	Species	Indigenous	Ecological status
Acanthaceae	*Barleria rigida*	indig	
	Pogonospermum australe	indig	
Amaranthaceae	*Caroxylon aphyllum*	indig	
	Boophone disticha	indig	
Anacardiaceae	*Searsia lancea*	indig	
Asparagaceae	*Asparagus suaveolens*	indig	
	Drimia fasciata	indig	
	Drimia cf sanguinea	indig	Nationally Protected (TOPS)
Asphodelaceae	*Aloe hereroensis*	indig	
	Aloe greatheadii	indig	
Asteraceae	*Gazania cf krebsiana*	indig	
	Kleinia longiflora	indig	
	Nolletia cilliaris	indig; end	
	Felicia hirsuta	indig; end	
	Helichrysum cerastioides	indig	
	Helichrysum sp.	indig	
	Tarchonanthus camphoratus	indig	
	Lactuca inermis	indig	

	Tarchonanthus camphoratus	indig	
Bignoniaceae	*Rhigozum obovatum*	indig	
	Rhigozum brevispinosum	indig	
Cactaceae	*Trichocereus spachianus*	notindig; cult; nat; inv	AIS
	Opuntia ficus-indica	notindig; cult; nat; inv	AIS
Capparaceae	*Boscia albitrunca*	indig	Nationally Protected (NFA)
Celastraceae	*Gymnosporia polyacantha*	indig; end	Provincially Protected (NCNCA Schedule 2)
Cleomaceae	*Cleome angustifolia*	indig	
Combretaceae	*Terminalia sericea*	indig	
Convolvulaceae	*Convolvulus sagittatus*	pres	
	Ipomoea bathycolpos	indig; end	
Cucurbitaceae	*Citrullus naudinianus*	indig; end	
Cyperaceae	*Afroscirpoides dioeca*	Indig	
Dipsacaceae	*Scabiosa columbaria*	indig	
Ebenaceae	*Diospyros lycioides*	indig; end	
	Diospyros austroafricana	indig; end	
Euphorbiaceae	*Euphorbia inaequilatera*	indig	
Fabaceae	*Entada elephantina*	indig	
	Melolobium candicans	indig	
	Neltuma velutina	notindig; nat; inv	AIS a. 1b in Eastern Cape, Free State, North-West and Western Cape. b. 3 in Northern Cape. c. The utilisation of the pods for fodder is not listed in the Northern Cape, Eastern Cape, Free State, North-West and Western Cape. d. Not listed elsewhere.
	Otoptera burchellii	indig	

	Senegalia mellifera	indig	
	Senna italica	indig	
	Vachellia erioloba	indig	Nationally Protected (NFA)
	Vachellia hebeclada	indig; end	
	Vachellia haematoxylon	indig; end	Nationally Protected (NFA)
Hyacinthaceae	*Albuca sp*	indig; end	
Lobeliaceae	*Lobelia thermalis*	indig	
Loranthaceae	*Tapinanthus oleifolius*	indig	
Malvaceae	*Grewia flava*	indig	
	Hermannia linnaeoides	indig; end	
	Melhania rehmannii	indig	
	Pavonia burchellii	indig	
Oleaceae	*Olea europaea africana*	indig	Provincially Protected (NCNCA Schedule 2
Pedaliaceae	*Harpagophytum procumbens*	indig	Nationally Protected (TOPS)
Poaceae	*Stipagrostis ciliata*	indig	
	Enneapogon desvauxii	indig	
	Aristida congesta	indig	
	Stipagrostis uniplumis	indig	
	Eragrostis annulata	indig	
	Eragrostis lehmanniana	indig; end	
	Enneapogon desvauxii	indig	
	Cynodon dactylon	indig	
	Themeda triandra	indig	
	Eragrostis trichophora	indig	
	Aristida stipitata	indig	
Rhamnaceae	*Ziziphus zeyheriana*	indig	
	Ziziphus mucronata	indig	
Ruscaceae	*Sansevieria aethiopica*	indig	
Scrophulariaceae	*Jamesbrittenia atropurpurea*	indig	Provincially Protected (NCNCA Schedule 2)

EMG

	Aptosimum albomarginatum	indig; end	
	Jamesbrittenia aurantiaca	indig	Provincially Protected (NCNCA Schedule 2)
Thymelaeaceae	*Lasiosiphon polycephalus*	indig; end	
Vahliaceae	*Vahlia capensis*	indig; end	