Appendix D:
Specialists Reports

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

Terrestrial Impact Assessment

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

SITE SENSITIVITY AND TERRESTRIAL ECOLOGY COMPLIANCE STATEMENT REPORT

COMPILED FOR THE PROPOSED UPGRADE OF SENDING WASTE WATER TREATMENT WORKS IN ONSEEPKANS, NORTHERN CAPE .

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January 2026

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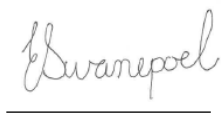
Declaration of independence:

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.



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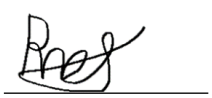

Ricus Nel

Table of Contents

Executive summary:

A upgrade of the Sending Waste Water Treatment Works (WWTW) Facility is proposed within a 5.2 km radius of Onseepkans (N of Pofadder), Northern Cape. The proposed development requires environmental authorisation in terms of the National Environmental Management Act (Act No. 10 of 1998), 2014.

According to the DFFE screening tool, the proposed development area falls within an area with Medium sensitivity for the plant species theme and Very High sensitivity for the terrestrial biodiversity theme. This report found the site to be of medium sensitivity for the site ecological importance sensitivity. However, it found the impacts of the proposed development to be very low. Thus, a terrestrial biodiversity compliance statement is required.

The vegetation on site is in fair ecological condition, with only minor current ecological disturbances. The area where the Existing WWTW is located is severely degraded due to past major ecological impacts, including the development of the existing WWTW. As such, the site is found to be in fair ecological condition and exhibits low species richness.

The vegetation of the proposed development is sparse and, in some places, severely degraded, with several native species remaining. The vegetation observed on site shares compositional and structural similarities with the Eastern Gariep Plains Desert vegetation type. Thus, the vegetation on site agrees with the vegetation type description (Mucina and Rutherford, 2006). Additionally, it was found that the vegetation is a good representative of the habitat; however, this region is at risk of further contamination from the waste-disposal facility to its east/north. Furthermore, as the existing WWTW is located within the study area, it is the most suitable place for the proposed WWTW upgrade. Therefore, it is recommended that the study area be exempted from the classification as an ESA area.

One nationally and two provincially protected flora species were observed within the proposed development area. No floral SCC were observed within the proposed development area. Despite no confirmed occurrences of these SCC species, some may occur in areas unaffected by disturbances. However, the likelihood remains low.

The study area's ecological sensitivity is medium, which disagrees with the DFFE screening tool's terrestrial biodiversity sensitivity theme of very high. However, the environmental impact assessment in terms of habitat and floral components is expected to be very low, with or without mitigation measures. Thus, the commencement of the proposed development is not expected to have a significant negative impact on the site environment. However, these influences will be permanent, and care must be taken to minimise the long-term environmental impact of the development.

1. Introduction:

1.1. Project background:

The proposed upgrade of the Sending Waste Water Treatment Works (WWTW) Facility is located on Portion 0 of Farm Onseepkans 88. The proposed development upgrades will additionally include the vegetation clearance of an area highlighted for the cultivation of a Date Palm Orchard.

The proposed site is located within a 5.2km radius of the Onseepkans border crossing, approximately 5.15 km, as the crow flies, southwest of Onseepkans and approximately 39.9km northwest of Pofadder in the Northern Cape.

Surrounding broadscale vegetation is largely natural, but barren. Within the study area, the land has previously been influenced by development and daily anthropogenic activities. The land has experienced waste disposal, alien invasions and domesticated animal grazing.

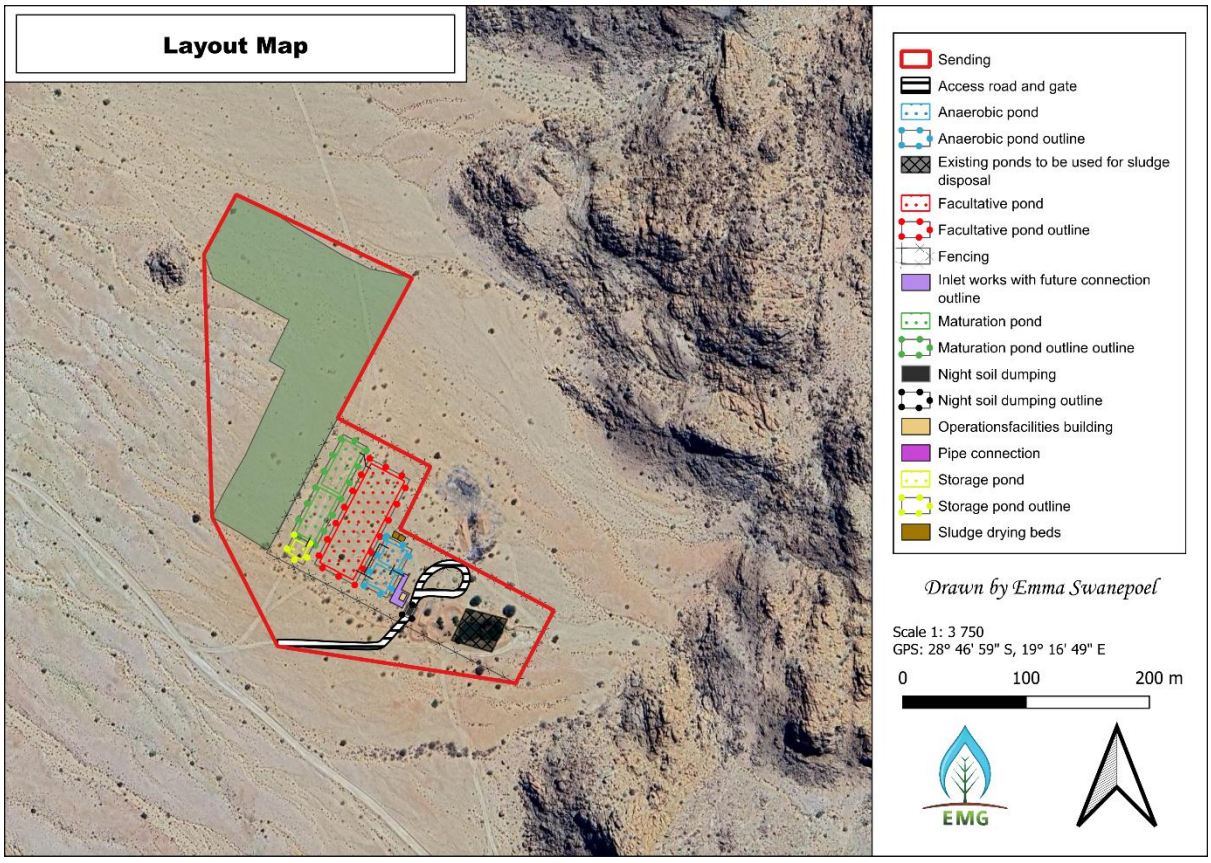

Figure 1: Layout map of the proposed upgrading of a Waste Water Treatment Works (WWTW) Facility development.

1.2. Terms of reference:

In accordance with the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2017, a site sensitivity verification has been undertaken to confirm the current land use and

environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).
Procedures and minimum criteria to be met in the site verification have been reported on in accordance with the Procedures for the Assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, When applying for Environmental Authorisation (GNR 320, 20 March 2020) as amended by the Amendment to the protocols for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal and plant species in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998 (GNR 3717, 28 July 2023).

Table 1Protocols for Terrestrial Biodiversity reports: determine report type based on area sensitivity to meet minimum requirements.

Protocols for Terrestrial Biodiversity specialist reports determination through area sensitivity.				
Theme sensitivity rating	Very High	Low	"Very High" found to be Medium or Low	"Low" found to have higher sensitivity
Applicable reporting type	Terrestrial Biodiversity Specialist Assessment	Terrestrial Biodiversity Compliance Statement	Terrestrial Biodiversity Compliance Statement	Terrestrial Biodiversity Specialist Assessment

1.3. Historical land use:

Historically, the proposed development has been largely natural (Figure 2a and 2 b). Figure 2 contains aerial photographs of the approximate study area region dating to 1941 (a), where the land and its surroundings remain largely untransformed and barren, and 2017 (b), where the existing WWTW development can be seen along with a few dirt roads and the agricultural land to the south.

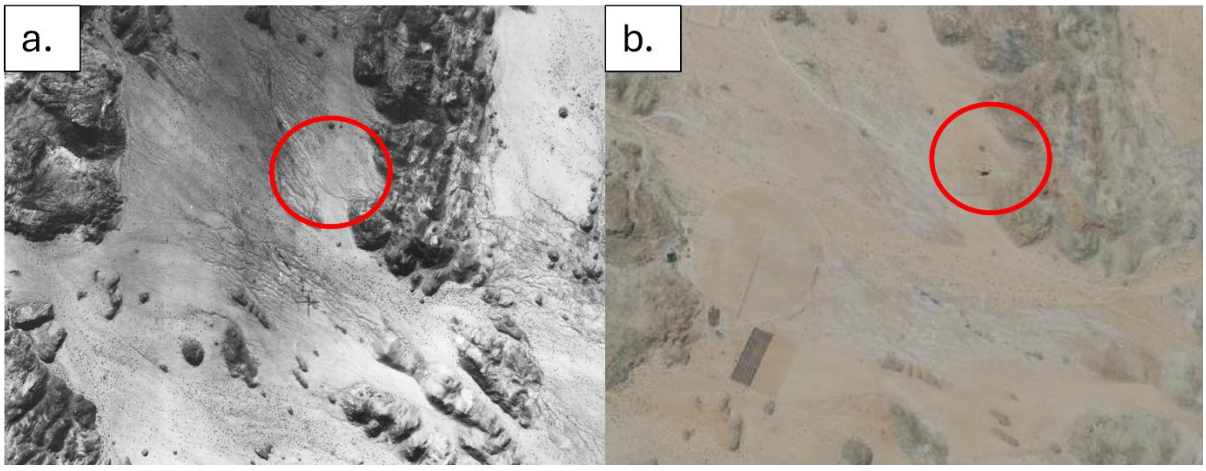

Figure 2: Location and approximate size of the study area throughout history. a). aerial view in 1941. b) and an aerial view in 2017.

1.4. DFFE screening tool identified theme sensitivities:

According to the DFFE screening tool, the proposed development area falls within an area with medium sensitivity for the plant species theme and very high sensitivity for the Terrestrial Biodiversity theme.

The DFFE screening tool highlighted the following sensitive features under the plant species theme: Species 144. The presence of these sensitive species is subject to confirmation, and their likelihood of occurrence will be discussed.

Figure 3: the study area in relation to the DFFE screening tool's plant sensitivity theme. Although the study area changed slightly in shape, the changes will not make any difference to the DFFE Screening Tool results.

The DFFE screening tool highlighted the following sensitive features under the terrestrial biodiversity sensitivity theme: ESA, FEPA Subcatchment, NPAES and SANParks PAES (2025).

According to the Northern Cape province's Biodiversity Spatial Plan's critical biodiversity areas (Oosthuysen and Geldenhuys, 2024), the proposed development site is located within Ecological Support Areas (ESA). ESA's are areas that must retain ecological processes, which often require at least semi-natural ecological conditions. According to NPAES and SANParks NPAES (2025), the study area is located within these priority focus areas.

Figure 4: The study area in relation to the DFFE screening tool's Terrestrial Biodiversity sensitivity Theme. Although the study area changed slightly in shape, the changes will not make any difference to the DFFE Screening Tool results.

2. Scope and limitations of the study:

- Perform a site inspection to determine the presence or likely presence or confirmed absence of SCC
- Perform a site sensitivity verification and evaluation for the study area's "*in situ*" environment.
- Identifying and assessing possible environmental impacts the proposed development could generate.

2.1. Assumptions and limitations:

- This report assumes the vegetation type description was unbiased and all relevant botanical/ ecological related information was accurately described.
- Not all plants have the same growth and/or flowering period; thus, it is likely that the survey could have occurred outside of a specific species' growth and/or flowering period.
- 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 are made outside the SCC's flowering season.
- Some aspects may have been overlooked because ecology is vast, dynamic, and highly complex. However, most floral communities have been accurately assessed and considered. Therefore, the information within this report is sufficient to allow informed decision-making.
- Most plant species in central South Africa experience summer rainfall, which allows for spring growth periods and summer-spring flowering season. The growing and flowering periods allow for the presence of identifiable characters. The presence of identifiable characters increases the accuracy and possibility of species identification, making vegetation community interpretation more thorough.

3. Methodology:

3.1. Verification of the *in situ* environment:

A desktop study was performed prior to field surveys with emphasis on the following:

- Vegetation type verification
- Possible species occurrence verification
- Current land use through satellite imagery

Date of Surveying: 30 October 2025
Season Relevance: Spring is an optimal season in which to perform vegetation surveying for this study region, as rainfall occurs most throughout the spring months.
Duration of Surveying: 30 minutes (11:53-12:23)
Site verification surveys were conducted in October 2025, focusing on ground truthing of information acquired during the desktop study. The survey was performed by means of transects traversed on foot. Attention was given to the current state of the environment regarding grazing impacts, anthropogenic disturbances, erosion and the presence of alien or invasive species.

3.2. Sources used for additional information:

Broader habitat:

- Satellite imagery (QGIS) was used in order to view the broader area on a landscape level.

Vegetation:

- The South African Red List of Plants (Raimondo et al. 2009).
- Vegetation types (Mucina and Rutherford, 2006; SANBI, 2006-2018).
- The INaturalist website was also consulted to obtain probable species presence identified by the general public.

- 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. Findings:

4.1. The physical environment:

The proposed site is located within a 5.2km radius of Onseepkans. Overall, the study area is expected to be larger than the proposed development area. The study area is less than 6 ha in a previously disturbed to natural area.
Most of the study area is in a natural state, with very little vegetation. Parts of the study area is degraded from previous development and use as a waste disposal facility. Few indigenous species were recorded at the site, resulting in a low species richness. It was observed that the study area is used as a rangeland for free-roaming horses. The study area's landscape is sloping, with a gentle slope ranging between 435m in the Western parts of the study area to 455m in the Eastern parts of the study area.
Physical landscape features of the Eastern Gariep Plains Desert (Dg9) vegetation type are sheet-wash sloping plains. Found at altitudes of 250 to 900 m a.m.s.l. The proposed development is located within an area surrounded by rocky mountains to the North and East.
The description of the physical environment observed on site agrees with the vegetation type described by Mucina and Rutherford (2006) for the study area (SANBI, 2006-2018).

4.2. Vegetation type and bioregional areas:

The proposed development is largely located in the Eastern Gariep Plains Desert vegetation type and minorly in the Eastern Gariep Rocky desert vegetation type (SANBI & DFFE, 2022; Mucina and Rutherford, 2006).
The Eastern Gariep Plains Desert vegetation type consists of gently sloping plains contrasting with the surrounding rocky hills and mountains near the Orange River. Grasslands dominated by white grasses, particularly spinescent *Stipagrostis* species, cover much of the flats, with additional shrubs and herbs concentrated in drainage lines and on gravelly or loamy soils near the mountains. Dominant species include the shrub *Sisyndite spartea* and graminoids such as *Stipagrostis ciliata* and *Stipagrostis brevifolia*.
The Eastern Gariep Rocky Desert vegetation type is a mountainous region in which all the mountains are mapped from Groot Pella to Vioolsdrif. This vegetation unit is sparsely vegetated, as a large portion of this vegetation type consists of barren rock outcrops. Sparse shrublands are often found on the southern foothills and a higher coverage in the southern ravines and rocky drainage lines. On higher southern slopes Justicia orchiodes dominates. Directly beneath steep slopes localised grasslands dominated by *Enneapogon scaber, Trirphis ramosissima* and *Danthoniopsis ramosa*. Cremnophytes such *as Ficus ilicina, Aloe dabenorisana* and *Bowiea gariepensis* can found on the south-facing quartzite cliffs. Summits, higher northern slopes and northern foothills are home to succulent species such as *Euphorbia avasmontana* and *Aloidendron dichotomum*.

However, as the majority of the area is classified as the Eastern Gariep Plains Desert and the physical environment does not resemble the Eastern Gariep Rocky Desert, only the former will be referred to hereafter.

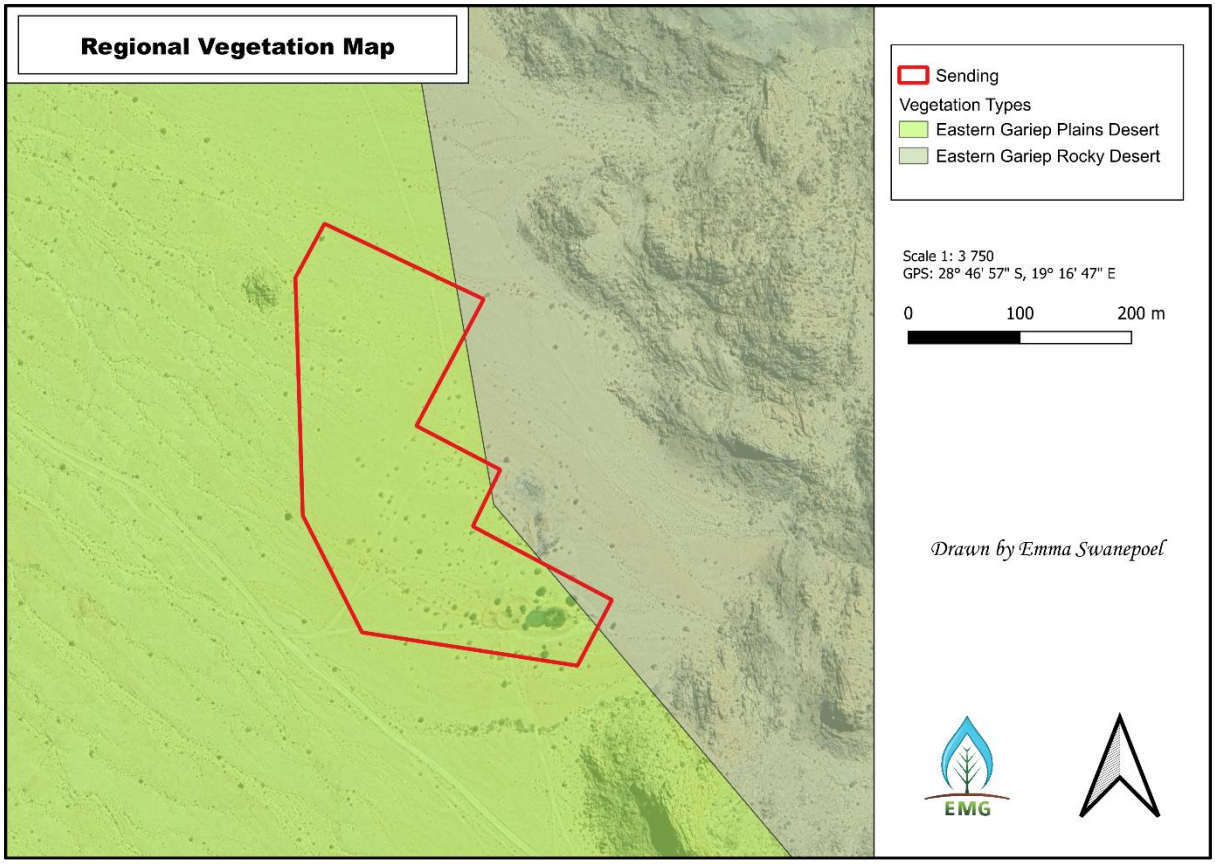

Figure 5: The regional vegetation type (SANBI, 2006-2018) in relation to the study area.

The Eastern Gariep Plains Desert has a conservation status of Least Concern (NBA, 2018).

The study area is located in areas classified under the Northern Cape's biodiversity plan as ESA's (ESA's) (Oosthuysen and Geldenhuys, 2024). ESA's are areas which must retain ecological processes, which often requires at least semi-natural ecological condition. Considering the study area's location, the previous development, leaving a fair portion of the study area in a degraded condition, and current land use as a natural rangeland, the majority of the study area meets the requirements of being an Ecological Support Area. The study area does fall within a priority focus area for the National Protected Area Expansion Strategy Plan. However, as there is existing waste disposal facilities north of the proposed site and an existing WWTW within the site, the upgrading of the Existing WWTW is best suited to occur within the given study area.

The findings of this report, as mentioned above, disagree with the very high sensitivity of the terrestrial biodiversity theme and medium sensitivity for the plant species theme in the DFFE screening tool.

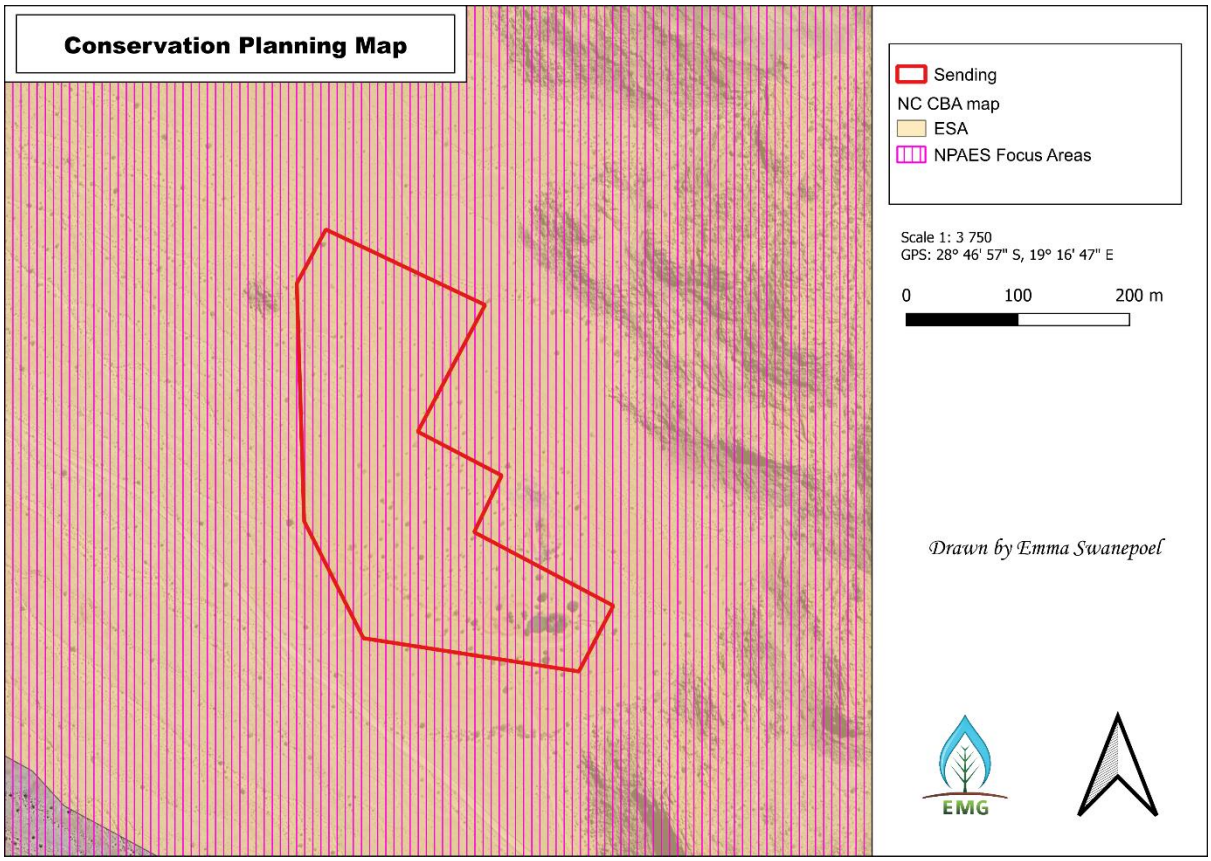

Figure 6: A map of the study area in relation to the map of the Northern Cape province's biodiversity plan map (Oosthuysen and Geldenhuys, 2024) and NPAES 2025_Q3 (DFFE, 2025).

4.3. Vegetation features:

The study site's physical environment agrees with the physical environment description of the Eastern Gariep Plains Desert vegetation type (Mucina and Rutherford). Very few similarities are shared between the vegetation observed and that of the Eastern Gariep Plains Desert (Mucina and Rutherford, 2006). However, it can be seen that the natural vegetation remaining within the study area has been largely influenced by ongoing ecological disturbances, such as the use of the site as a natural rangeland.

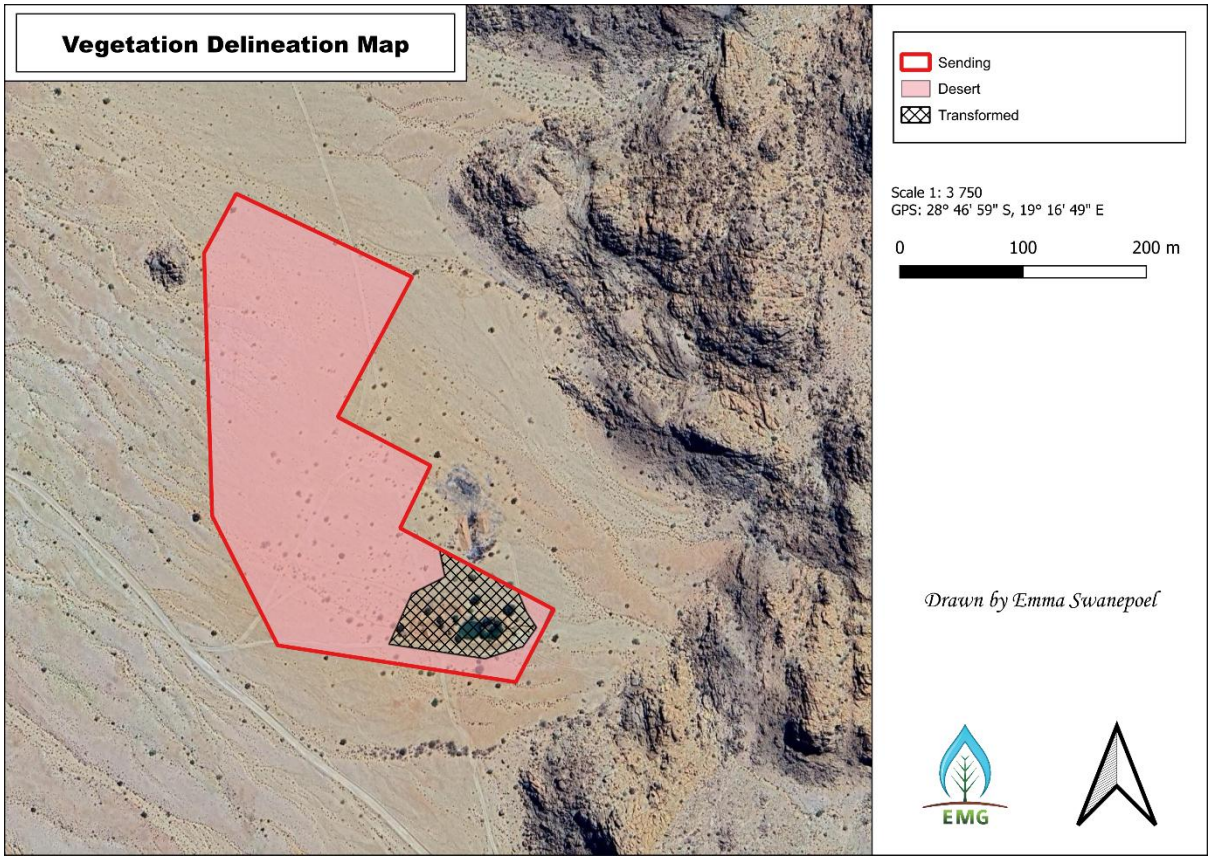

Figure 7: A vegetation delineation map showing the study area's vegetation which is naturally barren and which has been influenced by minor current and ongoing disturbance activities and previous developmental activities.

Disturbed Desert

This vegetation unit is found throughout the proposed development site. Barren or bare soil was a prominent physical feature of this vegetation unit. Vegetation coverage was rare. The small trees *Senegalia mellifera* and *Boscia albitrunca* (Nationally protected under the National Forest Act) individuals within the study area account for the most vegetation cover. These small trees provide life-sustaining shade for other smaller shrubs to grow beneath them. *Euphorbia gregaria* (Provincially protected under schedule 2 of the Northern Cape's Nature Conservation Act) is the second largest cover provider. Within the near-barren bottom layer, *Senegalia mellifera detinens* dominate as small trees. The shrubs which dominate are *Pogonospermum patulum, Codon royenii* and *Sisyndite spartea*. The ground layer consists of the following tall forb species: *Cleome foliosa, Cascanum gariepense* and *Trichodesma africanum*. The following low forb species, namely , *Monsonia parvifolia, Blepharis mitrata, Gazania lichtensteinii, Felicia namaquanum, Tribulus cristatus and Indigastrum* sp. were found. The grasses *Schmidtia kalahariensis, Enneapogon cencheroides* and *Stipagrostis ciliata* were dominant. One succulent species was found, *Euphorbia gregaria* (Provincially protected under schedule 2 of the Northern Cape's Nature Conservation Act). One ranking/climber plant was observed, namely *Microloma incanum*.

Neltuma glandulosa (Category 1B listed alien and invasive species in the Northern Cape Province) was the only alien and invasive species recorded for this vegetation unit. The individuals present were saplings and were in close proximity to the existing WWTW fenceline. Although the purposeful introduction of *Neltuma glandulosa* (Category 1b Listed species in the Northern Cape Province) is seen in the grounds of the existing WWTW, the species has only minimally escaped its planted realm. The presence of these alien and invasive species fully within and outside of their fence boundary, shows the impact of alien species introduction to natural areas.

Litter was observed frequently in this vegetation unit, with a large proportion of the site remaining natural. However, the waste disposal facility is North and East of the proposed development. A dirt road was present in this vegetation unit. Some horses were recorded to be grazing within this vegetation unit.
The ecological functioning of this area is likely negatively influenced by past and present ecological disturbances as listed above. Thus, the Ecosystem is considered in fair ecological condition.

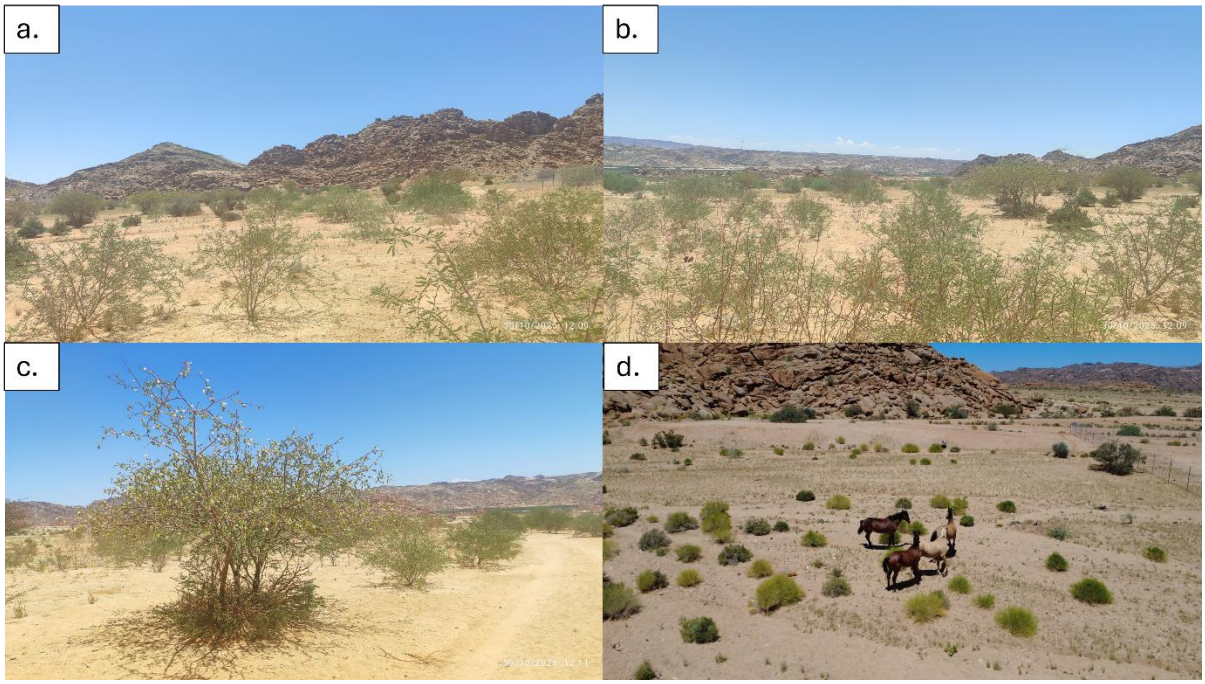

Figure 8: Ground view of the vegetation structure of the vegetation on site. (a). North-East facing. (b) West facing (c). South easterly facing (d) free roaming grazing horses.

A comprehensive floral survey was not conducted for this report due to the site's poor ecological condition . Severe modification of the environment within the study area has been recorded. The environment has been modified through low to moderate levels of disturbance from previous development and current anthropogenic activities causing ongoing current ecological disturbances. Such activities include littering and free-roaming domesticated livestock.

The vegetation observed within the study area has a fair floral species richness, is largely natural, with some areas disturbed through previous developmental activities and ongoing current ecological disturbances as listed above. Overall, the entire study area remains largely natural, with some level of influence by past and current activities seen. Thus, the site is in a fair ecological condition.

One nationally protected flora (*Boscia albitrunca*) was observed on site. Two provincially protected flora (*Euphorbia gregaria* and *Microloma incanum*) were observed. No confirmed or highly likely occurrence of SCC or range-restricted species were recorded for the site. Considering the overall natural condition of the proposed development site, with the exceptions of the Existing WWTW, litter and use as a natural rangeland, the occurrence of such species, namely sensitive species 144 is probable but unlikely. It is unlikely, as this species is not one which can be easily overlooked. Thus, the conservation importance of the site is considered low. The functional integrity of the site is medium, due to the several minor current negative ecological impacts and previous development within the site. These impacts include but are not limited to: previous infrastructure development, informal grazing, litter, waste disposal, intentional introduction of Alien and Invasive species and a dirt road. Thus, the sites biodiversity importance is Low.
The proposed area's resilience is expected to be Low due to the aridity of the region which is likely to affect the areas recovery time post development. Furthermore, the barrenness of the proposed development site's vegetation ultimately will influence the likelihood of species remaining on site in a negative manner. Thus, the site's ecological importance is medium. Minimisation and restoration mitigation is required. Thus, Development activities of medium impact are acceptable if they are followed by appropriate restoration activities.

5. Impact assessment and recommendations:

The proposed development will influence roughly less than 6 ha of a natural desert and partially degraded environment. The proposed development will affect one nationally protected flora, *Boscia albitrunca*. The proposed development will influence two provincially protected flora, *Euphorbia gregaria* and *Microloma incanum*. Total vegetation clearance is expected to influence less than 6 ha which has previously been influenced by severe degradation events. Strict monitoring and the effective implementation of all the mentioned mitigation measures will reduce the overall impact on the receiving environment.

Table 2 Impact assessment evaluation for concerned aspects relating to the proposed development.

Concerned aspect	**Impact evaluation pre and post mitigation**	**Mitigation**

Habitat loss	Low	Very low	• Before construction equipment is brought in to site, all soil must be removed from tyres, tracks, buckets, undercarriages, radiators and grills with high pressure hoses or compressed air to reduce the potential introduction of alien species to the site. • Habitat disturbance and vegetation clearance should be restricted to the authorised area. • Cleared alien and invasive vegetation should be burned within a controlled area (such as a metal drum) or removed from site and taken to a registered waste facility. • All barren/unvegetated spaces cleared during construction, which also includes the creation of topsoil stockpiles should be kept clear of vegetation. • Topsoil should not be accidentally mixed with waste or other contaminants. • An alien and invasive management plan should be drafted and implemented. • Alien and invasive species monitoring and eradication must take place quarterly. • Should any SCC be located during construction activities, construction should be halted and a qualified Botanist contacted to perform a search and rescue operation. • Upon rehabilitation of areas affected by activities associated with the proposed development must be reseeded with locally occurring indigenous species.
Loss of CBA and ESA area	Low	Very Low	
Loss of NPAES Focus area	Low	Low	
Loss of provincially protected flora	Very Low	Very low	
Loss of floral SCC	Very low	Very low	
Alien and Invasive Species	Medium	Low	

6. Conclusion:

The vegetation on site is in fair ecological condition, with only minor current negative ecological disturbances taking place. The area where the Existing WWTW is located is severely degraded due to past major ecological impacts, including the development of the existing WWTW. As such, the site is found to be in fair ecological functioning and exhibits poor species richness.

The vegetation of the proposed development is sparse and, in some places, severely degraded, with several native species remaining. The vegetation observed on site shares compositional and structural similarities with the Eastern Gariep Plains Desert vegetation type. Thus, the vegetation on site agrees with the vegetation type description (Mucina and Rutherford, 2006). Additionally, it was found that the vegetation is a good representative of the habitat; however, this region is at risk of further contamination from the waste-disposal facility to its east/north. Furthermore, as the existing WWTW is located within the study area, it is the most suitable place for

the proposed WWTW upgrade. Therefore, it is recommended that the study area be exempted from the classification as an ESA area.

One nationally and two provincially protected flora species were observed within the proposed development area. No floral SCC were observed within the proposed development area. Despite no confirmed occurrences of these SCC species, some may occur in areas unaffected by disturbances. However, the likelihood remains low.

The study area's ecological sensitivity is medium, which disagrees with the DFFE screening tool's terrestrial biodiversity sensitivity theme of very high. However, the environmental impact assessment in terms of habitat and floral components is expected to be very low, with or without mitigation measures. Thus, the commencement of the proposed development is not expected to have a drastic negative impact on the environment at the site. However, these influences will be permanent, and care must be taken to minimise the long-term environmental effects of the development.

7. References:

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Appendix A

This appendix is to provide verifiable evidence of the specialists site inspection in alignment with the Amendment to the protocols for the specialist assessment and minimum report content requirements for Environmental Impacts on Terrestrial Animal and Plant Species in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998. (GNR 3717 of 28 July 2023).

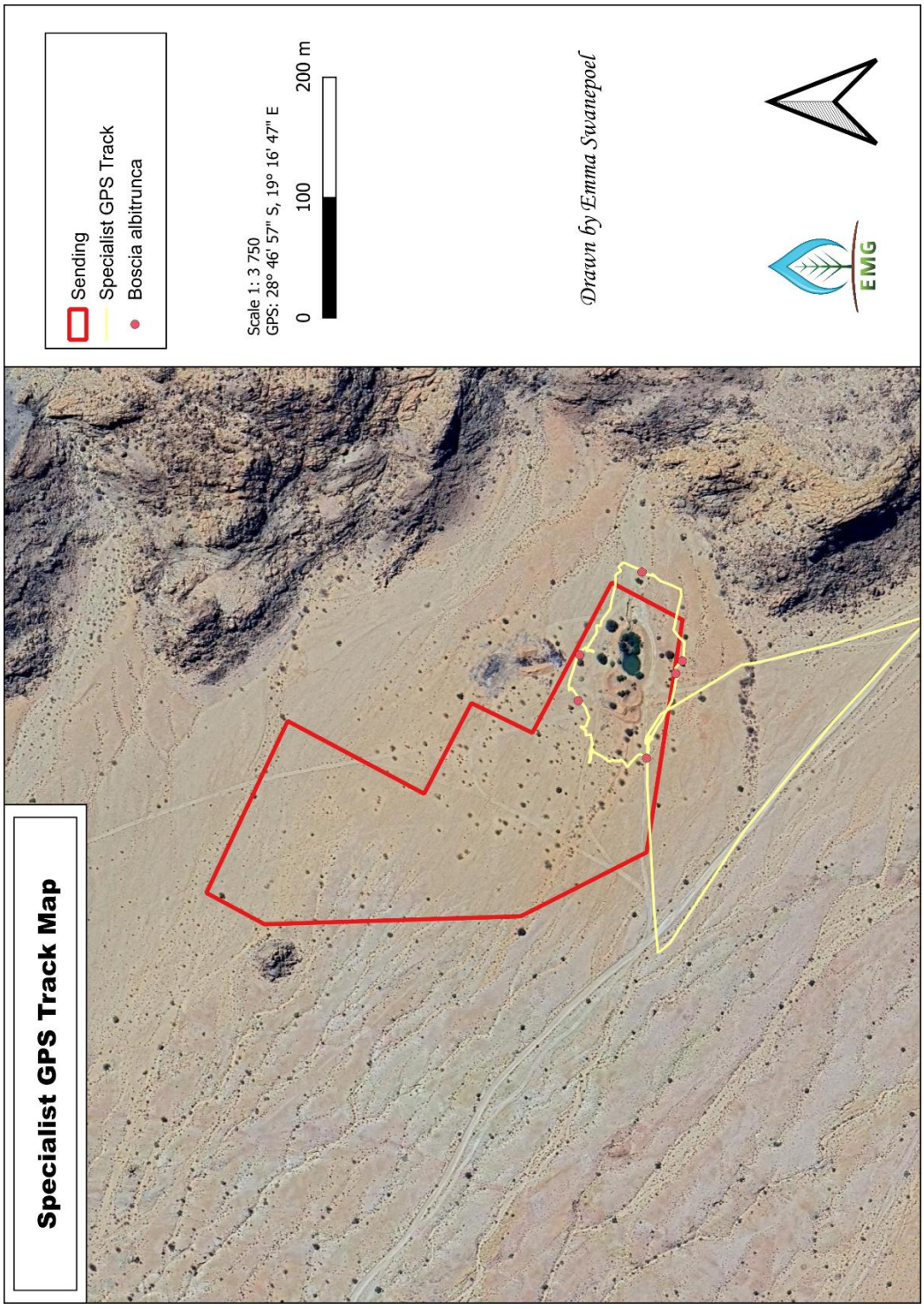

Figure 9: A map showing the specialist's GPS track in relation to the study area.

Appendix B

Family	Species	Indigenous	Ecological status	Red List Status
Acanthaceae	*Blepharis mitrata*	indig; end		Least Concern
	Pogonospermum patulum	indig		Least Concern
Apocynaceae	*Microloma incanum*	indig		Least Concern
Asteraceae	*Felicia namaquana*	indig; end		Least Concern
	Gazania lichtensteinii	indig; end		Least Concern
Boraginaceae	*Codon royenii*	indig; end		Least Concern
	Trichodesma africanum	indig		Least Concern
Capparaceae	*Boscia albitrunca*	indig		Least Concern
Cleomaceae	*Cleome foliosa*	indig; end		Least Concern
Euphorbiaceae	*Euphorbia gregaria*	indig; end		Least Concern
Fabaceae	*Neltuma glandulosa*	notindig; nat	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.	Not Evaluated
	Senegalia mellifera detinens	indig		#N/A
Geraniaceae	*Monsonia parvifolia*	indig; end		Least Concern
	Monsonia parvifolia	indig; end		Least Concern
Poaceae	*Enneapogon cenchroides*	indig		Least Concern
	Enneapogon scaber	indig		Least Concern
	Schmidtia kalahariensis	indig		Least Concern
	Stipagrostis ciliata	indig		Least Concern
Verbenaceae	*Chascanum garipense*	indig; end		Least Concern
Zygophyllaceae	*Sisyndite spartea*	indig; end		Least Concern
	Tribulus cristatus	indig; end		Least Concern

Heritage Impact Assessment

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

PALAEONTOLOGICAL AND HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED NEW SENDING WASTEWATER TREATMENT WORKS AND IRRIGATION AREA NEAR ONSEEPKANS, NORTHERN CAPE PROVINCE.

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

Report prepared by
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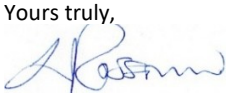
Specialist Info

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,



January 2026

SUMMARY

A Phase 1 Palaeontological and Heritage Impact Assessment was undertaken for the proposed 4-hectare development comprising a new Wastewater Treatment Works and irrigation area located approximately 1.2 km directly southeast of the Onseepkans Mission Station, Northern Cape. The footprint is underlain by palaeontologically insignificant lithologies of the Namaqua–Natal Metamorphic Complex, with superficial Quaternary sands and calcretised topsoils of low fossil potential. A systematic pedestrian survey identified no archaeological sites, no Stone Age material, no rock art, no graves, and no heritage structures older than 60 years within the footprint, as defined under Sections 34–36 of the NHRA. No culturally significant material or in situ deposits were observed, and subsurface archaeological potential is assessed as low. The anticipated changes are localised and will not alter the defining attributes of the area's cultural landscape. The project is expected to contribute positively to municipal infrastructure and community upliftment. Given the absence of heritage resources and the low sensitivity of the receiving environment, the proposed development is expected to have negligible impact on archaeological, palaeontological, or built-environment heritage. The study area is assigned a Generally Protected C (GP.C) rating. No further heritage mitigation is required, provided all activities remain confined to the assessed development footprint.

CONTENTS

INTRODUCTION

A Phase 1 Palaeontological and Heritage impact Assessment was carried out for the proposed development of a new Wastewater Treatment Works and irrigation area located about 1.2 km directly southeast of the Onseepkans Mission Station, Northern Cape Province. The entire site covers approximately 4 hectares, consisting of a 2-hectare wastewater treatment works (WWTW) area and an adjoining 2-hectare irrigation area (**Fig. 1**).

Map Reference: 1:50 000 scale topographic map 2819CD Oupvlakte and 1:250 000 scale geological map 2818 Onseepkans

Centroid Coordinates: 28°46'54.00"S 19°16'46.58"E

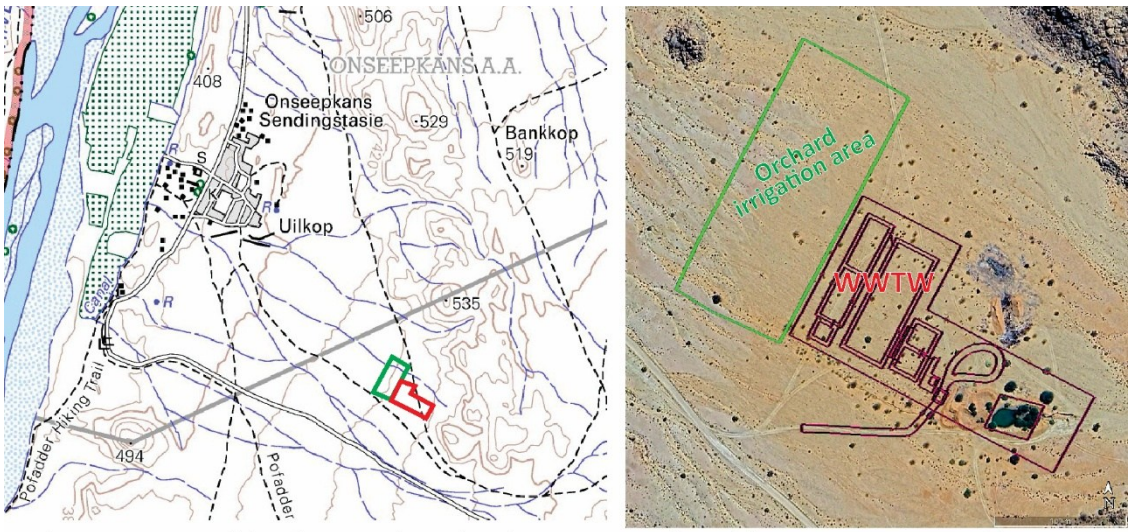


Figure 1. Proposed development footprint shown on a portion of the 1:50 000 topographic map 2819CD Oupvlakte, with an accompanying aerial view of the site on the right.

LEGAL FRAMEWORK

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. The NHRA prescribes a system of grading of places/objects via Section 7 and makes provision for the general protection of heritage resources via Sections 34, 35, 36, and 37 (in respect of the built environment, archaeology/ palaeontology, burial grounds/graves and monuments/memorials, respectively), while

Section 38 sets out guidelines under which heritage impact assessments are required when new developments may impact upon heritage resources.

Section 38(1) applies when a development triggers heritage assessment requirements but does not require an environmental authorisation from another regulatory authority, including:

1. Construction of a road, powerline or pipeline, canal or other similar form of linear development or barrier longer than 300m.
2. Construction of a bridge or similar structure exceeding 50 m.
3. Development exceeding 5,000 m².
4. Rezoning of land exceeding 10,000 m², or
5. Any development that may impact recognized heritage resources (e.g., archaeological sites, graves, buildings older than 60 years).

Section 38(8) of the NHRA applies when a development requires environmental authorisation from another regulatory authority, including:

- Environmental authorisation under NEMA (Act 107 of 1998),
- A water use licence under the National Water Act, or
- A mining right under the MPRDA (Act 28 of 2002).

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, 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; weathering and exposure can obscure diagnostic features such as stone alignments, midden deposits, or low-relief structures, especially in areas with high sedimentation or seasonal vegetation growth.

METHODOLOGY

The site assessment was carried out in line with the National Heritage Resources Act (Act No. 25 of 1999) and the 2016 SAHRA Minimum Standards for Archaeological and Palaeontological Impact Assessments. Initial site ratings were based on existing field data, relevant databases, and published literature. Topographic, aerial and geological maps were used for illustrative purposes and to identify potential fossil-bearing formations. Fieldwork involved direct observation through foot surveys, with vehicle access where possible. A Garmin Etrex Vista handheld GPS (set to the WGS 84 datum) and a digital camera were used to record spatial and visual data throughout the survey. GPS coordinates are presented in *Degrees, Minutes, Seconds* format in the report.

TERMS OF REFERENCE

The Terms of Reference outlines the scope and objectives for assessing potential impacts on heritage resources—both tangible and intangible—arising from the proposed development, in accordance with relevant legislative standards.

1. Conduct site investigation for a Heritage *Impact Assessment (HIA)* to identify and map heritage sites and occurrences in the affected area(s) and provide an assessment of their significance. This must be done regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool,* as the Department of

Environmental Affairs and its entities make no warranty—express or implied—regarding the accuracy, reliability, usefulness, or completeness of the *archaeological and cultural heritage theme layer.*

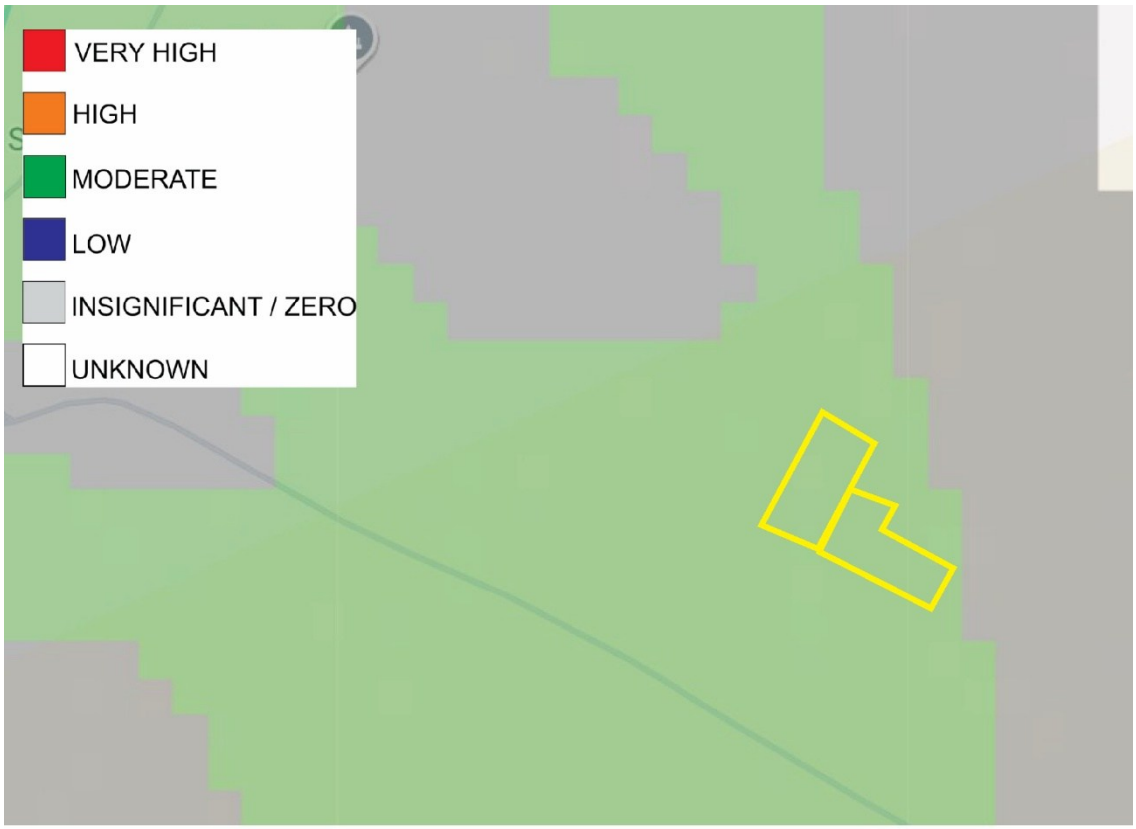


Figure 2. Study area indicated by a yellow polygon on a portion of the SAHRIS palaeosensitivity map, derived from the 1:250 000 geological map 2818 Onseepkans.

2. Conduct a site investigation for a Palaeontological Impact Assessment (PIA) using the SAHRIS PalaeoSensitivity Map (**Fig. 2**), regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool*. Identify and map fossils or exposures in the area and assess their significance. This is required as the Department of Environmental Affairs does not guarantee the accuracy or completeness of the *palaeontology theme layer*.
3. Assess impacts of the proposed development on heritage resources relative to the sustainable social and economic benefits to be derived from the development *if planned impacts will result in the loss of any resources*.

4. Provide a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories as prescribed under Section 7 of the NHRA (**Table 1**).

Table 1. Description of Field Rating categories as prescribed in Section 7(1) of the NHRA where SAHRA must by regulation establish a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories— (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance; (b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; (c) Grade 3: Heritage resources which can be considered to have special qualities which make them locally significant; and Generally Protected: Other heritage resources which may require mitigation before destruction.

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	-	High/medium significance	Mitigation before destruction
Generally Protected B	-	Medium significance	Recording before destruction
Generally Protected C	-	Low significance	Destruction

PALAEONTOLOGICAL BACKGROUND

The study area is underlain by lithologies of the Namaqua–Natal Metamorphic Complex, with localised outcrops of Precambrian gneisses and granites. The rugged arid landscape—

dominated by prominent inselbergs and hill ranges—reflects the structural complexity of the region, where metavolcanic and metasedimentary units of the Bushmanland Group form major, often overturned synformal infolds within the surrounding granitic gneisses (Bailie et al. 2007).

Valley floors are mantled by geologically recent superficial deposits comprising gritty to gravelly brown topsoils derived from weathered bedrock, calcrete development, and Quaternary aeolian sands. Additional Quaternary calcretes and sands occur as thin veneers across low-lying areas. Between Upington and Pella, late Cenozoic river-terrace deposits are preserved only as isolated remnants—bedrock lags and small sediment accumulations concentrated at local knickpoints along the Orange River (De Wit 2006).

No vertebrate fossil material has been recorded from alluvial deposits associated with the Orange River in this region. The nearest significant palaeontological occurrences include Paleogene fossil assemblages from the Stompoor volcanic pipe, approximately 160 km south of Upington, which preserve fish, amphibians, reptiles, insects, and palynological remains (Smith 1988). Further afield, fluvial deposits of the ancient Koa Valley have yielded fossil vertebrate bone and fossil wood (Maglio 1978; De Wit 1996; De Wit & Bamford 1993).

Overall, the geological context and available records indicate a very low likelihood of encountering palaeontological resources within the superficial deposits of the study area.

ARCHAEOLOGICAL BACKGROUND

The cultural landscape surrounding Onseepkans, extending southward toward Pofadder and northeast toward Augrabies, reflects a long and complex history of human occupation shaped by deep-time Stone Age traces, Khoisan pastoralism and colonial frontier expansion, culminating in 19th-century conflict along the Orange River.

Archaeological evidence demonstrates that the Middle Orange River and Bushmanland regions have been occupied continuously since prehistory, with intensive use by Khoi herders and San hunter-gatherers over the last 2,000 years (Morris & Beaumont 1991; Beaumont *et al.* 1995; Smith 1995). The area's archaeological visibility was particularly high during the Last

Glacial Maximum, and Middle Stone Age (MSA) artefacts remain widespread across Bushmanland, including sparse but significant occurrences on Gamsberg, located approximately 28 km southwest of Pella (Deacon and Thackeray 1984; Beaumont 1995, 1986; Morris 2010, 2013a, 2013b). Early 19th-century accounts describe Gamsberg as a place of refuge and conflict, reinforcing its long-standing role as a focal point in regional mobility and resistance (Penn 2005).

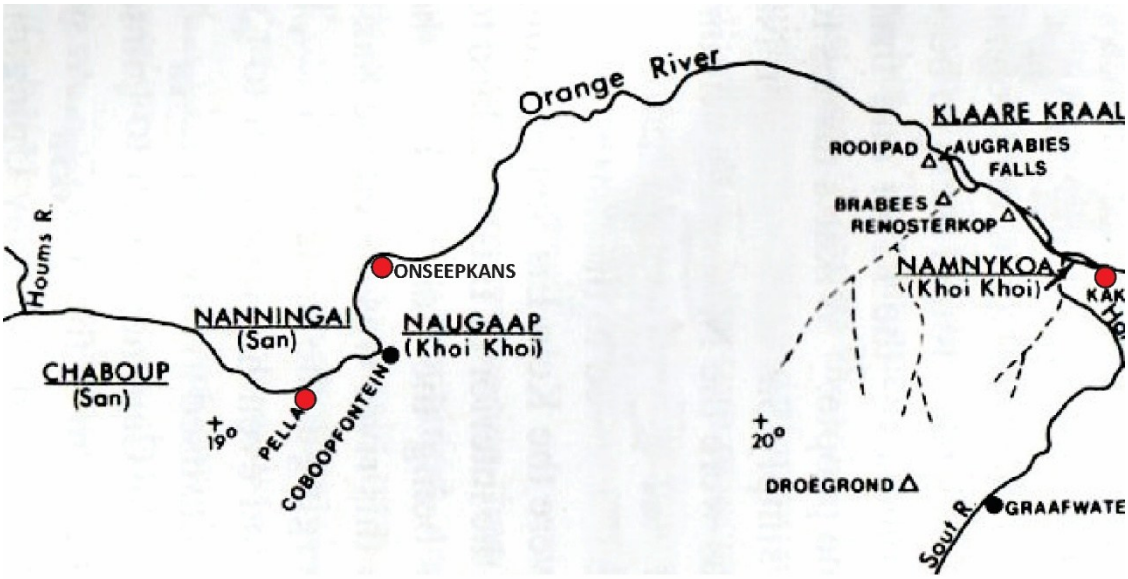


Figure 3. Distribution of indigenous groups between Pella and Kakamas (names shown in uppercase) based on the travel observations of Wikar and Gordon, as presented in Penn (1995).

The Orange River corridor, especially between Pella and Prieska, supported the densest pre-colonial Khoikhoi populations (**Fig. 3**). Groups such as the Einiqua, Namaqua, and Korana relied on the river's perennial water and floodplain grazing, establishing substantial herder encampments in contrast to the more ephemeral hinterland sites of Bushmanland (Penn 1988). Burial cairns near Kakamas and pottery-rich herder sites near Aggeneys and Schuitdrift South attest to this long-term pastoralist presence (Morris 1995).

By the 18th century, the region entered a period of escalating conflict (Penn 1995, 2005). Trekboer expansion after 1700 placed increasing pressure on Khoi grazing systems. From 1750 to 1800, the Orange River became a strategic frontier zone marked by intensified clashes between Trekboers, Khoi, and San. Mixed-descent raiding groups emerged along the river, using its islands and dense riparian vegetation as natural fortresses. Wikar's 1770s

observations describe thriving Khoisan river communities already destabilised by raiding, while Gordon's 1779 journey records conflict between San and Khoi near present-day Pella. The early 19th century saw further fragmentation. Bastard (Baster) groups moved into the middle Orange around 1813, while the area between Pella and Augrabies remained politically unstable. Dr Andrew Smith's 1826 report describes the region as anarchic, with dispersed Khoisan groups lacking central authority.

Between 1830 and 1834, the raiding leader Stuurman operated south and east of Pella, using the Orange River islands for refuge until his group was destroyed in 1834. For several decades thereafter, raiding pressure shifted north into Namibia, but by the 1850s, large multi-ethnic commandos targeting San groups across Bushmanland forced surviving communities toward the river corridor. Boer and Baster settlement expanded northwards from Pofadder, increasing pressure on the remaining Khoisan groups. By the 1860s, the collapse of Oorlam raiding power in Namibia pushed new raiders south into the Pella–Augrabies zone. !Kora groups consolidated along the river, including those led by Cupido Pofadder, Piet Rooi, Jan Kivido, and the Springbok !Kora near Olyvenhout's Drift (Upington). The killing of Klein Pofadder in 1867 reshaped local alliances, strengthening the raiding networks centred on the river islands. The final suppression of the !Kora in 1879 ended large-scale resistance along the Orange River. By 1880, the river islands between Pella and Augrabies no longer functioned as raiding strongholds, marking the close of a century of frontier conflict.

Founded in 1916 as an irrigation community, Onseepkans has been overseen by a village management board since 1936. Its name comes from the Khoi language and translates to "bend in the river where orange thorn trees grow" (Raper 1984) (**Fig.** 4).

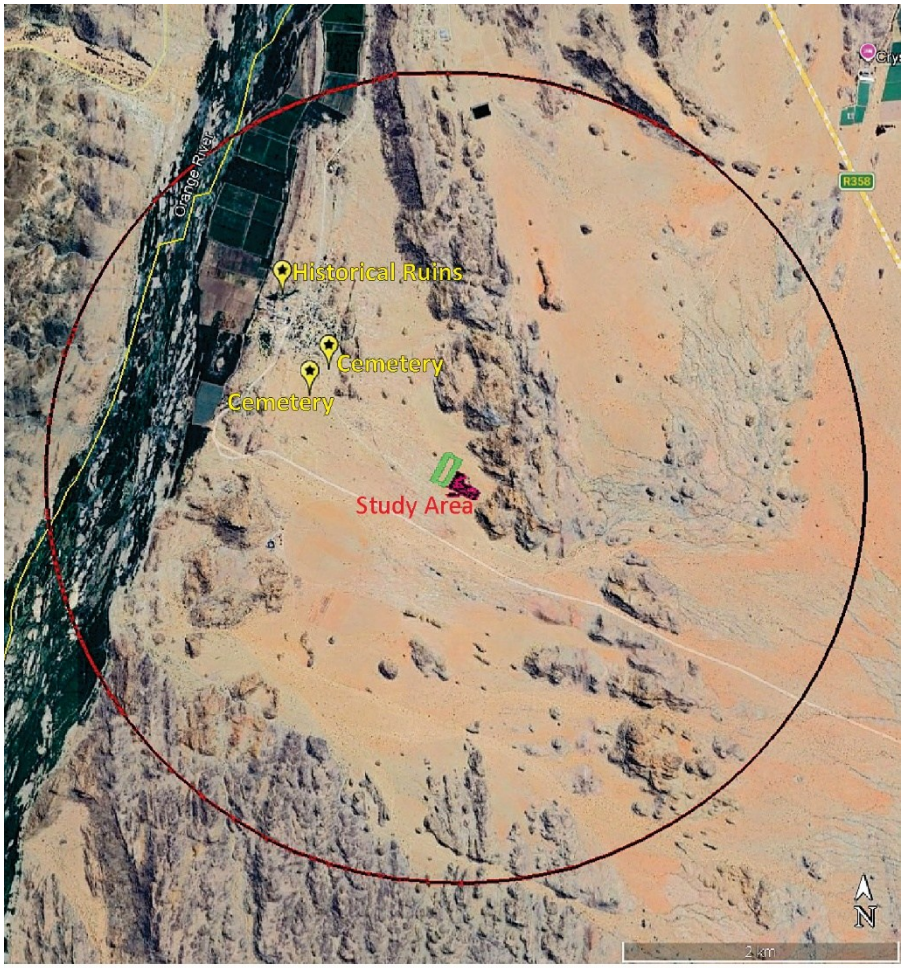


Figure 4. Known heritage sites/features located within 3 km radius of the study area.

FIELD ASSESSMENT

The proposed development area is underlain by palaeontological insignificant lithologies of the Namaqua–Natal Metamorphic Complex, including exposures of Bushmanland Group rocks and Precambrian granites. Valley-floor sediments comprise geologically recent, gritty to gravelly brown topsoils formed from weathered bedrock and Quaternary aeolian sands.

A systematic pedestrian survey confirmed that the more developed superficial deposits along gullies and drainage lines hold a very low likelihood of containing palaeontological heritage resources. The area is therefore not considered palaeontologically sensitive. No above-ground evidence of Stone Age archaeological material, prehistoric structures, rock art, marked graves, or other heritage features was identified within the proposed development

footprint. The field assessment similarly revealed no buildings older than 60 years, no culturally significant material, and no in situ archaeological deposits. Subsurface archaeological potential is assessed as low, and the occurrence of significant buried artefacts is considered unlikely.

IMPACT STATEMENT AND RECOMMENDATIONS

When considered within the wider historical context of the region, the residual impacts of the proposed development should remain limited in scale. The proposed new wastewater treatment works and irrigation area will introduce localized change that will not intrude upon the key attributes that define region's cultural landscape. The project is anticipated to support broader social upliftment through the enhancement of municipal infrastructure and commercial activities.

Given the absence of intact heritage resources within the project footprint, the proposed development is expected to have negligible impact on archaeological or palaeontological resources. The study area is therefore assigned a Generally Protected C (GP.C) rating (**Table 1**). No further heritage mitigation is required, provided that all construction and associated activities remain strictly confined to assessed development footprint.

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Aquatic Impact Assessment

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

Aquatic Assessment for the proposed new Waste Water Treatment Works (WWTW) situated near the settlement of Sending in Onseepkans, Northern Cape Province.

March 2026

Prepared by:

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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	**Aquatic Assessment for the proposed new Waste Water Treatment Works (WWTW) situated near the settlement of Sending in Onseepkans, Northern Cape Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Mar'26**

Executive Summary

The proposed new Waste Water Treatment Works (WWTW) will be situated within the area of Sending approximately 6 km to the west of the small settlement of Onseepkans (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 2 hectares, while an associated irrigation area will also be approximately 2 hectares. The footprint of the proposed WWTW will be situated in an already disturbed area, consisting of a sewage disposal pit and landfill disposal site. The area is therefore already transformed, while the immediate surroundings, which still consist of natural vegetation, contain varying degrees of disturbance associated with the waste disposal site. The site forms part of an arid region and watercourses are consequently limited to ephemeral systems.

The surface water of the surrounding area consists of a series of small drainage lines, all of which originate on the hill to the east, draining northwards toward the surrounding sandy plains, where their drainage pattern is not clearly defined. They are however considered eventual tributaries of the Orange River (Appendix A: Map 1). The assessment will therefore be based on the affected drainage lines, though still taking into account the impact that the development may have on the downstream Orange River. These drainage lines form part of an intricate drainage network, approximately 3 km long, originating on the prominent hill to the east and north of the site, flowing into the Orange River to the west of the site. In addition, at least one of these drainage lines will be situated in the WWTW layout, while a large portion of the irrigation area will be situated within the drainage line, thus resulting in the diversion and disruption of any surface flow within it. Furthermore, the existing waste disposal site also results in significant disturbance of several of these drainage lines, while several dirt track crossings also disrupt their natural flow pattern. This should therefore significantly decrease the anticipated impact of the new WWTW and irrigation area on these drainage lines, as they have already been modified. As indicated, the drainage network contains several drainage lines, ranging in size, with the channel ranging from being less than a metre wide, to approximately 2 metres in width. These drainage lines originate along the large hill to the east, where they can be quite prominent, although once reaching the plain, they become less defined, becoming completely obscured where they infiltrate into the sandy plains. This is a consequence of the sandy substrates, which promote infiltration and diffuse flows, as opposed to concentrated channel flows. This also indicates the small nature of these drainage lines, with low volume flows occurring on a very infrequent basis. All these drainage lines are therefore ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events (which will only very rarely occur).

As indicated, the Orange River downslope of the site is highly unlikely to be affected by the development (Appendix A: Map 1). The drainage pattern of the drainage lines, including an obscured downstream channel, also confirms that it is highly unlikely for any contamination to reach the river. However, groundwater contamination remains likely, which coupled with groundwater flows, may then still have an indirect impact on the Orange River. Furthermore, the Orange River in this section is listed as a National Freshwater Ecosystem Priority Area (NFEPA), which is afforded to only a select few watercourses in South Africa. Very few watercourses in the country are still natural with almost all being affected by some significant impact and being modified. Being an NFEPA system signifies that this system has been identified as one of those few remaining natural watercourses and it is therefore of utmost importance that its natural condition be retained and the current and proposed WWTW should not result in any adverse impact upon it. This can be done by managing the WWTW as a closed system, preventing any impacts to downstream areas.

Delineation of the small drainage lines affected by the WWTW and proposed irrigation area was done by a combination of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). The small drainage lines all clearly form part of a natural drainage network, though also having been modified by the existing waste disposal site (Appendix A: Map 2). None of these drainage lines however contain any wetland conditions. Though they do not contain any natural wetland conditions, they clearly contain riparian conditions, also containing a defined channel, with active channel banks and sparse, but visible riparian vegetation, confirming that most of these must be regarded as natural watercourses.

An Index of Habitat Integrity (IHI) was conducted for this drainage line network as a whole, which will be affected by the WWTW (Appendix D). The results of the IHI indicated that the ephemeral drainage line network has an Instream IHI of category C: Moderately Modified and Riparian IHI of category C: Moderately Modified. This is considered accurate, given the largely natural catchment and surroundings, though the existing waste disposal site clearly results in significant impacts upon it, resulting in a moderate modification of the drainage line network. Despite being somewhat modified and also taking into account that it may also affect the downstream Orange River, which is a highly sensitive system, the drainage line network should still be considered as sensitive and while it is inevitable that the WWTW will have an impact on it, these impacts should not be allowed to affect the downstream system. The EI&S of the affected drainage line network at the site has been rated as being Moderate.

A Risk Assessment for the proposed WWTW and irrigation area which will affect the small drainage line network, has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). The following risks, activities and impacts associated with the proposed WWTW and irrigation area which are likely to affect a few of the surrounding drainage lines have been identified:

- The proposed layout will encroach marginally into two small portions of the drainage lines around the site, which is likely to result in some impacts on them (Appendix A: Map 2). The existing waste disposal site has already modified these drainage lines and the proposed WWTW will therefore not entail a large additional impact on these drainage lines. The anticipated risk will therefore also be low.
- During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase susceptibility of the system to increased infestation by invasive plant species.
- The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding drainage lines. Instead, the WWTW makes use of oxidation ponds, while effluent is used for irrigation of a proposed irrigation area (most likely supporting dates). This effectively prevents discharge and the associated impacts from affecting the downstream system.
- The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates). The irrigation area itself, will encroach into several of the smaller drainage lines (Appendix A: Map 2). However, given the small size of the drainage lines, arid environment and high evaporation rates, this is likely to remain a localised impact and should therefore also entail a low risk, as long as the drainage lines are retained as natural channels within the irrigation area.

Table of contents

Aquatic and 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 top ten 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 order to manage our water resources more effectively, several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

Through our usage of our water resources for our daily needs, we are also degrading the quality of our water resources. Thus, it is vital to improve the quality of the water effluent before it is returned to our water-ways. Therefore, it is necessary to construct sewage plants at strategic locations to treat the waste water generated on a daily basis in residential and industrial areas. These waste plants must also be maintained and expanded as necessitated by the growing population. These waste plants must not be allowed to process a larger amount of waste than determined by their capacity. If this is the case, the plant should be expanded to prevent spillage of untreated waste into the natural water system.

Development around cities and towns is necessary to accommodate an ever-growing population. Areas along the boundaries of cities and towns are usually in a degraded state, due to the impact caused by the large population these areas house. Though this may be the case in most situations, there may still be areas that consist of sensitive habitats, such as watercourses, wetlands or rare vegetation types that need to be conserved.

The proposed new Waste Water Treatment Works (WWTW) will be situated within the area of Sending approximately 6 km to the west of the small settlement of Onseepkans (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 2 hectares, while an associated irrigation area will also be approximately 2 hectares. The footprint of the proposed WWTW will be situated in an already disturbed area, consisting of a sewage disposal pit and landfill disposal site. The area is therefore already transformed, while the immediate surroundings, which still consist of natural vegetation, contain varying degrees of disturbance associated with the waste disposal site. The site forms part of an arid region and watercourses are consequently limited to ephemeral systems. A series of small drainage lines occur on and around the site, originating along a prominent mountainous area to the east and with at least one of these being directly affected by the WWTW and the proposed irrigation area. An existing access road will be used for the proposed WWTW. The proposed development of the WWTW will therefore have to take into account its effect on this drainage system and implement comprehensive mitigation in order to minimise its impact on this drainage system (Appendix A: Map 2).

A site visit was conducted on 14 January 2026. The entire footprint of the WWTW, irrigation area and immediate surroundings was surveyed. A detailed survey of the watercourses which will be affected by the WWTW and irrigation area was undertaken. The survey was conducted during mid-summer, and with scant rainfall having occurred previously in spring, the plant identification on the site was considered sufficient, though given the arid climate of the region, it is likely that several plant species were overlooked.

For the reasons mentioned above, it is necessary that an aquatic and wetland assessment of the area proposed for development be conducted.

The report together with its recommendations and mitigation measures should be used to minimise the impact caused by the proposed development.

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes (Johnson 2005).

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.

- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

1.3 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 among 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, support 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 the banks and break down pollutants draining from the surrounding land.

1.4 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.
  2025: 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 WWTW 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 extent 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 importance relative to the larger system.
- Conducting a habitat integrity assessment of watercourses to inform the condition and status of these systems.

2.3 Limitations

- 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 disturbance, several grass species may have been overlooked, as they would be unidentifiable without inflorescences.
- Some geophytic or succulent species may have been overlooked due to a specific flowering time or cryptic nature.

- Given the aridity of the region, dormancy in many plant species limits identification and it is possible that many species were overlooked or absent at the time of the survey.
- Due to time constraints, only limited surveys of watercourses were done.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.

3. Methodology

3.1 Several reference 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.
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- Field guides used for vegetation and riparian species identification (Adams 1976, Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al.* 2015, Gerber *et al.* 2004, Gibbs Russel *et al.* 1990, Grifiths & Picker 2015, Manning 2009, Moller & Becker 2019, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Van Ginkel *et al.* 2011, Van Ginkel & Cilliers 2020, Van Oudtshoorn 2004, Van Rooyen 2001, Van Rooyen & Van Rooyen 2019, 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, Macfarlane, Ollis & Kotze 2020, Ollis *et al.* 2013, Nel *et al.* 2011, SANBI 2009.

3.2 Survey

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

- 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 aspects outline 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-metre 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 on 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 caused by the development.

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 boundaries of these systems.

The following was 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 was 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

The following criteria were applied during the site survey to further inform the general sensitivity and conservation value of the site or specific elements on the site. These criteria were used to assess the site 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 the overall ecological importance.

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 may however vary significantly, 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 climate 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 trees, shrubs, 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 in 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 few 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. Aquatic and Wetland Assessment

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

4.1 Ecology and description of the study area

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

The proposed new Waste Water Treatment Works (WWTW) will be situated within the area of Sending approximately 6 km to the west of the small settlement of Onseepkans (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 2 hectares, while an associated irrigation area will also be approximately 2 hectares. The footprint of the proposed WWTW will be situated in an already disturbed area, consisting of a sewage disposal pit and landfill disposal site. The area is therefore already transformed, while the immediate surroundings, which still consist of natural vegetation, contain varying degrees of disturbance associated with the waste disposal site. The site forms part of an arid region and watercourses are consequently limited to ephemeral systems. A series of small drainage lines occur on and around the site, originating along a prominent mountainous area to the east and with at least one of these being directly affected by the WWTW and the proposed irrigation area. An existing access road will be used for the proposed WWTW. The proposed development of the WWTW will therefore have to take into account its effect on this drainage system and implement comprehensive mitigation in order to minimise its impact on this drainage system (Appendix A: Map 2).

The footprint of the existing sewage disposal pit and the majority of the landfill site have been completely transformed from the natural conditions. This has also been confirmed by the current survey and any remaining vegetation on the site itself consists of pioneer species and invasive trees (Appendix A: Map 1). The existing sewage pit and landfill site are therefore largely irrelevant to this assessment. The areas identified for the proposed WWTW (west of the site) do however still consist of natural vegetation, though high levels of disturbance were also noted here. The area is dominated by sandy plains, sloping toward the Orange River, with mountainous terrain occurring to the east of the site, where several small drainage lines, transecting the area, originate. This results in a moderate diversity of habitat which includes low ridges, rocky and sandy habitats and drainage lines supporting a low and sparse riparian vegetation layer. As a result of the moderate habitat diversity, the area also contains a moderate species diversity which includes scant dwarf karroid shrubs, grasses, succulents and several riparian shrubs.

As previously indicated, the topography of the surroundings consists of sandy plains, with a gradual slope towards the Orange River, which is situated approximately 3 km to the west. Prominent hills and ridges surround the site to the east and north, and these also generate significant runoff which leads to the formation of small drainage lines within the lower lying sandy plain. Several of these drainage lines also surround the site, with at least one being situated within it and several of these being affected by the WWTW and irrigation area (Appendix A: Map 2). These drainage lines are incised into the landscape and also contribute toward the diversity of topography and habitats. The topography of the existing disposal site is modified to a significant extent by the sewage pit, landfill site and dirt roads associated with it.

The region is characterised by an arid climate and receives on average less than 200 mm annual rainfall with mean annual rainfall recorded at the nearest weather station at Pella, situated to the

west of Onseepkans, being 136 mm. The average annual, daily temperature given for Goodhouse is 23.3°C. The highest average daily temperature occurs during January with an average of 44.9°C and the lowest average occurs during July with an average of 1.9°C.

The geology dominating the study area is quite diverse. The higher lying hills, ridges and mountainous terrain are dominated by leucocratic biotite gneiss and quartz-feldspar gneiss of the Stalhoek Complex, while lesser amounts of leucocratic biotite gneiss occur, with intercalations of calc-silicate rocks, mafic gneiss and quartzite-schist association of the Hom Subgroup, Bushmanland Group. The lower lying plains contain much deeper soils, with quaternary sheet-wash alluvial deposits and sands being common.

As indicated, the existing site, sewage pit and landfill disposal site, are considered to be largely transformed, while surrounding natural areas also contain a high level of disturbance, mostly associated with the disposal site, dirt tracks and overgrazing by domestic livestock. Invasive species are prominent, especially the invasive *Prosopis glandulosa* (MesquiteTree). The vegetation in the surrounding terrestrial areas is dominated by a sparse layer of scattered grasses and low shrubs.

According to Mucina & Rutherford (2006), the vegetation in the area, consisting of the valley floor, consists of Eastern Gariep Plains Desert (Dg 9), while the surrounding rocky areas consist of Eastern Gariep Rocky Desert (Dg 10). Both these vegetation types are currently listed as being of Least Concern (LC) (National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)) (Appendix A: Map 1). They are currently not subjected to any significant development pressures. As indicated, they are also affected by significant levels of disturbance.

The Northern Cape Critical Biodiversity Areas Plan (2016) has recently been updated (2024) and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e., Critical Biodiversity Areas. The site for the new WWTW is however regarded as an Ecological Support Area (ESA), which is itself not regarded as essential for meeting conservation targets, but still aids in supporting such surrounding areas, including the Orange River situated to the north of the site.

Figure 1: Aerial view of the recent condition of the study area (Google Earth 2023) which indicates largely natural surroundings, though the site itself contains visible disturbances due to the

existing sewage pit (blue) and landfill disposal site (yellow). The site itself is situated within a sandy plain, with a few prominent hills and ridges immediately to the east.

Figure 2: The surrounding terrestrial areas are dominated by a lower lying sandy plain and surrounding mountainous terrain, with an abundance of rocky hills and ridges. The area is clearly very arid, with vegetation being limited to a sparse layer of grasses and shrubs.

Figure 3: Given the arid environment, watercourses in the area are limited to small drainage lines (red), containing limited riparian conditions.

4.2 Wetland and Watercourses Assessment

4.2.1 Introduction

The surface water of the surrounding area consists of a series of small drainage lines, all of which originate on the hill to the east, draining northwards toward the surrounding sandy plains, where their drainage pattern is not clearly defined. They are however considered eventual tributaries of the Orange River (Appendix A: Map 1). The Orange River is situated more than 3 km to the west of the site, and is therefore unlikely to be directly affected by the WWTW. However, these small drainage lines which will be affected by the WWTW and irrigation area may therefore still have an indirect impact on downstream areas. The assessment will therefore be based on the affected drainage lines, though still taking into account the impact that the development may have on the downstream Orange River.

As indicated, several drainage lines are present on and around the site, containing small, but distinct channels, all of which drain from east to west (Appendix A: Map 2). These drainage lines form part of an intricate drainage network, approximately 3 km long, originating on the prominent

hill to the east and north of the site, flowing into the Orange River to the west of the site. In addition, at least one of these drainage lines will be situated in the WWTW layout, while a large portion of the irrigation area will be situated within the drainage line, thus resulting in the diversion and disruption of any surface flow within it. Furthermore, the existing waste disposal site also results in significant disturbance of several of these drainage lines, while several dirt track crossings also disrupt their natural flow pattern. This should therefore significantly decrease the anticipated impact of the new WWTW and irrigation area on these drainage lines, as they have already been modified. However, should the WWTW be managed as a closed system, the drainage lines allowed to flow past the WWTW and the irrigation area accommodate adequate flow through it, this will limit the impact on downstream areas. This is particularly likely, given the arid climate of the area, which limits surface runoff significantly. The proposed WWTW and irrigation area should therefore ensure suitable management to prevent downstream impacts. As indicated, the drainage network contains several drainage lines, ranging in size, with the channel ranging from being less than a metre wide, to approximately 2 metres in width. These drainage lines originate along the large hill to the east, where they can be quite prominent, although once reaching the plain, they become less defined, becoming completely obscured where they infiltrate into the sandy plains. This is a consequence of the sandy substrates, which promote infiltration and diffuse flows, as opposed to concentrated channel flows. This also indicates the small nature of these drainage lines, with low volume flows occurring on a very infrequent basis. All these drainage lines are therefore ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events (which will only very rarely occur).

As indicated, the Orange River downslope of the site is highly unlikely to be affected by the development (Appendix A: Map 1). The drainage pattern of the drainage lines, including an obscured downstream channel, also confirms that it is highly unlikely for any contamination to reach the river. However, groundwater contamination remains likely, which coupled with groundwater flows, may then still have an indirect impact on the Orange River. Furthermore, the Orange River in this section is listed as a National Freshwater Ecosystem Priority Area (NFEPA), which is afforded to only a select few watercourses in South Africa. Very few watercourses in the country are still natural with almost all being affected by some significant impact and being modified. Being an NFEPA system signifies that this system has been identified as one of those few remaining natural watercourses and it is therefore of utmost importance that its natural condition be retained and the current and proposed WWTW should not result in any adverse impact upon it. This can be done by managing the WWTW as a closed system, preventing any impacts to downstream areas.

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.

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification (Figure 4). All of the drainage lines at the site being affected by the WWTW are

situated at their origin and are therefore first order watercourses, while the Orange River is a large lowland river system and therefore a seventh order system.

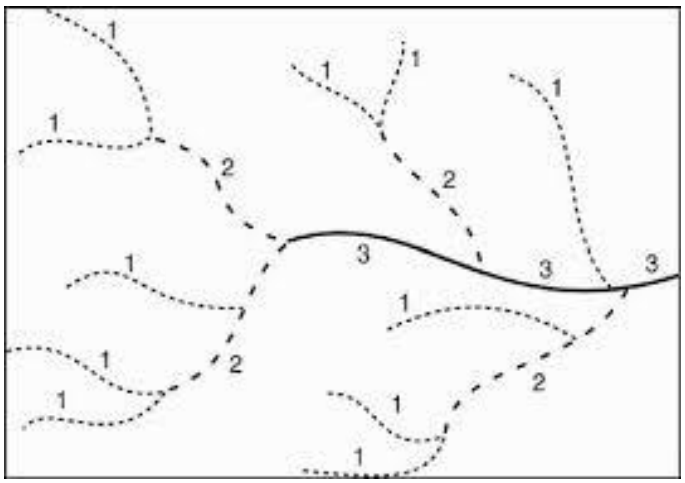


Figure 4: The classification of stream orders from 1 to 3 (Strahler 1952).

4.2.2 Wetland and riparian indicators

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).

Delineation of the small drainage lines affected by the WWTW and proposed irrigation area was done by a combination of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). Due to time constraints, soil samples were only taken within sample points along the channel of the drainage lines in order to confirm the presence of wetland or riparian conditions. The following guidelines and frameworks were used to determine and delineate the drainage line system 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 and border of wetlands, while riparian vegetation was used to confirm the presence of a watercourse or floodplain. Soil samples were used to determine the border and also to confirm the presence of wetland soils along the small drainage line affected by the WWTW (Appendix C). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

The small drainage lines all clearly form part of a natural drainage network, though also having been modified by the existing waste disposal site (Appendix A: Map 2). None of these drainage lines however contain any wetland conditions, both in terms of soils and vegetation. Though they do not contain any natural wetland conditions, they contain clear riparian conditions, also containing a defined channel, with active channel banks and sparse, but visible riparian vegetation, confirming that most of these must be regarded as natural watercourses. The WWTW

will therefore have to ensure that none of these will be affected by any storm water inflow from the site nor any overflow from the oxidation ponds. This is likely to affect at least one of these drainage lines. Managing the impact can easily be attained by diverting the drainage line around the border of the WWTW and erecting a diversion berm around the borders of the WWTW. Where the drainage line flows through the irrigation area, it should be excluded from planting, allowing for unimpeded flow to occur.

Figure 5: Recent aerial images (Google Earth 2023) indicate the existing waste disposal site (landfill and sewage disposal), which contributes to the modification of at least one of the drainage lines in the area. The proposed WWTW and irrigation area (red), may also have an impact on some of these drainage lines (yellow).

The absence of wetland soil indicators was confirmed by the absence of any obligate wetland vegetation, while the presence of at least some riparian species confirmed the presence of a watercourse. Unlike the delineation of wetland areas, where soil wetness indicators are the primary indicators, the identification of riparian areas relies heavily on vegetative indicators. Obligate riparian species occur almost exclusively in the riparian zone (> 90% probability). They are seldom found in non-riparian areas, but where they are found outside of riparian areas, they still indicate wetness (DWAF 2008).

4.2.3 Classification of wetland systems

The affected drainage lines are devoid of wetland conditions and can therefore not be placed within any of the defined wetland hydrogeomorphic units but can to some extent be regarded as a channel system:

Though devoid of wetland conditions, the drainage lines can, to some extent, be characterised as a channel 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)."

The drainage lines on and around the site do fit well within this description as they contain a small, but distinct channel, as well as concentrated, unidirectional flow, occurring very infrequently though. The majority of these drainage lines can be confirmed as natural watercourses (Appendix A: Map 2).

Figure 6: The affected drainage lines all contain a very small, though clearly defined channel (red), while alongside it, riparian vegetation is also present.

4.2.4 Description of watercourses and wetlands

The WWTW and proposed irrigation area contain several small drainage lines around the site, with some of these also likely to be affected by the development (Appendix A: Map 2). A short, overall description of this drainage network will be provided below.

Obligate wetland vegetation was used to determine the presence of wetland conditions. 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.

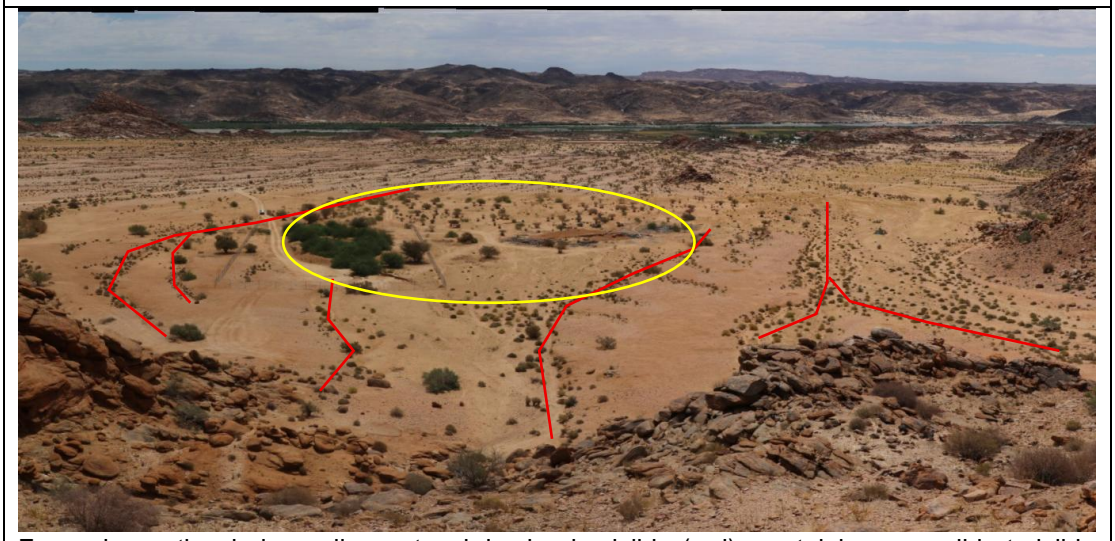
Table 2: Description of the watercourses and wetlands which form part of the study area (Appendix A: Map 2) (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#1 Drainage line network – several affected by the border of the WWTW and irrigation area.	S 28.782608°, E 19.280028° S 28.781462°, E 19.280394° S 28.782613°, E 19.281447°	Ephemeral
Description of watercourse: The drainage network which will be affected by the WWTW and proposed irrigation area consists of numerous small drainage lines, with the majority containing a distinct channel. While the majority of these drainage lines are situated outside the boundaries of the proposed WWTW, a few of the smaller drainage lines will be situated along the borders of the WWTW and the proposed irrigation area. Some of these drainage lines also already contain significant levels of disturbance, caused by refuse dumping within the existing waste disposal site, while also being crossed over by several dirt tracks, resulting in further impacts on their flow regime. Upstream and downstream of the waste disposal site, these drainage lines are however largely natural and the impact on them appears to remain localised to the site. This would also seem to indicate that the proposed development can retain impacts on these drainage lines to the immediate area, provided suitable mitigation is implemented. These drainage lines differ from being small, barely visible channels, to containing somewhat larger, more prominent channels, varying in width from 0.5 to 2 metres. Some of these drainage lines also may become obscured, where they infiltrate into the sandy plains, with a defined flow pattern becoming invisible. Furthermore, none of them contain any wetland conditions and all of these drainage lines function as ephemeral watercourses, which will flow for very short periods after heavy rainfall events. These drainage lines are also without any prominent floodplain, though a narrow riparian zone is present along the channel, being indicated by the presence of sparse riparian shrubs. Vegetation along these drainage lines is fairly sparse, also a consequence of the arid environment, but does contain some prominent riparian species. The low shrubs comprising the majority of this vegetation layer are almost all known to be obligate riparian species within this arid region and can reliably be used to confirm the presence of watercourses. Scattered specimens of invasive *Prosopis glandulosa* also occur within this riparian vegetation and are of concern, as they can often form dense infestations along watercourses in this region.		
Dominant plant species: Drainage line and riparian zone: *Schmidtia kalaharienss, Sisyndite spartea, *Prosopis glandulosa, Codon royenii, Petalidium setosum, Boscia albitrunca, Phaeoptilum spinosum, Aptosimum spinescens, Senegalia mellifera* subsp. *detinens, Indigofera pungens, Justicia spartoides, Adenolobus garipensis, Blepharis mitrata, Cadaba aphylla, Stipagrostis sp*.		
Protected plant species: *Boscia albitrunca.*		

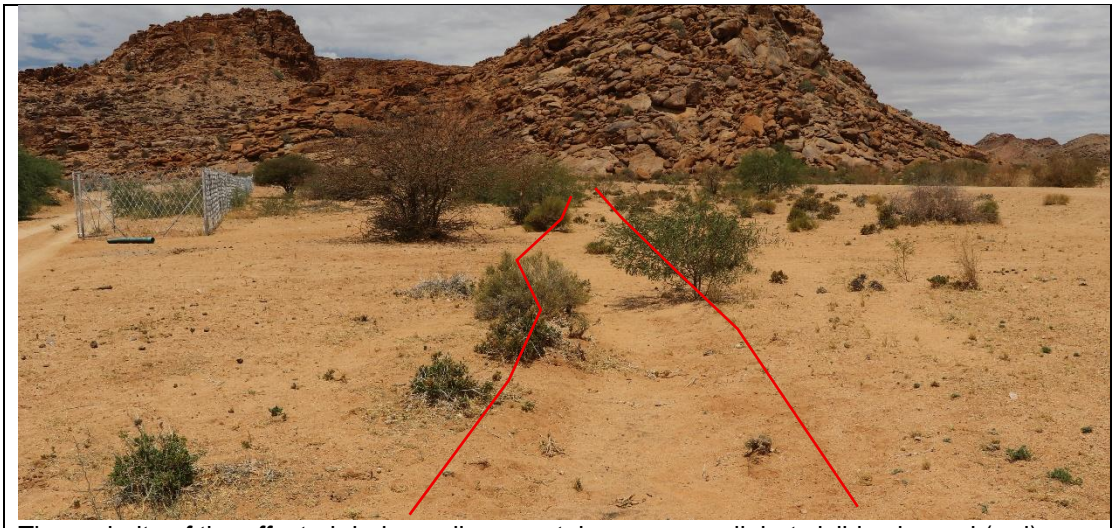
View of the delineated drainage line network (yellow) around the site (red). Note how the existing waste disposal site has already affected several of these drainage lines and how the proposed WWTW and irrigation area will encroach into them.

Soil samples:

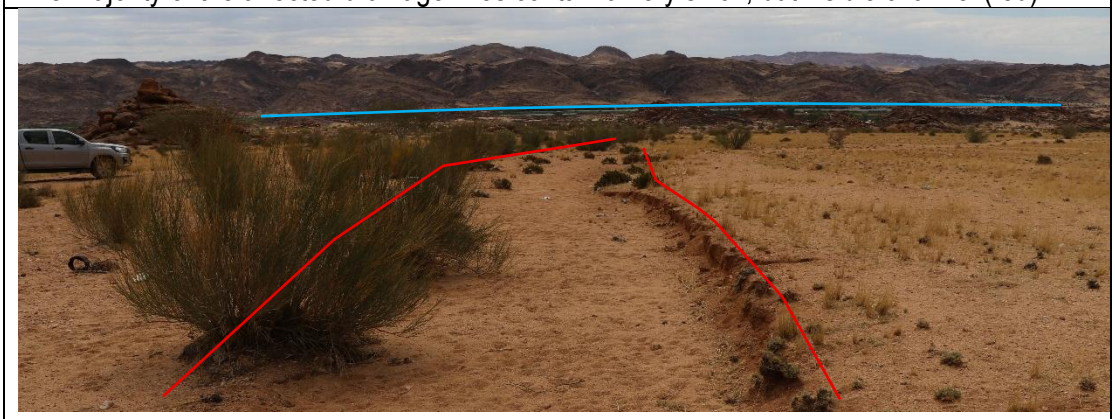
Soils within the drainage line consist of yellow, sandy soils with gravel and contain no wetland conditions.



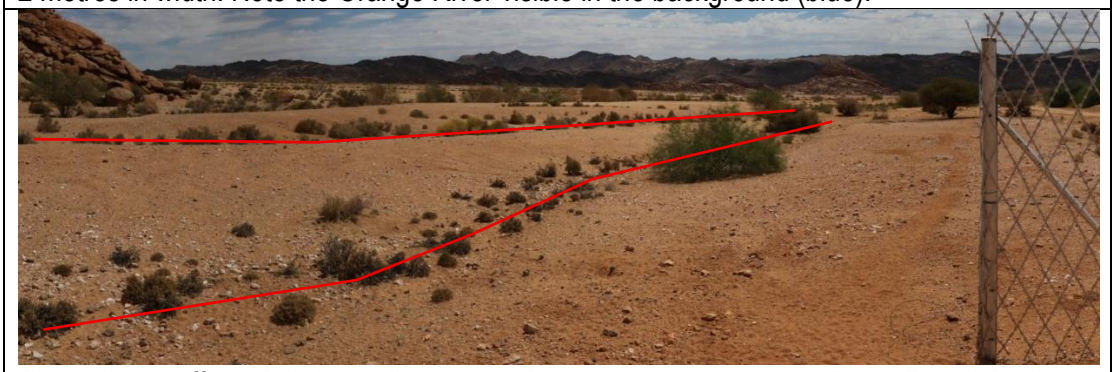
From above, the drainage line network is clearly visible (red), containing a small but visible channel. Note also the waste disposal site and dumping already resulting in significant impacts upon it (yellow).



The majority of the affected drainage lines contain a very small, but visible channel (red).



Some of the drainage lines in the area are more prominent than others, this one with a channel 2 metres in width. Note the Orange River visible in the background (blue).



Although the affected drainage lines are quite small, they are generally easily visible due to the riparian vegetation concentrated along their channels (red).

4.2.5 Condition and importance of the affected watercourses

The drainage line network which will be affected by the WWTW consists of several small, ephemeral drainage lines (Appendix A: Map 2). Being devoid of wetland conditions and not being characterised by any of the hydrogeomorphic wetland types, a WET-Health determination is not applicable to this system. In addition, since the system is strictly ephemeral and contains no aquatic component, it is also not possible to conduct a SASS5 macro-invertebrate assessment. These small drainage lines can however still be accurately assessed by using an overall

determination of the Index of Habitat Integrity (IHI) (Appendix D). This is considered to give a good representation of the condition of the drainage line system which will be affected by the WWTW. The IHI will be taken as representative of the Present Ecological State (PES) of this system.

Table 3 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 system (Kleynhans & Louw 2007).

Table 4 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 3: 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 4: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High	>2 and <=3	B

Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.		
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

According to previous desktop assessments of the area, this particular drainage line network was not included in the assessments, probably as a result of its small size (Kleynhans 2000, Van Deventer *et al.* 2018). The Orange River, situated immediately downstream, was however considered being Largely Natural to Moderately Modified. This can also be considered as fairly accurate for the drainage line network, because whereas the upstream areas appear to be largely natural, the existing waste disposal site results in it being moderately modified.

From previous sections and descriptions of the drainage line network, it has clearly been modified to some degree by the existing waste disposal site. The following discussion will explain some of these impacts and how the drainage lines have been modified by them. Upstream of the waste disposal site, the drainage line network is largely intact, with livestock overgrazing, trampling and dirt tracks being the only noticeable impacts. The waste disposal site itself encroaches into at least one of these drainage lines, while another is also affected by the landfill site, with refuse dumping being common, resulting in some degree of obstruction to the natural flow pattern of these two drainage lines. This will also affect water quality, though flow occurring only very sporadically will be a localised impact. The more prominent impact is likely to be on the groundwater, towards which the drainage line network will also contribute. Likewise, the sewage disposal pit situated within the drainage line network, is also likely to contribute toward contamination of the groundwater in the area. Current indications are that it sporadically overflows, which then directly affects one of these drainage lines in terms of moisture regime and water quality. An additional significant impact associated with the waste disposal site involves several dirt tracks and roads which cross over several of these drainage lines, contributing to obstruction of flow, and possibly contributing toward erosion within these drainage lines. The area also forms part of the local communal grazing grounds with overgrazing and trampling by domestic livestock being evident and considered a significant impact on the drainage line network. The drainage line network would therefore seem to be still intact, though having been modified to some degree by impacts associated with the existing waste disposal site.

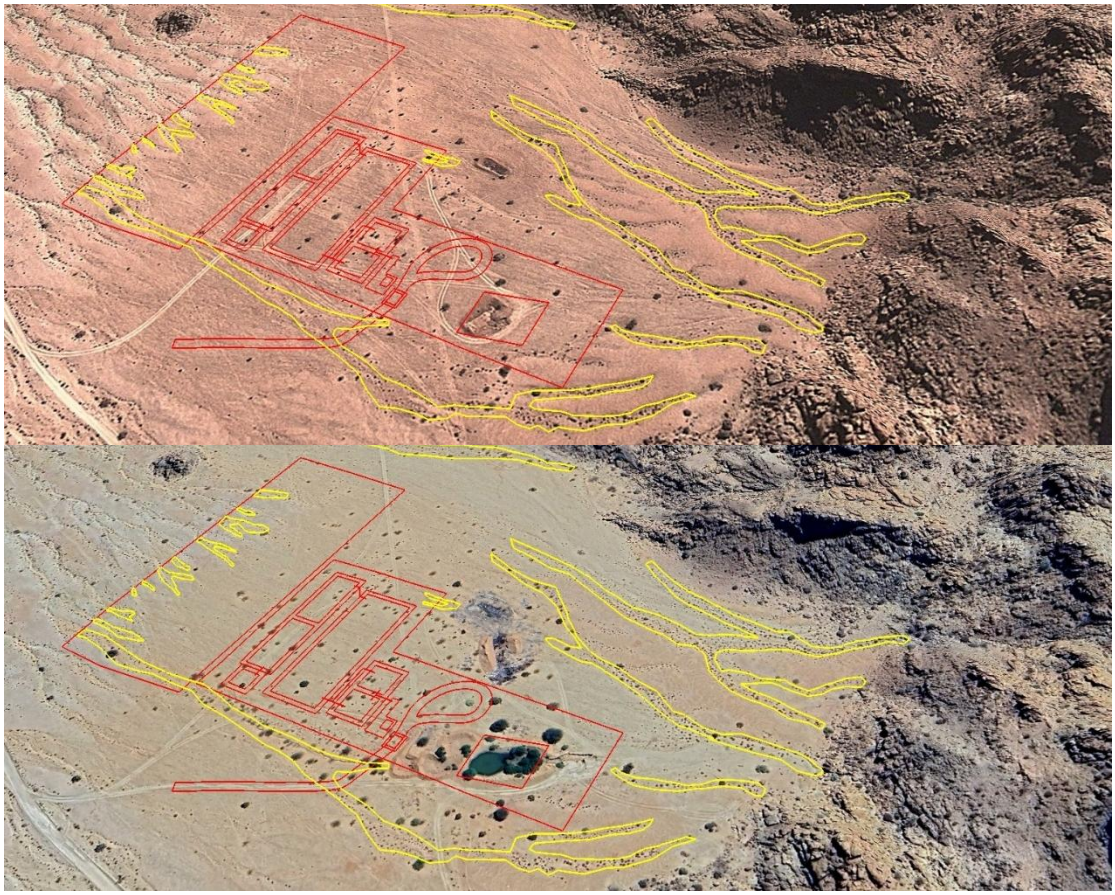


Figure 7: View of the affected drainage line network, indicating how the system and surroundings, which previously had been natural (Top - Google Earth 2010), have become quite degraded and modified since the establishment of the waste disposal site, which has also encroached into two of these drainage lines (Bottom – Google Earth 2023).

Figure 8: One of the affected drainage lines is situated within the existing sewage disposal pit, resulting in obstruction of flow and erosion. This can be avoided by diverting flow around the perimeter of the proposed WWTW.

Figure 9: The landfill site affects at least one of the small drainage lines, resulting in extensively disturbing it and obstructing its natural flow.

The drainage line network on the site which is already being affected by the waste disposal site and which will also be affected by the proposed WWTW, is considered to be modified to some degree, its modification mostly associated with the impacts caused by the waste disposal site. Though several drainage lines are present on and around the site, these were assessed as a single drainage network system. An Index of Habitat Integrity (IHI) was conducted for this drainage line network as a whole, which will be affected by the WWTW (Appendix D). The results of the IHI indicated that the ephemeral drainage line network has an Instream IHI of category C: Moderately Modified and Riparian IHI of category C: Moderately Modified. This is considered accurate, given the largely natural catchment and surroundings, though the existing waste disposal site clearly results in significant impacts upon it, resulting in a moderate modification of the drainage line network. Despite being somewhat modified and also taking into account that it may also affect the downstream Orange River, which is a highly sensitive system, the drainage line network should still be considered as sensitive and while it is inevitable that the WWTW will have an impact on it, these impacts should not be allowed to affect the downstream system.

The EI&S of the affected drainage line network at the site has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is usually not sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. This is most likely a result of the small nature of the drainage line network, which has already been modified by the existing waste disposal site, containing a moderate habitat and species diversity. However, the drainage line network will still affect the downstream Orange River, and despite its small size, is still considered to have a Moderate EI&S.

4.2.6 Risk Assessment

A Risk Assessment for the proposed WWTW and irrigation area which will affect the small drainage line network, has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Activities likely to be associated with the WWTW and which will likely affect some of the drainage lines around the site, include encroaching into and modifying a portion of the drainage line, spillages and overflow of the WWTW entering the drainage line which may affect the downstream system, and increased disturbance and sedimentation of the drainage line due to the construction and operation of the WWTW (Appendix A: Map 2). Activities likely to be associated with the irrigation area and which will likely affect several of the drainage lines include encroaching into and modifying a portion of the drainage lines, increased moisture

regime and modification of the flow regime due to irrigation runoff, and consequent increased erosion of the channel.

The WWTW and proposed irrigation area will encroach into some of these drainage lines and therefore a buffer zone between the WWTW, irrigation area and drainage lines will not be applicable. Furthermore, the WWTW will make use of an existing access road, which was therefore not included in the assessment.

As indicated, the existing waste disposal site has already resulted in some modification of some of the drainage lines in the area and this will significantly decrease the anticipated impact and risk that the proposed WWTW will have.

The following risks, activities and impacts associated with the proposed WWTW and irrigation area which are likely to affect a few of the surrounding drainage lines have been identified:

- The proposed layout will encroach marginally into two small portions of the drainage lines around the site, which is likely to result in some impacts on them (Appendix A: Map 2). The existing waste disposal site has already modified these drainage lines and the proposed WWTW will therefore not entail a large additional impact on these drainage lines, i.e. the waste disposal site has already resulted in modification of a portion of the drainage lines and the additional encroachment of the WWTW into them will therefore not add extensive impacts/modification to them. The anticipated risk will therefore also be low.

- During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase susceptibility of the system to increased infestation by invasive plant species. This can effectively be prevented by implementing an adequate storm water management system which should mainly consist of erecting a low berm around the entire perimeter of the WWTW. This is also a standard management practice at WWTWs. This berm should then enable dirty water to be retained within the operational area, keeping it separate from the water around the site and within the drainage line. Monitoring and eradication of exotic weeds and invasive species on and around the WWTW should be implemented and maintained throughout the operation of the WWTW. This should also specifically target the highly invasive *Prosopis glandulosa* trees in the area.

- The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding drainage lines. Instead, the WWTW makes use of oxidation ponds, while effluent is used for irrigation of a proposed irrigation area (most likely supporting dates). This effectively prevents discharge and the associated impacts from affecting the downstream system. This is however entirely dependent on the WWTW not exceeding its capacity and resulting in sewage overflow into any drainage lines. As long as no overflow takes place, the anticipated risk is regarded as low. The impacts that the proposed WWTW will have will therefore entirely depend on the ability to prevent effluent discharging into the downstream system.

- The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates). The irrigation area itself, will encroach into several of the smaller drainage lines (Appendix A: Map 2). However, these drainage

lines should be excluded and retained within the irrigation area, to maintain their natural function. Furthermore, the irrigation will generate runoff, which may then alter the moisture and flow regime of these drainage lines, further modifying them. However, given the small size of the drainage lines, arid environment and high evaporation rates, this is likely to remain a localised impact and should therefore also entail a low risk, as long as the drainage lines are retained as natural channels within the irrigation area.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

Mitigation as recommended should be implemented as far as possible.

For the complete risk assessment please refer to Appendix E.

Phases	Activity	Impact	Risk Rating	Confidence level	Control measures
Construction/ Operation	Construction of the Sending WWTW.	The proposed WWTW will encroach into and occur in close proximity to some of the small drainage lines in the surroundings. This will include removal of the vegetation layer, transforming the soil profile and in so doing affecting the hydrology, geomorphology, flow and flooding regime. Increased establishment of exotic weeds and invaders due to disturbance is also probable.	**L**	**80%**	Construction of the WWTW is likely to permanently modify small portions of these drainage lines. However, since the existing waste disposal site has already modified these drainage lines, the proposed WWTW is unlikely to further increase this impact to a significant extent. As a result, the risk is anticipated to remain low. However, this is dependent on the WWTW preventing any impacts on the downstream section of these drainage lines.
Construction/ Operation		During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase susceptibility of the system to increased infestation by invasive plant species.	**L**	**80%**	This impact will be mainly during the operational phase but will only cease once rehabilitation has been completed and an indigenous vegetation layer has become established. This activity is anticipated to have a low risk of impact as long as adequate mitigation and comprehensive rehabilitation are adhered to. Measures must be implemented to minimise the amount of sediment entering these drainage lines. An adequate storm water management system which should mainly consist of a low berm around the entire perimeter of the WWTW should be implemented. This berm should then enable dirty water to be retained within the operational area, separating it from the water around the site and within the surrounding drainage lines.
Construction/ Operation		The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding drainage lines. Instead, the WWTW makes use of oxidation ponds while effluent is used for irrigation of a proposed irrigation area. This effectively prevents	**L**	**80%**	This is however entirely dependent on the WWTW not exceeding its capacity and resulting in sewage overflow into any drainage lines. As long as no overflow takes place, the anticipated risk is regarded as low. The impacts that the proposed WWTW will have are therefore entirely dependent on the ability to prevent effluent discharge into the downstream system.

		discharge and the associated impacts from affecting the downstream system.			
Construction/ Operation	Construction of the associated irrigation area.	The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates). The irrigation area itself, will encroach into several of the smaller drainage lines.	**L**	**80%**	These drainage lines should be excluded and retained within the irrigation area, to maintain their natural function. Furthermore, the irrigation will generate runoff, which may then alter the moisture and flow regime of these drainage lines, further modifying them. However, given the small size of the drainage lines, arid environment and high evaporation rates, this is likely to remain a localised impact and should therefore also entail a low risk, as long as the drainage lines are retained as natural channels within the irrigation area.

5. Biodiversity Sensitivity Rating (BSR)

Habitat diversity and species richness:
Habitat diversity at and around the site can be considered as moderate. The area, which is dominated by sandy plains, hills and ridges, also contains numerous small drainage lines transecting it. This results in a moderate diversity of habitat which includes low ridges, rocky and sandy habitats and drainage lines supporting a low and sparse riparian vegetation layer. As a result of the moderate habitat diversity, the area also contains a moderate species diversity which includes scant low shrubs, grasses, succulents and riparian vegetation dominated by low shrubs and herbaceous species. However, the site has a small extent which therefore limits the habitat diversity. Likewise, the species diversity is also considered moderate and not significant when seen in the context of the surrounding area.

Presence of rare and endangered species:
The site and surroundings contain a high number of protected species with several also being considered uncommon and of high conservation value. However, the site itself only contains a few widespread, but protected species, including *Boscia albitrunca* (Appendix B).

Ecological function:
The site together with the proposed WWTW functions as habitat for a variety of fauna, supports a specific vegetation type and also functions as part of the drainage line system. As a result of the existing waste disposal site, these functions have been affected to a significant extent. The local ecological function at the site is therefore modified, while the surroundings still support a natural ecosystem and the ecological function is therefore overall considered as moderately modified.

Degree of rarity/conservation value:
The existing waste disposal site has already been transformed, however, the surrounding areas proposed for the new WWTW, still consist of a natural vegetation layer. The proposed expansion will therefore result in the loss of habitat and vegetation. In terms of species diversity, species composition and uniqueness of the habitat, the site is considered to have a moderate conservation value.

Percentage ground cover:
Percentage ground cover is low, which is however natural for this arid region. The portion occupied by the existing waste disposal site is considered even lower than the surrounding natural areas, and overall percentage vegetation cover is therefore considered as at least moderately modified.

Vegetation structure:
The footprint of the existing waste disposal site has been completely transformed and any remaining vegetation on the site itself consists of pioneer species and invasive species. The area for the proposed WWTW still consists of natural vegetation which includes scant low shrubs, grasses, succulents and riparian vegetation dominated by low shrubs and herbaceous species. Overall, the vegetation structure is therefore considered as at least moderately modified.

Infestation with exotic weeds and invader plants:
The existing waste disposal site and also the surrounding areas contain the invasive tree, *Prosopis glandulosa*, present as scattered specimens and overall, the presence of weeds and invasive species must therefore be regarded as high (Appendix B).

Degree of grazing/browsing impact:
The site which forms part of the municipal area is therefore affected by a significant level of overgrazing and trampling by domestic livestock.

Signs of erosion:
Due to the slope and moderate overgrazing of the area, some erosion is present but still considered to be moderate.

Terrestrial animals:
Tracks and signs of mammals are not abundant around the site. It is considered highly likely that the mammal population has been affected by the existing waste disposal site. As a result, it is considered unlikely that species of conservational importance will occur on and around the site. The mammal population is therefore anticipated to be dominated by generalist species which are better adapted to these disturbed areas. In addition, mammal species which are rare and endangered are often habitat specific and sensitive to habitat change. It is therefore considered unlikely that such species would occur on the site.

Table 5: Biodiversity Sensitivity Rating for the proposed WWTW.

	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	3		
Degree of grazing/browsing impact		2	
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Subtotal	6	16	0
Total		22	

6. Biodiversity sensitivity rating (BSR) interpretation

Table 6: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Sending WWTW	22	Degraded	3

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

The area proposed for the new Sending WWTW has been rated as being Degraded. This is mostly a result of the existing waste disposal site, which has already modified the area and resulted in significant disturbances, though elements of high conservation value, in particular the small drainage line system, are still present.

The proposed new Waste Water Treatment Works (WWTW) will be situated within the area of Sending approximately 6 km to the west of the small settlement of Onseepkans (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 2 hectares, while an associated irrigation area will also be approximately 2 hectares. The footprint of the proposed WWTW will be situated in an already disturbed area, consisting of a sewage disposal pit and landfill disposal site. The area is therefore already transformed, while the immediate surroundings, which still consist of natural vegetation, contain varying degrees of disturbance associated with the waste disposal site. The site forms part of an arid region and watercourses are consequently limited to ephemeral systems. A series of small drainage lines occur on and around the site, originating along a prominent mountainous area to the east and with at least one of these being directly affected by the WWTW and the proposed irrigation area. An existing access road will be used for the proposed WWTW. The proposed development of the WWTW will therefore have to take into account its effect on this drainage system and implement comprehensive mitigation in order to minimise its impact on this drainage system (Appendix A: Map 2).

The footprint of the existing sewage disposal pit and the majority of the landfill site have been completely transformed from the natural conditions. This has also been confirmed by the current survey and any remaining vegetation on the site itself consists of pioneer species and invasive trees (Appendix A: Map 1). The existing sewage pit and landfill site are therefore largely irrelevant to this assessment. The areas identified for the proposed WWTW (west of the site) do however still consist of natural vegetation, though high levels of disturbance were also noted here. The area is dominated by sandy plains, sloping toward the Orange River, with mountainous terrain occurring to the east of the site, where several small drainage lines, transecting the area, originate. This results in a moderate diversity of habitat which includes low ridges, rocky and sandy habitats and drainage lines supporting a low and sparse riparian vegetation layer. As a result of the moderate habitat diversity, the area also contains a moderate species diversity which includes scant dwarf karroid shrubs, grasses, succulents and several riparian shrubs.

The surface water of the surrounding area consists of a series of small drainage lines, all of which originate on the hill to the east, draining northwards toward the surrounding sandy plains, where their drainage pattern is not clearly defined. They are however considered eventual tributaries of the Orange River (Appendix A: Map 1). The Orange River is situated more than 3 km to the west of the site, and is therefore unlikely to be directly affected by the WWTW. However, these small drainage lines will be affected by the WWTW and irrigation area and may therefore still have an indirect impact on downstream areas. The assessment will therefore be based on the affected drainage lines, though still taking into account the impact that the development may have on the downstream Orange River.

As indicated, several drainage lines are present on and around the site, containing small, but distinct channels, all of which drain from east to west (Appendix A: Map 2). These drainage lines form part of an intricate drainage network, approximately 3 km long, originating on the prominent hill to the east and north of the site, flowing into the Orange River to the west of the site. In

addition, at least one of these drainage lines will be situated in the WWTW layout, while a large portion of the irrigation area will be situated within the drainage line, thus resulting in the diversion and disruption of any surface flow within it. Furthermore, the existing waste disposal site also results in significant disturbance of several of these drainage lines, while several dirt track crossings also disrupt their natural flow pattern. This should therefore significantly decrease the anticipated impact of the new WWTW and irrigation area on these drainage lines, as they have already been modified. However, should the WWTW be managed as a closed system, the drainage lines allowed to flow past the WWTW and the irrigation area accommodate adequate flow through it, this will limit the impact on downstream areas. This is particularly likely, given the arid climate of the area, which limits surface runoff significantly. The proposed WWTW and irrigation area should therefore ensure suitable management to prevent downstream impacts. As indicated, the drainage network contains several drainage lines, ranging in size, with the channel ranging from being less than a metre wide, to approximately 2 metres in width. These drainage lines originate along the large hill to the east, where they can be quite prominent, although once reaching the plain, they become less defined, becoming completely obscured where they infiltrate into the sandy plains. This is a consequence of the sandy substrates, which promote infiltration and diffuse flows, as opposed to concentrated channel flows. This also indicates the small nature of these drainage lines, with low volume flows occurring on a very infrequent basis. All these drainage lines are therefore ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events (which will only very rarely occur).

As indicated, the Orange River downslope of the site is highly unlikely to be affected by the development (Appendix A: Map 1). The drainage pattern of the drainage lines, including an obscured downstream channel, also confirms that it is highly unlikely for any contamination to reach the river. However, groundwater contamination remains likely, which coupled with groundwater flows, may then still have an indirect impact on the Orange River. Furthermore, the Orange River in this section is listed as a National Freshwater Ecosystem Priority Area (NFEPA), which is afforded to only a select few watercourses in South Africa. Very few watercourses in the country are still natural with almost all being affected by some significant impact and being modified. Being an NFEPA system signifies that this system has been identified as one of those few remaining natural watercourses and it is therefore of utmost importance that its natural condition be retained and the current and proposed WWTW should not result in any adverse impact upon it. This can be done by managing the WWTW as a closed system, preventing any impacts to downstream areas.

Delineation of the small drainage lines affected by the WWTW and proposed irrigation area was done by a combination of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). The small drainage lines all clearly form part of a natural drainage network, though also having been modified by the existing waste disposal site (Appendix A: Map 2). None of these drainage lines however contain any wetland conditions, both in terms of soils and vegetation. Though they do not contain any natural wetland conditions, they clearly contain riparian conditions, also containing a defined channel, with active channel banks and sparse, but visible riparian vegetation, confirming that most of these must be regarded as natural watercourses. The WWTW will therefore have to ensure that none of these will be affected by any storm water inflow from the site nor any overflow from the oxidation ponds. This is likely to affect at least one of these drainage lines. Managing the impact can easily be attained by diverting the drainage line around the border of the WWTW and erecting a diversion berm around the borders of the WWTW. Where the drainage line flows through the irrigation area, it should be excluded from planting, allowing for unimpeded flow to occur.

The drainage line network which will be affected by the WWTW consists of several small, ephemeral drainage lines (Appendix A: Map 2). Being devoid of wetland conditions and not being characterised by any of the hydrogeomorphic wetland types, a WET-Health determination is not applicable to this system. In addition, since the system is strictly ephemeral and contains no aquatic component, it is also not possible to conduct a SASS5 macro-invertebrate assessment. These small drainage lines can however still be accurately assessed by using an overall determination of the Index of Habitat Integrity (IHI) (Appendix D). This is considered to give a good representation of the condition of the drainage line system which will be affected by the WWTW. The IHI will be taken as representative of the Present Ecological State (PES) of this system.

The drainage line network on the site which is already being affected by the waste disposal site and which will also be affected by the proposed WWTW, is considered to be modified to some degree, its modification mostly associated with the impacts caused by the waste disposal site. Though several drainage lines are present on and around the site, these were assessed as a single drainage network system. An Index of Habitat Integrity (IHI) was conducted for this drainage line network as a whole, which will be affected by the WWTW (Appendix D). The results of the IHI indicated that the ephemeral drainage line network has an Instream IHI of category C: Moderately Modified and Riparian IHI of category C: Moderately Modified. This is considered accurate, given the largely natural catchment and surroundings, though the existing waste disposal site clearly results in significant impacts upon it, resulting in a moderate modification of the drainage line network. Despite being somewhat modified and also taking into account that it may also affect the downstream Orange River, which is a highly sensitive system, the drainage line network should still be considered as sensitive and while it is inevitable that the WWTW will have an impact on it, these impacts should not be allowed to affect the downstream system. The EI&S of the affected drainage line network at the site has been rated as being Moderate.

A Risk Assessment for the proposed WWTW and irrigation area which will affect the small drainage line network, has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Activities likely to be associated with the WWTW and which will likely affect some of the drainage lines around the site, include encroaching into and modifying a portion of the drainage line, spillages and overflow of the WWTW entering the drainage line which may affect the downstream system, and increased disturbance and sedimentation of the drainage line due to the construction and operation of the WWTW (Appendix A: Map 2). Activities likely to be associated with the irrigation area and which will likely affect several of the drainage lines include encroaching into and modifying a portion of the drainage lines, increased moisture regime and modification of the flow regime due to irrigation runoff, and consequent increased erosion of the channel.

The following risks, activities and impacts associated with the proposed WWTW and irrigation area which are likely to affect a few of the surrounding drainage lines have been identified:

- The proposed layout will encroach marginally into two small portions of the drainage lines around the site, which is likely to result in some impacts on them (Appendix A: Map 2). The existing waste disposal site has already modified these drainage lines and the proposed WWTW will therefore not entail a large additional impact on these drainage lines, i.e. the waste disposal site has already resulted in modification of a portion of the drainage lines and the additional encroachment of the WWTW into them will therefore

not add extensive impacts/modification to them. The anticipated risk will therefore also be low.

- During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase susceptibility of the system to increased infestation by invasive plant species. This can effectively be prevented by implementing an adequate storm water management system which should mainly consist of erecting a low berm around the entire perimeter of the WWTW. This is also a standard management practice at WWTWs. This berm should then enable dirty water to be retained within the operational area, keeping it separate from the water around the site and within the drainage lines. Monitoring and eradication of exotic weeds and invasive species on and around the WWTW should be implemented and maintained throughout the operation of the WWTW. This should also specifically target the highly invasive *Prosopis glandulosa* trees in the area.
- The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding drainage lines. Instead, the WWTW makes use of oxidation ponds, while effluent is used for irrigation of a proposed irrigation area (most likely supporting dates). This effectively prevents discharge and the associated impacts from affecting the downstream system. This is however entirely dependent on the WWTW not exceeding its capacity and resulting in sewage overflow into any drainage lines. As long as no overflow takes place, the anticipated risk is regarded as low. The impacts that the proposed WWTW will have will therefore entirely depend on the ability to prevent effluent discharging into the downstream system.
- The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates). The irrigation area itself, will encroach into several of the smaller drainage lines (Appendix A: Map 2). However, these drainage lines should be excluded and retained within the irrigation area, to maintain their natural function. Furthermore, the irrigation will generate runoff, which may then alter the moisture and flow regime of these drainage lines, further modifying them. However, given the small size of the drainage lines, arid environment and high evaporation rates, this is likely to remain a localised impact and should therefore also entail a low risk, as long as the drainage lines are retained as natural channels within the irrigation area.

8. Recommendations

- Where construction activities occur, it is important that comprehensive rehabilitation and monitoring of the rehabilitation take place. This includes removal of all construction material. Excavated rock may not be left in heaps and must be removed or distributed evenly over the terrain to represent a natural environment. Compacted areas must be ripped. Construction roads not being utilised, must afterwards be rehabilitated.

- The following mitigation should be implemented to prevent or decrease the anticipated impacts on the small drainage line on the site and any impacts on the downstream system (Appendix A: Map 2):

    - An adequate storm water management system must be implemented, which should mainly consist of erecting a low berm around the perimeter of the WWTW. This is also a standard management practice at WWTWs. This berm should then enable dirty water to be retained within the operational area, separating it from clean water around the site and within the drainage lines.
    - The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding drainage lines. Instead, the WWTW should make use of oxidation ponds, while effluent should be used for irrigation of a proposed irrigation area (most likely supporting dates).
    - Monitoring and eradication of exotic weeds and invasive species on and around the WWTW should be implemented and maintained throughout the operation of the WWTW. This should also specifically target the highly invasive *Prosopis glandulosa* trees in the area.
    - The drainage lines downstream of the site should constantly be monitored for erosion, especially where the runoff generated by the irrigation area may result in erosion of the drainage channel. Where erosion is evident, this must be remedied.
    - Should erosion occur within any of the drainage lines, it is recommended that geotextiles be utilised to stabilise soils. Available options include gabions and geotextile materials.
    - A monitoring programme should be followed to quantify impacts and recommend mitigation to minimise impacts on the drainage lines at the site as well as the downstream system. Such monitoring should also consider monitoring of groundwater quality downstream of the site.
    - The required authorisations must also be lodged with the Department of Water and Sanitation (DWS) for the WWTW and the consequent impacts on the drainage line being affected by the development (Appendix A: Map 2).
    - Monitoring of construction and compliance with recommended mitigation measures must take place.

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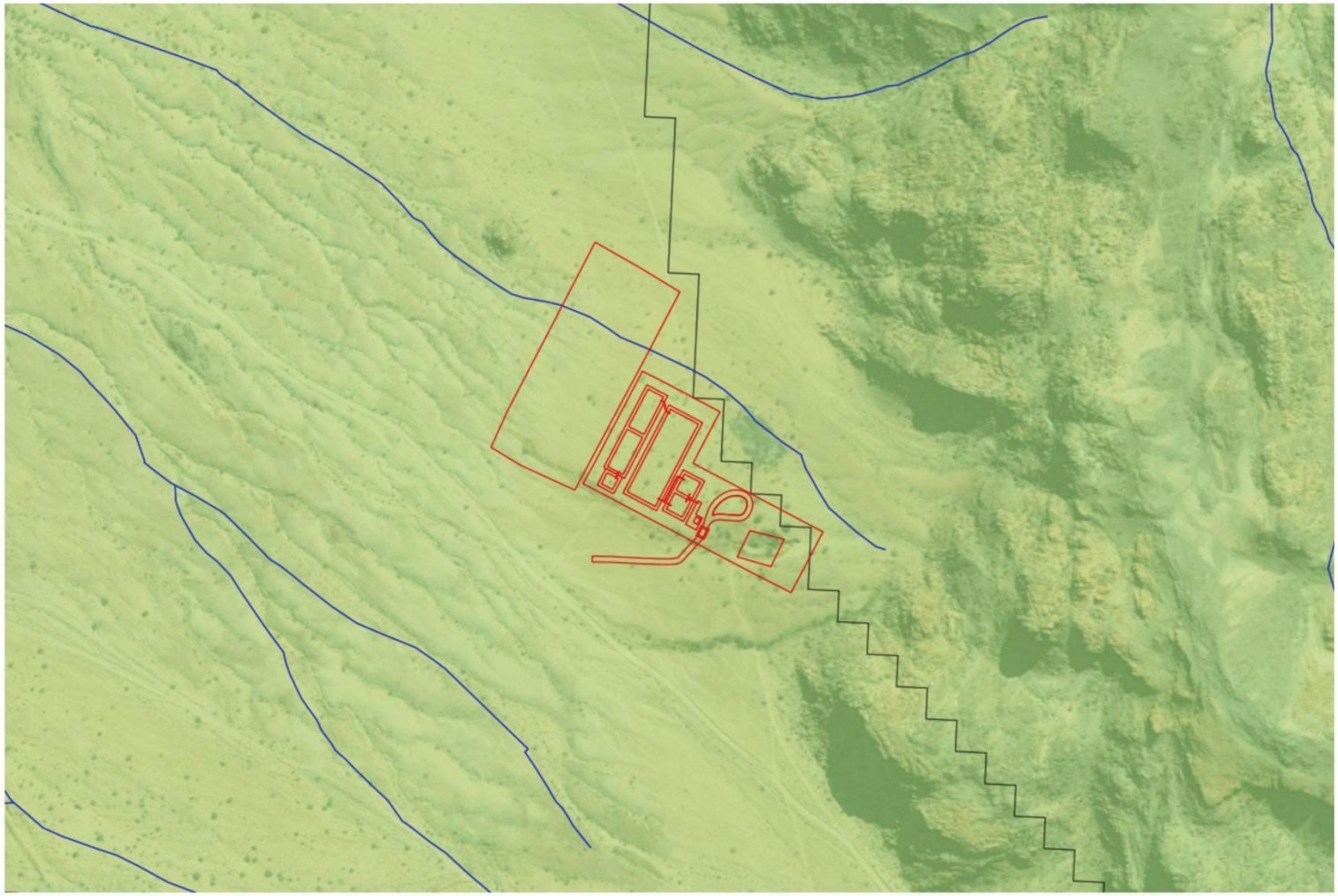
Appendix A: Maps

Locality map for the proposed new Waste Water Treatment Works (WWTW) situated near the settlement of Sending in Onseepkans Northern Cape Province.



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

Legend:

- WWTW and irrigation area
- Watercourses
- Remaining natural vegetation
- Wetlands and impoundments

Map Information

Spheroid: WGS 84

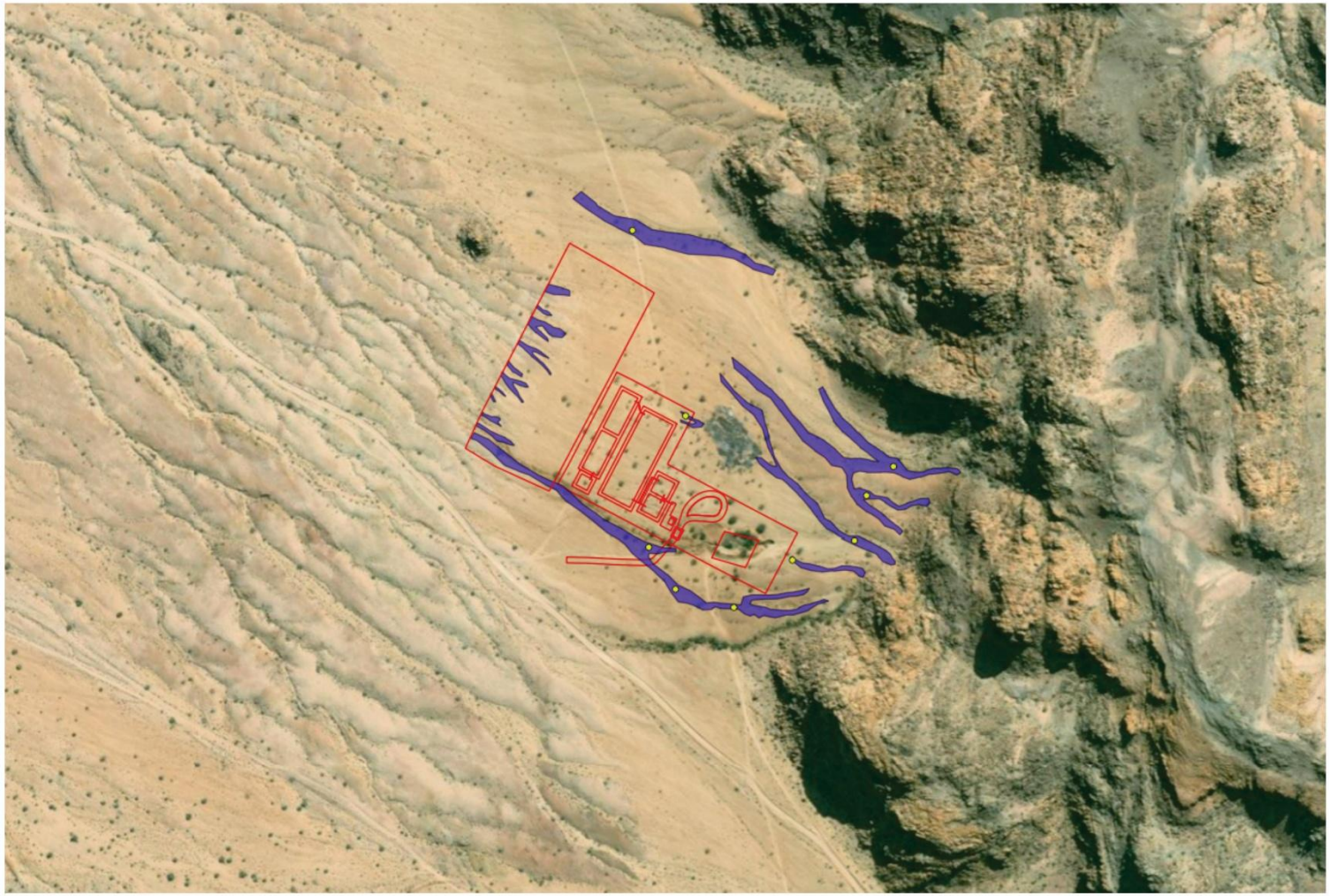
Quantum GIS

Scale: 1:6 000

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 proposed new WWTW and irrigation area near Sending. The approximate extent of remaining natural vegetation is indicated (National Biodiversity Assessment 2018) and indicates the area still consists of natural vegetation, however, the existing waste disposal site has resulted in localised loss of natural vegetation at the site. Available mapping resources also indicates the presence of small drainage lines on and around the site, which was also confirmed by the site survey, with several additional drainage lines also identified and the delineation refined by on-site delineation (refer to Map 2).

Riparian and wetland delineation map for the proposed new Waste Water Treatment Works (WWTW) situated near the settlement of Sending in Onseepkans, Northern Cape Province.



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Danhof
9310

Legend:

- WWTW and irrigation
- Delineated riparian zone
- Riparian sampling sites

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:6 000

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Map 2: Riparian delineation map of proposed new WWTW and irrigation area near Sending. The numerous drainage lines on and around the site have been delineated and the associated riparian indicated. This indicates several small drainage lines, originating along the hill to the east, draining westwards. The WWTW will avoid the majority of these, though marginally encroaching into two, while the irrigation area will encroach into several of these. The WWTW will need to be managed as a closed system, diverting flow associated with the drainage lines around the perimeter of the site. The irrigation area will also have to accommodate the drainage lines within its layout, allowing flow to continue along these drainage lines to the downstream areas.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Prosopis glandulosa*	Tree
Adenolobus garipensis	Tree
Aptosimum spinescens	Dwarf shrub
Blepharis mitrata	Herb
Boscia albitrunca	Tree
Cadaba aphylla	Shrub
Codon royenii	Herb
Indigofera pungens	Dwarf shrub
Justicia spartoides	Dwarf shrub
Petalidium setosum	Dwarf shrub
Phaeoptilum spinosum	Shrub
Schmidtia kalahariensis	Grass
Senegalia mellifera subsp. *detinens*	Tree
Sisyndite spartea	Shrub
Stipagrostis sp.	Grass

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 would consequently be permanently saturated, i.e. permanent zone of wetness. Moving 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. 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 would 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 altogether disappear 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)

For the complete IHI please contact the author of this report.

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Sending WWTW
UPPER LATITUDE	S 28.782735°
UPPER LONGITUDE	E 19.282421°
UPPER ALTITUDE	460m
LOWER LATITUDE	S 28.779825°
LOWER LONGITUDE	E 19.279830°
LOWER ALTITUDE	440m
SURVEY SITE (if applicable)	Sending drainage network
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Lower Orange
QUATERNARY	D81F
ECOREGION 2	28_1
DATE	14/01/2026
RIVER	Ephemeral Drainage Line
TRIBUTARY	Orange River
PERENNIAL (Y/N)	**N**
GEOMORPH ZONE	**FOOTHILL**
WIDTH (m)	**>0-2**

	MRU
INSTREAM IHI	
Base Flows	-0.5
Zero Flows	0.0
Floods	0.0
HYDROLOGY RATING	**0.2**
pH	1.0
Salts	2.0
Nutrients	2.0
Water Temperature	0.0
Water clarity	2.0
Oxygen	0.0
Toxics	2.5
PC RATING	**1.5**
Sediment	1.5
Benthic Growth	1.5
BED RATING	**1.5**
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 %	**76.9**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**2.8**

	MRU
RIPARIAN IHI	
Base Flows	-0.5
Zero Flows	0.0
Moderate Floods	0.0
Large Floods	0.0
HYDROLOGY RATING	**0.2**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	1.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	1.0
Erosion (non-marginal)	0.0
Physico-Chemical (marginal)	1.5
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 %	**74.5**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.7**

Appendix E: Risk Assessment Matrix

PROJECT:	**The proposed new Waste Water Treatment Works (WWTW) situated near the settlement of Sending in Onseepkans, Northern Cape Province.**

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities - Version 2.1

Name of Assessor:	Darius van Rensburg	**Signature:**	
SACNASP Registration Number:	400284/13		
Date of assessment:	14/01/2026		

Risk to be scored for all relevant phases of the project (**factoring in specified control measures**). MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	Overall Watercourse Importance	Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
CONSTRUCTION	Construction of the Sending WWTW.	The proposed WWTW will encroach into and occur in close proximity to some of the small drainage lines in the surroundings.	Drainage line network	C	Moderate	2	3	2	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		This will include removal of the vegetation layer, transforming the soil profile and in so doing affecting the hydrology, geomorphology,																		
		flow and flooding regime. Increased establishment of exotic weeds and invaders due to disturbance is also probable.																		
	Construction of the Sending WWTW.	During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil	Drainage line network	C	Moderate	2	3	1	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase																		
		susceptibility of the system to increased infestation by invasive plant species.																		
	Construction of the Sending WWTW.	The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding	Drainage line network	C	Moderate	1	2	1	1	1	**4**	1	4	**9**	**3**	**27**	80%	**21.6**	L	High
		drainage lines. Instead, the WWTW makes use of oxidation ponds while effluent is used for irrigation of a proposed irrigation area.																		
		This effectively prevents discharge and the associated impacts from affecting the downstream system.																		
	Construction of the associated irrigation area.	The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates).	Drainage line network	C	Moderate	3	2	3	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		The irrigation area itself, will encroach into several of the smaller drainage lines.																		
OPERATIONAL	Construction of the Sending WWTW.	The proposed WWTW will encroach into and occur in close proximity to some of the small drainage lines in the surroundings.	Drainage line network	C	Moderate	2	3	2	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		This will include removal of the vegetation layer, transforming the soil profile and in so doing affecting the hydrology, geomorphology,																		
		flow and flooding regime. Increased establishment of exotic weeds and invaders due to disturbance is also probable.																		
	Construction of the Sending WWTW.	During construction and extending into the operational phase, the WWTW will require clearance of vegetation disturbance of the soil	Drainage line network	C	Moderate	2	3	1	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		surface, which will increase surface erosion, sedimentation of some of the surrounding drainage lines and also increase																		
		susceptibility of the system to increased infestation by invasive plant species.																		
	Construction of the Sending WWTW.	The WWTW will be operated as a closed system and will not require discharge of treated effluent into any of the surrounding	Drainage line network	C	Moderate	1	2	1	1	1	**4**	1	4	**9**	**3**	**27**	80%	**21.6**	L	High
		drainage lines. Instead, the WWTW makes use of oxidation ponds while effluent is used for irrigation of a proposed irrigation area.																		
		This effectively prevents discharge and the associated impacts from affecting the downstream system.																		
	Construction of the associated irrigation area.	The treated effluent generated by the WWTW will be used to irrigate an adjacent irrigation area (most likely supporting dates).	Drainage line network	C	Moderate	3	2	3	2	1	**6**	2	4	**12**	**3**	**36**	80%	**28.8**	L	High
		The irrigation area itself, will encroach into several of the smaller drainage lines.																		