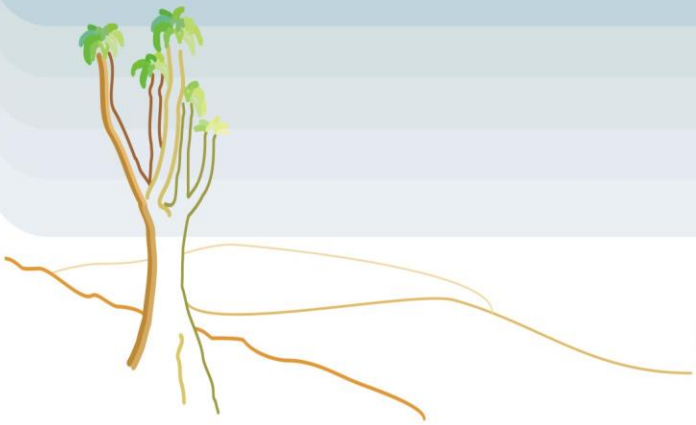


DPR
Ecologists & Environmental Services

Report on the ecological and wetland assessment for the proposed abstraction works in the Orange River near Keimoes and the bulk water pipeline extending to the settlement of Plangeni, Northern Cape Province.

April 2023

Prepared by:

Darius van Rensburg
Pr.Sci.Nat. 400284/13
T 083 410 0770
darius@dprecologists.co.za
P.O. Box 12726
Brandhof
9324

61 Topsy Smith Street
Langenhovenpark
9300

Prepared for:
MDA Consultants
9 Barnes Street
Westdene
9301

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	**Report on the ecological and wetland assessment for the proposed abstraction works in the Orange River near Keimoes and the bulk water pipeline extending to the settlement of Plangeni, Northern Cape Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Apr'23**

Executive Summary

The development consists of a small abstraction works situated on the southern bank of the Orange River near the small settlement of Blaauws Kop which is located approximately 10 km to the east of the town of Keimoes (Appendix A: Map 1). The abstraction works is quite small and will include an abstraction pipeline along the banks, a concrete platform and pump with below ground raw water pipeline. From this abstraction works a bulk water pipeline will be constructed which follows a route of approximately 2 km to the east and providing water to the small settlement of Plangeni (Appendix A: Map 1).

Endangered or Red Listed species are absent from the site and also considered somewhat unlikely to occur due to significant disturbance in the area. However, as indicated, several protected plant species do occur along the pipeline route (Appendix B). These are all relatively widespread but do still retain a significant conservation value. Where the shrub, *Boscia foetida*, as well as the tree, *Boscia albitrunca* will be affected and will require removal, the necessary permits will have to be obtained to do so. A few protected succulents are so common and widespread that they do not require transplanting though permits will still have to be obtained to remove them. These include *Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium,* and *Mesembryanthemum guerichianum.* A few other succulents are considered less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga.* These species transplant easily and the impact on them should be mitigated by doing a walkthrough survey prior to construction, permits obtained for all affected specimens and those transplanted to adjacent areas where they will remain unaffected.

From the description of the vegetation on the site it is evidently largely natural with significant levels of disturbance, while the western portion is also modified to a significant degree. The species diversity is fairly low while disturbance also promotes an increase in exotic weed establishment in many areas. In general, the pipeline route therefore does not contain elements of high terrestrial importance. However, the Orange River itself as well as several small drainage lines and watercourses occurring along the pipeline route will have a very high conservation value but will be discussed in detail within the wetland assessment section of the report (Appendix A: Map 3). In the regional context the area is listed as being a Critical Biodiversity Area 1 & 2 (CBA 1 & 2) due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops (Appendix A: Map 1 & 2). As a consequence, the proposed development may therefore still have significant impacts on the area. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the development should remain feasible. However, adequate mitigation will have to be implemented to ensure the impacts remain as low as possible. This should include keeping the clearance of vegetation and the construction footprint to a minimum and where laydown areas are required, to utilised only previously transformed areas for this.

The impact that the proposed pipeline will have on the mammal population is mainly concerned with the loss of habitat. The survey has indicated that the available habitat is already somewhat disturbed and will most probably support a population of generalist mammals. Furthermore, the footprint of the development will not be extensive and should therefore limit the impact on mammals. The impact would also be mostly temporary as long as adequate rehabilitation is

undertaken. Similar pipeline projects have indicated that adequate rehabilitation and topsoil management allows the affected area to return to a close to natural condition which would therefore re-instate the habitat for fauna and minimise the impact on the faunal population.

The Orange River flows from north east to south west with the abstraction works being situated on the southern banks and floodplain of the river (Appendix A: Map 3). The river contains a significant floodplain or riparian zone which will be dominated by alluvial soils and riparian vegetation. The floodplain has also been heavily affected by agricultural transformation and activities associated with it. As indicated, the pipeline route has a gradual slope toward the river and as a consequence several small watercourses have formed flowing toward the river (Appendix A: Map 3). These watercourses are generally quite small though the larger streams may still attain a channel width of approximately 3 meters. They are also ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events.

The Orange River and its associated riparian zone were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). The soil samples taken along the banks of the Orange River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 3). The upper zone or floodplain contains a minimal grey matrix, no mottles and is not considered as being a wetland area. Several small watercourses will also be crossed by the pipeline which drain toward the Orange River (Appendix A: Map 3). They all contain a fairly well defined main channel with riparian vegetation evident while wetland conditions are completely absent. This was also confirmed by soil samples which are completely devoid of soil wetness indicators.

An Index of Habitat Integrity (IHI) was conducted along the Orange River within the study area (Appendix D). The results of the IHI indicated that the Orange River has an Instream IHI of category C/D: Moderately to Largely Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts such as irrigation and clearance of riparian vegetation for agricultural operations. An IHI determination was also undertaken for the larger watercourse in the southern portion of the pipeline route and will be taken as indication of the overall condition of the three small watercourses that will be affected by the pipeline. The results of the IHI indicated that the affected watercourses an Instream and Riparian IHI of category B/C: Largely Natural to Moderately Modified. This largely corresponds with the on-site observations which indicate largely natural watercourses with a natural catchment but which has been modified to some degree by the Plangeni settlement.

A Risk Assessment for the proposed pipeline and abstraction works which will affect the Orange River and small watercourses along the pipeline route has been undertaken (Appendix E). The construction of the abstraction works at the bank of the Orange River can be retained to a low risk, as long as the construction footprint is retained to approximately 100 m^2 for both the abstraction pipeline and pump mountings. Where the construction of the pipeline will cross perpendicularly over the small watercourses the risk will likely be retained as low, especially since infrastructure crossings are already present. However, should the pipeline be located within the main channel and parallel to the direction of flow, the disturbance of the watercourse will be higher and the subsequent risk will be moderate. This scenario is most likely for the southern, larger watercourse, depending on the pipeline alignment that is followed (Appendix A: Map 3). These risk determinations are however subject to the recommended mitigation being implemented.

Table of contents

Ecological 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 amount of endemic species and in terms of plant diversity ranks third 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 better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

Water is essential and crucial to the survival of all living organisms as well as ecosystem processes. This also applies to the survival of humans as we need daily intake of water. We, as humans, also utilise water for a range of other daily tasks and it is considered an essential component of our daily lives. It is therefore necessary for a community to have easy access to a potable water supply. The provision of water to a community must therefore take priority.

The development consists of a small abstraction works situated on the southern bank of the Orange River near the small settlement of Blaauws Kop which is located approximately 10 km to the east of the town of Keimoes (Appendix A: Map 1). The abstraction works is quite small and will include an abstraction pipeline along the banks, a concrete platform and pump with below ground raw water pipeline. From this abstraction works a bulk water pipeline will be constructed which follows a route of approximately 2 km to the east and providing water to the small settlement of Plangeni (Appendix A: Map 1). The abstraction will undoubtedly affect the banks of the Orange River though the impact should remain limited due to the small size of the proposed works. The pipeline itself will also likely affect a few small watercourses and which will have to be taken into account. The footprint of the proposed pipeline still consists of natural

vegetation but which contains moderate levels of disturbance as a result of the activities associated with the surrounding agriculture and residential land uses.

A site visit was conducted on 09 January 2023. The study area includes the entire footprint of the abstraction works as well as the 2km bulk water pipeline. A detailed survey of the Orange River at the site was undertaken as well as the terrestrial vegetation along the pipeline route and watercourses which will be affected by it. The site survey was conducted during mid-summer and though the area has recently received ample rains, because it is situated in a very arid region, this would still influence vegetation identification. However, vegetation was much more prominent than normal and the delineation of wetland and riparian areas were accurately undertaken.

For the above reasons it is necessary to conduct an ecological and wetland assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed mining 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.

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 contributes toward economic, aesthetic, spiritual, cultural and many recreational values. Yet the integrity of freshwater ecosystems in South Africa is 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 recourses between different stakeholders, i.e. individuals, communities, corporate and industrial) and institutional (Implementing appropriate governance and management). Water affects every activity and aspiration of human society and sustains all ecosystems.

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

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

1.4 Details and expertise of specialist

DPR Ecologists and Environmental Services (Pty) Ltd.
Darius van Rensburg *Pr. Sci. Nat.*
61 Topsy Smith
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 attend conferences and courses in order to stay up to date with current methods and trends:

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

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the abstraction and pipeline development.
- To identify possible negative impacts that could be caused by the proposed clearing of vegetation and construction of the pipeline development.
    - Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the ecosystem.
    - Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.
    - Extent refers to the spatial influence of an impact.
    - Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.
    - Probability refers to how often the activity/event or aspect has an impact on the environment.
- To provide a description of watercourses, wetlands and riparian vegetation included within the study area.
- 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 evaluate the present state of the wetlands and riparian vegetation in close proximity to the site. The importance of the ecological function and condition will also be assessed.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in close proximity to construction.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the proposed site.
- The overall status of the vegetation on site.
- Species composition with the emphasis on dominant-, rare- and endangered species.

The amount of disturbance present on the site assessed according to:

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

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).

- The overall condition of the habitat.

2.3 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Determine the presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.
- Describe watercourses and wetlands and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

2.4 Limitations

- Due to the very arid region several bulbs, seasonal herbs and subterranean succulents may have been overlooked as leaves and flowers may be absent due to their dependence on rainfall events.
- Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- Due to extensive agriculture operations and transformation this may have altered soil layers and the morphology of the river banks which would complicate the delineation of wetland and riparian areas.
- Due to time constraints only limited surveys of watercourses were done.
- Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

General ecology:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE).
- NBA 2018 Technical Report: Inland Aquatic (Freshwater) Realm.
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- Namakwa District Biodiversity Sector Plan (2008).
- Northern Cape Critical Biodiversity Areas Plan (2016).

Terrestrial vegetation:

- Red Data List (Raymondo *et al.* 2009)
- Vegetation types (Mucina & Rutherford 2006)
- Field guides used for species identification (Adams 1976, Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Fish *et al* 2015, Gibbs-Russell *et al* 1990, Manning 2009, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Van Oudtshoorn 2004, Van Rooyen 2001, Van Rooyen & Van Rooyen 2019, Van Wyk & Van Wyk 1997).

Terrestrial fauna:

- Field guides for species identification (Smithers 1983, Child *et al* 2016, Cillié 2018).

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. Observation w.r.t. the general ecology of the area includes:

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

Ecological aspects surveyed and recorded includes:

- The overall ecology of an area including the diversity of species, uniformity or diversity of habitats and different vegetation communities.
- Identification and delineation of distinct vegetation communities ad habitats and the ecological drivers responsible for these distinct communities, i.e. soil, geology, topography, aspect, etc.
- A comprehensive plant species survey including the identification of protected, rare or threatened species.
- Any ecological process or function which is important to the ecosystem including ecological drivers such as fire, frost, grazing, browsing, etc. and any changes to these processes.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.
The state of the habitat was also assessed.

In order to provide a visually representative overview of the results obtained from the survey, site sensitivity mapping will also be done. This should indicate the relative importance of different ecological elements on the site as obtained from the survey. In general, these levels of sensitivity will include:

- Low Sensitivity – normally confined to areas that are completely transformed from the natural condition or degraded to such an extent that they are no longer representative of the natural ecosystem. Such areas will also no longer contain any ecological processes of importance relative to the surrounding areas, i.e. in some instances such as watercourses which are completely transformed but still provide important ecological functions, a low level of sensitivity will not apply.

- Moderate Sensitivity – normally applicable to areas that are still natural and therefore does still have some ecological importance but which do not contain elements of high conservation value and are not essential to the continued functioning of surrounding areas. Areas of Moderate Sensitivity usually require some mitigation but can be developed without resulting in high impacts.

- High Sensitivity – areas of high sensitivity contain one or more ecological elements which are considered of high conservation value. Such areas are normally preferred to be excluded from a development but where this is not possible, will require comprehensive mitigation and is also likely to result in high impacts.

- Very High Sensitivity – these areas are critical to the continued functioning of the ecosystem on and around the site. Development of such areas normally represent a fatal flaw and should be excluded from development. No manner of mitigation is able to decrease the anticipated impact in these areas.

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

- Perform desktop overview of the study area utilising available resources (Section 3.1). From the desktop overview identify the different landscape forms, possible wetland

areas, watercourses and their relative flow patterns. Using this information, identify transects and sample plots for possible on-site survey. This should be both representative of the wetland or watercourse as a whole but should also include any prominent or significantly unique features.

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

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

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

the riparian vegetation along the banks of the watercourse. This will also include the description of any impacts or modification of the watercourse.

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

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

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

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

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

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

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

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

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

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

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

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

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

3.3 Criteria used to assess sites

The following criteria is also 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 importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 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 though, can 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 practises (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 tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

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

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows 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 signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

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

3.4 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 the Table 1:

Table 1: Biodiversity sensitivity ranking

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

4. ECOLOGICAL OVERVIEW OF THE SITE

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

4.1 Overview of ecology and vegetation types (Mucina & Ruterford 2006)

Refer to the list of species encountered on the pipeline route and surroundings in Appendix B.

According to Mucina & Rutherford (2006) and utilising current mapping resources (National Biodiversity Assessment 2018) the site is indicated to consist of Lower Gariep Alluvial Vegetation (Aza 3) along the riparian zone of the Orange River while the terrestrial portion of the pipeline route consists of Bushmanland Arid Grassland (NKb 3) (Appendix A: Map 1). The former is currently listed as an Endangered (EN) ecosystem while the latter is still listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 2). The Lower Gariep Alluvial Vegetation is associated with the riparian zone or floodplain of the Orange River and this area is being extensively utilised for irrigation which is therefore largely transformed. Any remaining portions of this vegetation type would therefore be considered to have a high conservation value. The Bushmanland Arid Grassland consists of extensive plains dominated by sparse grassland but which is not currently subjected to any pronounced development pressures.

The Northern Cape Critical Biodiversity Areas Plan (2016) has been published in order to identify areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA). The western portion of the pipeline route falls within a Critical Biodiversity Area 1 (CBA 1) while the eastern portion falls within a Critical Biodiversity Area 2 (CBA 2) and these areas are therefore of high conservation value (Appendix A: Map 2). The reason for being listed as CBA 1 and CBA 2 is due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the extent and magnitude of the impacts should remain fairly low.

The development consists of a small abstraction works situated on the southern bank of the Orange River near the small settlement of Blaauws Kop which is located approximately 10 km to the east of the town of Keimoes (Appendix A: Map 1). The abstraction works is quite small and will include an abstraction pipeline along the banks, a concrete platform and pump with below ground raw water pipeline. From this abstraction works a bulk water pipeline will be constructed which follows a route of approximately 2 km to the east and providing water to the small settlement of Plangeni (Appendix A: Map 1). The abstraction will undoubtedly affect the banks of the Orange River though the impact should remain limited due to the small size of the proposed works. The pipeline itself will also likely affect a few small watercourses and which will have to be taken into account. The footprint of the proposed pipeline still consists of natural vegetation but which contains moderate levels of disturbance as a result of the activities associated with the surrounding agriculture and residential land uses.

The majority of the pipeline route, especially the eastern portion, is still dominated by natural vegetation and consists of a sparse but natural grass layer with scattered shrub and small

trees. The western portion of the pipeline route, situated largely within the floodplain or riparian zone of the Orange River and which would normally be dominated by Lower Gariep Alluvial thicket vegetation has been transformed to a significant extent with only small patches of natural vegetation remaining. These two sections of the pipeline route can also be differentiated in terms of soils and vegetation composition where the western alluvial thicket is dominated by fine alluvial soils with large trees, dense thicket and stands of reeds while the eastern terrestrial portion is dominated by coarse, sandy soils with rocky outcrops and a sparse grass layer adapted to highly arid conditions.

Given the surrounding agricultural land use and the proximity of the Plangeni settlement the natural vegetation also contains significant levels of disturbance in many areas. In the western portion, the adjacent vineyards and irrigation leads to significant disturbance while the removal of the riparian thicket, runoff from irrigation and historical land use has resulted in significant degradation of this area. The eastern portion situated in natural areas are mostly affected by the proximity of the Plangeni settlement in terms of refuse dumping, dirt tracks, overgrazing by domestic livestock and increased runoff from the urban area. This has caused substantial degradation of the natural vegetation though elements of conservation value are clearly still present.

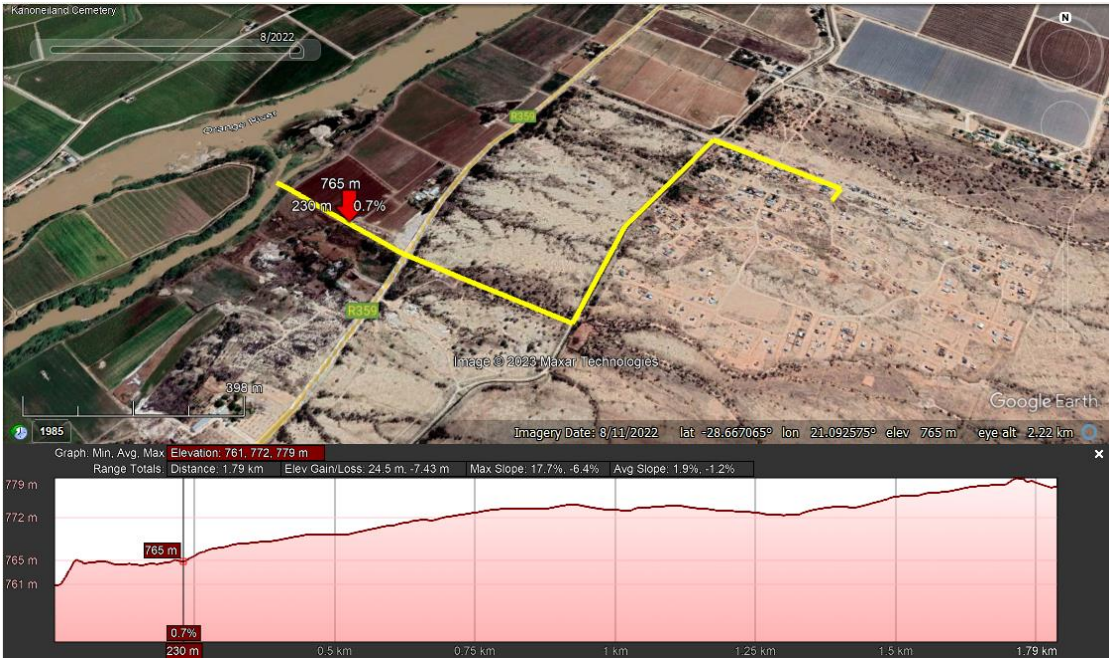


Figure 1: Aerial view of the proposed pipeline route (Google Earth 2022). The elevation profile clearly illustrates the gradual slope from the settlement of Plangeni toward the Orange River. Note also extensive agriculture along the river.

Figure 2: The western portion of the pipeline near the Orange River has been heavily affected by transformation for agriculture and irrigation.

Figure 3: The majority of the pipeline route, especially the eastern portion still consists primarily of natural vegetation. Note the low vegetation cover due to the arid region.

Figure 4: Localised disturbance and transformation in the area include dirt tracks and an irrigation canal.

Figure 5: The portion of the pipeline situated adjacent to the Plangeni settlement is characterised by high levels of disturbance.

As previously indicated, the topography of the pipeline route is dominated by a sandy plain in the eastern portion which gradually slopes toward the west, with the western portion of the pipeline route consisting of the floodplain or riparian zone of the Orange River which is largely level with only a slight slope towards the river. The banks of the river is dominated by steep slopes. The overall slope of the area is therefore gentle, except for the riverbanks which are very steep. The topography is still largely intact with only dirt tracks, an irrigation canal and R359 tarred road causing some modifications to the surface topography. The gradual slope toward the Orange River does promote the formation of concentrated runoff patterns which promotes the formation of drainage and stream channels and several of these will also be crossed by the pipeline route of which a few are fairly large and the survey also indicated that these experience significant flash flooding after rainfall events. The Orange River and these associated drainage lines and stream channels and the affect that the pipeline will have on them will be discussed in detail in the wetland assessment section of the report (Appendix A: Map 1 & 3). The pipeline route has an elevation of 780 m at the Plangeni settlement which then decreases along the gradual slope to approximately 760 m along the banks of the Orange River. This also illustrates the gradual slope along the pipeline route.

Figure 6: The gradual slope of the pipeline route promotes the formation of several watercourses, some of which are clearly quite large and functions in terms of flash floods.

The soils are dominated by fine alluvial soils in the western portion within the floodplain and riparian zone of the Orange River while the eastern portion is dominated by red-yellow apedal soils which are freely draining. The soils depth seems to be fairly shallow in most areas, but notably so along watercourses where gneiss bedrock become exposed. A few scattered outcrops of gneiss also occurs along the pipeline route.

The following description of the vegetation on the site should give a good indication of the condition of the ecology on it.

As previously indicated, the pipeline route can roughly be divided into two sections, the western section consisting of alluvial vegetation associated with the floodplain and riparian zone of the Orange River and which is largely transformed and the eastern portion which consists of arid grassland and which is still largely natural.

The western portion of the pipeline route is dominated by high levels of disturbance and transformation which is also clearly visible in the vegetation composition. Large areas are dominated by reedbeds of the indigenous *Phragmites australis* which also indicates the presence of temporary saturation associated with the floodplain of the river but which is also most likely affected by runoff from adjacent irrigated areas and transformation which causes modification of runoff patterns and contributes to surface accumulation. Within and around the reedbeds are also numerous exotic weeds which may also form dense stands and also indicate the high levels of disturbance in this area. These exotic weeds also include *Argemone ochroleuca, Lactuca seriola, Conyza bonariensis* and *Verbena officinalis*. A few invasive trees have also become established, including *Morus alba* and *Prosopis glandulosa* of which the latter is also a seriously invasive plant in this region. These floodplains and riparian zone associated with large lowland rivers are naturally also characterised by significant disturbance (flooding and alluvial erosion often promote the establishment of pioneer vegetation). As a consequence, pioneer herbaceous species are also common in these areas and included *Boerhavia sp., Chenopodium album, Convolvulus sagittatus, Tribulus terrestris, Tetraena simplex* and *Mesembryanthemum guerichianum*. The riparian grass, *Cynodon dactylon* is also abundant within the floodplain. This description of the vegetation in this portion of the pipeline route therefore indicates high levels of disturbance and significant transformation. Remnants of the natural vegetation are however also still present and since this portion consists of Lower Gariep Alluvial Vegetation, an Endangered vegetation type, the proposed development will still have to take this into consideration (Appendix A: Map 1).

Figure 7: The vegetation in the western portion of the pipeline route is dominated by reedbeds and alluvial vegetation. While disturbance and transformation is extensive, remnant of the natural vegetation still remain and will have a high conservation value.

The eastern portion of the pipeline route is dominated by natural vegetation consisting of an arid grass and dwarf shrub layer. Areas of significant disturbance is however also present as a result of the proximity of the Plangeni settlement. The natural vegetation layer is dominated by dwarf karroid shrubs such as *Tetraena microcarpa, Tetraena decumbens, Justicia australis, Rhigozum trchotomum* and *Aptosimum spinescens*. The grass component is quite sparse and poorly represented and may be a result of the arid environment but is also likely coupled with livestock overgrazing. Grass species consist largely of *Schmidtia kalahariensis*. A few scattered larger shrubs occur around rocky outcrops consisting mostly of *Boscia foetida,* which is also a protected species and will have a significant conservation value. Given the arid nature of this region, a variety of succulent species are also present and include species such as *Kleinia longiflora, Ruschia sp., Talinum arnotii, Mesembryanthemum coriarium, Potulaca kermesina, Ruschia cononotata* and *Monsonia salmoniflorum*. Several of these are also listed as protected species though are quite widespread and common and where the pipeline construction will affect them, the necessary permits will have to be obtained for their removal (Appendix B). A few other protected succulent species are considered somewhat less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga* (Appendix B).

Figure 8: The eastern portion of the pipeline route is dominated by natural vegetation. Note the arid nature of this region and the low percentage vegetation cover as a result.

Endangered or Red Listed species are absent from the site and also considered somewhat unlikely to occur due to significant disturbance in the area. However, as indicated, several protected plant species do occur along the pipeline route (Appendix B). These are all relatively widespread but do still retain a significant conservation value. Where the shrub, *Boscia foetida*, as well as the tree, *Boscia albitrunca* will be affected and will require removal, the necessary permits will have to be obtained to do so. A few protected succulents are so common and widespread that they do not require transplanting though permits will still have to be obtained to remove them. These include *Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium,* and *Mesembryanthemum guerichianum.* A few other succulents are considered less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga.* These species transplant easily and the impact on them should be mitigated by doing a walkthrough survey prior to construction, permits obtained for all affected specimens and those transplanted to adjacent areas where they will remain unaffected.

From the description of the vegetation on the site it is evidently largely natural with significant levels of disturbance, while the western portion is also modified to a significant degree. The species diversity is fairly low while disturbance also promotes an increase in exotic weed establishment in many areas. In general, the pipeline route therefore does not contain elements of high terrestrial importance. However, the Orange River itself as well as several small drainage lines and watercourses occurring along the pipeline route will have a very high conservation value but will be discussed in detail within the wetland assessment section of the report (Appendix A: Map 1 & 3). In the regional context the area is listed as being a Critical Biodiversity Area 1 & 2 (CBA 1 & 2) due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops (Appendix A: Map 1 & 2). As a consequence, the proposed development may therefore still have significant impacts on the area. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the development should remain feasible. However, adequate mitigation will have to be implemented to ensure the impacts remain as low as possible. This should include keeping the clearance of vegetation

and the construction footprint to a minimum and where laydown areas are required, to utilised only previously transformed areas for this.

4.2 Overview of terrestrial fauna (actual & possible)

Tracks and signs of mammals are not abundant along the pipeline route. It is considered highly likely that the mammal population has been affected by the adjacent residential areas and agricultural activities in the surroundings. As a result it is considered unlikely that species of conservational importance will occur on 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. Extensive natural areas to the south and east of the site should provide adequate habitat and the mammal population will still be largely natural here. It is also considered likely that the area will also contain several other mammal species but these were not observed on the site.

The impact that the proposed pipeline will have is mainly concerned with the loss of habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. However, the survey has indicated that the available habitat is already somewhat disturbed and will most probably support a population of generalist mammals. Large natural areas also occur around the site and any mammals on the site are likely to vacate the site into these adjacent areas should development take place. Furthermore, the footprint of the development will not be extensive and should therefore limit the impact on mammals. The impact would also be mostly temporary as long as adequate rehabilitation is undertaken. Similar pipeline projects have indicated that adequate rehabilitation and topsoil management allows the affected area to return to a close to natural condition which would therefore re-instate the habitat for fauna and minimise the impact on the faunal population.

In order to ensure no direct impact on the mammals on the site the hunting, capturing or trapping of mammals on the site should be strictly prohibited during construction.

Table 2: List of mammal species previously recorded in the region (Mammalmap & Child *et al* 2016).

Order	Common name	Scientific name	Status
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey	Least Concern (2016)
Felidae	*Panthera pardus*	Leopard	Vulnerable (2016)
Herpestidae	*Cynictis penicillata*	Yellow Mongoose	Least Concern (2016)
Macroscelididae	*Elephantulus rupestris*	Western Rock Elephant Shrew	Least Concern (2016)
Molossidae	*Sauromys petrophilus*	Roberts's Flat-headed Bat	Least Concern (2016)
Muridae	*Aethomys namaquensis*	Namaqua Rock Mouse	Least Concern
	Desmodillus auricularis	Cape Short-tailed Gerbil	Least Concern (2016)
	Parotomys littledalei	Littledale's Whistling Rat	Near Threatened (2016)
	Rhabdomys pumilio	Xeric Four-striped	Least Concern (2016)

		Grass Rat	
Nesomyidae	*Saccostomus campestris*	Southern African Pouched Mouse	Least Concern (2016)
Nycteridae	*Nycteris thebaica*	Egyptian Slit-faced Bat	Least Concern (2016)
Pedetidae	*Pedetes capensis*	South African Spring Hare	Least Concern (2016)
Sciuridae	*Xerus inauris*	South African Ground Squirrel	Least Concern
Vespertilionidae	*Neoromicia capensis*	Cape Serotine	Least Concern (2016)

4.3 Wetland Assessment

4.3.1 Introduction

The surface water of the area is dominated by the Orange River which will be affected by the abstraction works (Appendix A: Map 1 & 3). The river will therefore form the main focus of the wetland assessment. A few small watercourses are also situated along the pipeline route and will also be included in the assessment (Appendix A: Map 1 & 3).

The Orange River flows from north east to south west with the abstraction works being situated on the southern banks and floodplain of the river (Appendix A: Map 3). It is a perennial system and flows throughout the year but has been heavily modified in terms of its flow and flooding regime by upstream containment dams. The river is also being used for extensive irrigation and water abstraction will also have a significant impact on it. The river contains a significant floodplain or riparian zone which will be dominated by alluvial soils and riparian vegetation. The floodplain has also been heavily affected by agricultural transformation and activities associated with it.

As indicated, the pipeline route has a gradual slope from the Plangeni settlement toward the river and as a consequence several small watercourses have formed flowing toward the river (Appendix A: Map 3). These watercourses are generally quite small though the larger streams may still attain a channel width of approximately 3 meters. These watercourses originate from the plains approximately 2 km to the east and drain toward the Orange River. They are also ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events. This does happen from time to time as evidenced by flood debris deposited within the main channel of these watercourses.

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 follows:

Watercourse means:

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

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

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification (Figure 9). The Orange River affected by the abstraction works is a large lowland river and is a fifth order system.

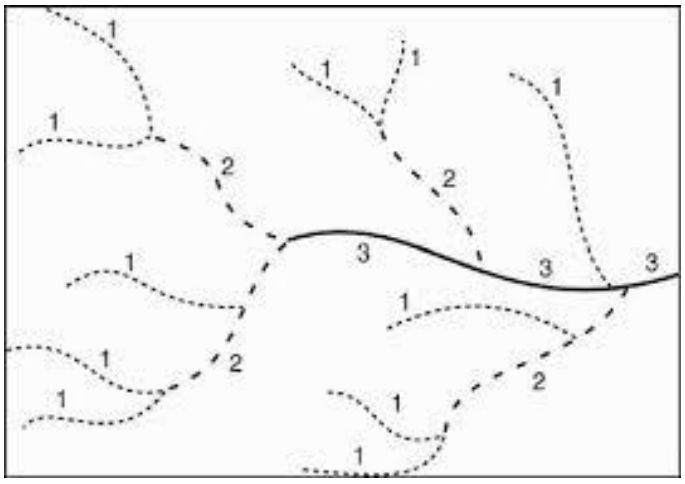


Figure 9: The classification of stream orders from 1 to 3 (Strahler 1952)

4.3.2 Wetland 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).

The Orange River and its associated riparian zone were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). Due to time constraints and the extent of the study area soil samples were only taken within sample points within the watercourses and wetlands to confirm the presence of wetland conditions. The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

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

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to determine the border and also to confirm the presence of wetland soils along the banks of the Orange River as well as the small watercourses along the pipeline route (Appendix C). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

The soil samples taken along the banks of the Orange River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 3). The marginal and lower zones of the

Orange River contain distinctive wetland soil indicators with the Marginal Zone showing soil characters of a permanent zone of wetness. The upper zone contains a minimal grey matrix, no mottles and is not considered as being a wetland area. However, the marginal and lower zone of the Orange River contains distinctive wetland soil indicators. The banks (Lower Zone) show indications of a seasonal zone of wetness whilst the Marginal Zone shows soil characters of a permanent zone of wetness. The Orange River and its banks are clearly defined and easily identifiable. The boundary of the floodplain is not easily identified due to previous transformation by agriculture and infrastructure such as the R359 tarred road which makes accurate delineation of the riparian zone difficult. However, a few reference points could be determined and here the soils within the riparian zone or floodplain consists of fine, silty sediments with a lighter colour being deposited by large flooding events and can be differentiated from the adjacent terrestrial areas which contain red-yellow coloured sandy soils. Furthermore, where the riparian vegetation is still intact it can also be used to differentiate between the riparian zone and adjacent terrestrial areas. Where agriculture has transformed the riparian zone an estimate of the natural extent can be made by using aerial images and where the accuracy can also be improved by using historical imagery. This does however also indicate the transformation of the area over many decades which also confirms the largely transformed condition of the riparian zone of the river.

Several small watercourses will also be crossed by the pipeline which drain from the east toward the Orange River (Appendix A: Map 3). These watercourses vary in length from approximately 0.4 km to 2.5 km. They all contain a fairly well defined main channel with riparian vegetation evident while wetland conditions are completely absent. This was also confirmed by soil samples which are completely devoid of soil wetness indicators.

Figure 10: Recent aerial images (Google Earth 2022) clearly indicate extensive transformation of the riparian zone by agricultural operations. The border of the riparian zone (red) can be estimated by using aerial images, remaining riparian vegetation and soil samples)

Figure 11: Utilising historical images (National Geospatial Database 1941) also provides confirmation of the border of the riparian zone. Note however that transformation of the riparian zone had already occurred at that time also indicating the long period of disturbances in the area.

4.3.3 Classification of wetland systems

The wetland conditions identified along the Orange River can be classified into a specific wetland type.

The wetland conditions associated with the Orange River can be characterised as a channel wetland system (SANBI 2009):

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

This accurately describes the wetland conditions along the Orange River (Appendix A: Map 3). Here the wetland conditions are most prominent along the main channel and decrease in distance from the channel.

4.3.4 Description of the Orange River

The Orange River at the abstraction works was surveyed along a lateral transect from the water's edge at the riverbank toward the surrounding terrestrial areas while several sample points were also taken in the riparian zone within the floodplain (Appendix A: Map 3). This represents the abstraction point and pipeline route from the riverbank to the surrounding terrestrial areas. Although the Orange River is well known to be heavily modified by upstream impacts and land uses, it still performs several vital ecosystem services as well as services rendered to downstream users. The river in the area, especially the floodplain, is quite heavily transformed by agriculture and irrigation and consequently the main channel, vegetation structure and species composition is fairly similar overall.

River systems can be divided into different riparian zones within the lateral section of the system. These zones are as follows:

The marginal zone is the lowest zone and is always present in river systems while the other two zones may not always be present. The zone is situated from the water level at low flow, if present, up to the features that are hydrologically activated for the most of the year (Figure 15). The marginal zone of the river is considered to be largely intact in terms of the geomorphology although the vegetation structure is modified to a large degree. The geomorphology of the marginal zone consists of a very narrow strip along the main channel, uniform along the study area at least along the southern bank to be affected by the abstraction works, which does not contain any extensive rocky, braided or marshy areas. As a result extensive wetland areas are also absent and at least in this stretch no significant wetland habitat is present and the purification functioning of the river is relatively low. The stretch at the site as well as upstream contain extensive centre-pivot irrigation areas and these are associated with high nutrient values originating from fertiliser runoff. The high nutrient levels in the river promote the proliferation of reedbeds (*Phragmites australis*). These are indigenous reeds but where high nutrient values and slow flow occurs they proliferate greatly to the point where they exclude most other vegetation and this has also occurred on the site which is considered a significant modification of the vegetation in the marginal zone and to some extent also the lower zone. Vegetation in the marginal zone is therefore dominated almost exclusively by the reed, *Phragmites australis*. Scattered specimens of exotic weeds are also present and include *Conyza bonariensis* and *Oenothera rosea*. It is evident that the marginal zone is very low in species diversity, uniform and quite significantly affected by upstream impacts.

Figure 12: View of the banks of the Orange River in the study area where dense reedbeds dominate and obscures the riparian zonation: Marginal (red), Lower (yellow) and Upper Zones (blue).

The lower zone is characterised by seasonal features and extends from the marginal zone up to an area of marked elevation. This area may be accompanied by a change in species distribution patterns. The lower zone consists of geomorphic features that are activated on a seasonal basis (Figure 15). The lower zone is also quite narrow, though somewhat broader than the marginal zone. Its borders are also well defined and it is an easily distinguished zone. It is quite steep and narrow and has a clear border with the upper zone where the slope levels off into a more gradual slope. Its geomorphology is also considered to still be mostly intact though the riparian vegetation is also considered modified to some degree by upstream impacts on the river, though somewhat less so than the marginal zone. The lower zone is inundated less frequently though still annually during flooding. As a result, reedbeds (*Phragmites* australis) are also able to establish at the lower border of the lower zone. Its density and extent is however lower than in the marginal zone and consequently a few other species also occur. The riparian grass, Cynodon *dactylon*, a pioneer grass often dominant along riverbanks is common while scattered riparian trees such as *Searsia pendulina* and *Salix mucronata* were also noted. Exotic weeds are present though not abundant and also include *Verbena officinalis*.

Figure 13: The lower zone is situated on the steep banks of the river and is dominated by dense reedbeds.

The upper zone is characterised by ephemeral features as well as the presence of both riparian and terrestrial species. The zone extends from the lower zone to the riparian corridor. The upper zone contains geomorphic features that are hydrologically activated on an ephemeral basis (Figure 15). The upper zone is extensive and quite broad at the site and represents the riparian zone of the river. The zone is quite heavily disturbed and modified and consequently the natural riparian vegetation composition is also heavily modified. The border between the upper- and lower zones are clearly visible as a drastic decease in slope gradient with the upper zone having a much more gradual slope. The border between the upper zone and surrounding terrestrial areas are much less clear, especially where disturbance caused by agriculture and historical land use has transformed the topography but can still be distinguished by soils and riparian vegetation and combining this with historical aerial imagery. Soils within the riparian zone or floodplain consists of fine, silty sediments with a lighter colour being deposited by large flooding events and can be differentiated from the adjacent terrestrial areas which contain coarse sandy soils with a yellow-red colour. The upper zone is also synonymous with the floodplain of the river and therefore also represents the riparian zone (Map 1). In general, the upper zone has been quite heavily modified by agriculture and historical land use.

Figure 14: The upper zone is most obviously discernible as a decrease in the slope gradient but also quite visibly degraded with exotic weeds dominating in some areas.

Habitat and species diversity is considered quite low which is normally not the case along large watercourses. This is in part a result of upstream impacts on the river but also due to historical transformation largely associated with agriculture which had occurred at the site in the floodplain and in close proximity of the river. The habitat and banks of the river is rather uniform and species diversity is very low in many areas. However, the functioning and habitat provided by the river and its floodplain should still be regarded as important and highly sensitive.

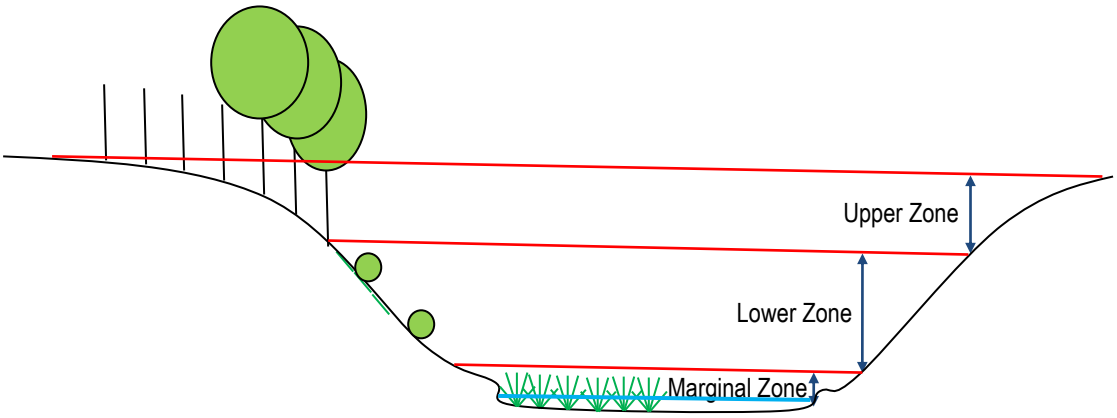


Figure 15: Illustration showing the different riparian zones of the of Orange River in the study area. This is the situation along the entire river section and also illustrates its rather uniform nature in this section.

4.3.5 Condition and importance of the affected watercourses

An Index of Habitat Integrity (IHI) was conducted for the Orange River for the section forming part of the study area (Appendix D). The IHI will be taken as representative of the Present Ecological State (PES) of this system. The Orange River will form the main recipient of impacts caused by the abstraction works and will also affect the same downstream section of the Orange River. Therefore, one IHI will be conducted for the Orange River to represent the overall condition of the river on the site. This is considered to give a good representation of the condition of the Orange River system within the study area. The IHI will be taken as representative of the Present Ecological State (PES) of this system.

In addition, three smaller ephemeral tributaries will also be affected by the pipeline route and though they also flow into the Orange River and form part of the same system, a separate assessment will also be undertaken for these in order to provide an indication of their relative condition. This will be done by conducting an Index of Habitat Integrity (IHI) for the larger stream which will be affected in order to serve as a representation of these affected watercourses. Therefore, one IHI will be conducted to represent the overall condition of the three small affected watercourses (Appendix D). This is considered to give a good representation of the overall condition of the three drainage lines which will be affected by the pipeline as they all drain into the Orange River and will affect the same downstream area. The IHI will be taken as representative of the Present Ecological State (PES) of these small watercourses.

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 river (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 predominately 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/wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains/wetlands are usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains/wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Floodplains/wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains/wetlands are not usually	>1 and <=2	C

sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.		
Low/marginal Floodplains/wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains/wetlands are 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 Kleynhans (2000) a desktop assessment of the Orange River in the study area and which will be affected by the abstraction works is considered to have a PES of Category C: Moderately Modified. More recent desktop assessments (Van Deventer *et al* 2018) indicate a PES of Category D: Largely Modified which is considered somewhat more accurate given the extensive transformation of especially the riparian component. Despite this the system still provides vital services including water transportation, flood dissipation, riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and development should endeavour to keep impacts on it to a minimum (Appendix A: Map 3).

The section of the Orange River within the study area is considered to be largely modified by several impacts. The flood dynamics of the river has been altered to a large degree by the construction of large dams upstream. The construction of large containment dams such as the Gariep- and Vaal Dams has influenced the frequency and magnitude of flooding which is part of the natural system. The river is now largely a regulated system in an attempt to enable agricultural operations within the floodplain. As a result thereof the flooding of the floodplain within the upper zone does no longer take place at the same regular intervals and magnitude. The floodplain within the upper zone of the river is now more dependent on surface runoff. The magnitude of floods is also controlled and much diminished from the natural condition and are no longer able to clear reedbeds which essentially start to choke the flow of the river and cause a significant decrease in species diversity. Agricultural operations within the floodplain of the river is extensive and large-scale irrigation also result in large impacts on the river. This has visibly had a high impact on the river as a result of fertiliser runoff and enrichment, pesticides and other impacts associated with commercial irrigation. This also results in the removal of large areas of riparian vegetation which in turn causes the modification of runoff patterns and the transformation of the ecosystem. In addition, the indirect impacts are also quite substantial where fertiliser causes the enrichment of downslope areas and the consequent modification of the vegetation composition. Continuous irrigation also increases surface flow and groundwater seepage.

Impacts on the site itself are also mostly associated with agriculture and irrigation which has visibly had a high impact on the river as a result of fertiliser runoff and enrichment, pesticides and other impacts associated with commercial irrigation. Algae blooms are evident within the main channel of the river and will have a high impact on the aquatic component of the river.

The Orange River and its associated floodplain is considered a sixth order watercourse (Appendix D). This is also due to the river being a large lowland river. The quaternary catchment of this area is D73F. The largest impact on the site itself is considered the extensive transformation caused by agriculture and irrigation. This will undoubtedly also have an impact on the ecological functioning of the Orange River. Upstream impacts are also numerous and

cause alteration in the functioning of the river. The most prominent impacts are agriculture, irrigation and construction of containment dams which alter the flooding regime and the functioning and habitat of the river and its floodplains. An Index of Habitat Integrity (IHI) was conducted along the Orange River within the study area (Appendix D). The results of the IHI indicated that the Orange River has an Instream IHI of category C/D: Moderately to Largely Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts such as irrigation and clearance of riparian vegetation for agricultural operations. A summary of these results are included in Appendix D.

The EI&S of the floodplains associated with the Orange River 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 are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. Though the floodplains of the Orange River would naturally have been considered to be highly important in terms of habitat and ecosystem services, agricultural operations have resulted in the almost complete removal of riparian vegetation and the functioning of the floodplain is therefore heavily modified.

As indicated, three small watercourses also occur along the pipeline route which will be affected by it. In order to give an overall indication of the condition of these watercourses, an Index of Habitat Integrity (IHI) determination was undertaken for the larger stream system in the southern portion of the pipeline route which should provide an accurate representation of the overall condition of these affected watercourses. Previous desktop assessments (Kleynhans 2000, Van Deventer *et al* 2018) have not included any of these small watercourses, most probably due to their small size. These watercourses drain from the east of the area which is dominated by natural areas with low levels of impacts and they are therefore still largely natural. However, they all flow through the settlement of Plangeni which does contribute some impacts on them. The following impacts associated with the settlement have affected the watercourses to varying degrees. The settlement result in vegetation clearing and an increase in runoff and effluent and this does contribute toward an modification of the flow regime within these watercourses. Coupled with this is also poor water quality linked to the sewer network of the settlement as well as livestock pens which increase the nutrient values and decrease the water quality of runoff flowing into these watercourses. There was also a notable amount of rubbish dumping in some area which will also affect these watercourses. A large irrigation channel also transects these watercourses and though provision has been made for continuous flow in the shape of concrete bridges over the channel, it will still have some impact in terms of the flow- and flooding regime of these watercourses.

From the above described impacts, it should be clear that the small watercourses are still natural but has been modified to some extent by the urban settlement of Plangeni. An IHI determination was undertaken for the larger watercourse in the southern portion of the pipeline route and will be taken as indication of the overall condition of the three small watercourses that will be affected by the pipeline. The results of the IHI indicated that the affected watercourses an Instream and Riparian IHI of category B/C: Largely Natural to Moderately Modified. This largely corresponds with the on-site observations which indicate largely natural watercourses with a natural catchment but which has been modified to some degree by the Plangeni settlement. A summary of these results are included in Appendix D.

The EI&S of the small watercourses along the pipeline route has been rated as being Moderate: Watercourses that are considered to be ecologically important and sensitive on a

provincial or local scale. The biodiversity of these watercourses are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers. This is also a result of the small size of these watercourses which does not significantly contribute toward the functioning of the Orange River.

According to DWAF (2009) the Recommended Ecological Class (REC) for WMA D73F which is situated within the Lower Orange at Kanon Eiland is considered as Category B: Largely Natural. The Present Ecological State is given as Category C while the REC is given as Category B and this indicates that the river system must be improved over time while the proposed abstraction works should not result in a further decrease of this condition.

4.3.6 Description of watercourses and wetlands

A comprehensive description has been provided for the Orange River and its associated floodplain/riparian zone in previous sections. However, as indicated, a few small watercourses also occur along the pipeline route. A short description of each of these will be provided below (Table 5).

Obligate wetland vegetation was also 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 5: Description of the individual watercourses and wetlands which forms part of the study area (Appendix A: Map 1) (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species) (Appendix A: Map 3).

Watercourse name:	**Coordinates of watercourse:**	**Flow regime:**
#1 Watercourse – Stream system in southern portion of pipeline route (Appendix A: Map 3)	S 28.506722°, E 24.735737°	Ephemeral stream system
Description of watercourse: The largest of the three watercourses which will be affected by the pipeline. This stream will also be affected by a long section of the pipeline route (approximately 450 meters) according to the current pipeline route alignment and will occur within the main channel of the watercourse. This stream system also flows into the Orange River approximately 350 meters downstream of the pipeline route. Any significant impacts on this watercourse would therefore also likely affect		

the Orange River which contributes towards its importance. The stream flows from east to west and has its origin approximately 2 km to the east of the pipeline site. From aerial imagery, the catchment of the watercourse is also largely natural and unmodified which will translate to a largely natural system. A small portion of the stream does pass through the Plangeni settlement which will contribute some impacts in terms of storm water runoff and poor water quality.

The stream system represents numerous similar watercourses in this area which include small ephemeral stream systems originating in the arid surroundings and drain toward the Orange River. The watercourse does contain a floodplain but which is not extensive though the main channel can be quite broad (approximately 10 meters) which do indicate significant flash floods occurring from time to time. The main channel is also quite broad and deep in some areas which also indicates that it conveys large volumes of water during flash floods but which will only occur very infrequently and after heavy rainfall events in the catchment. AT the time of the survey surface water was absent, though flood debris did indicate recent flooding and the system can reliably be characterised as an ephemeral system discharging by means of flash floods.

As indicated, a large section of the pipeline will be situated within the main channel of the watercourse and this will result in significant disturbance of the stream. Construction and excavations in the main channel is also likely to cause significant scouring and erosion of the stream. The present of shallow bedrock may also considerably increase disturbance. The alignment of the pipeline should consider re-alignment in order to cross the watercourse perpendicularly and should not be located parallel within the main channel. This should considerably decrease the anticipated impact of the pipeline which would otherwise remain significant should the current alignment be retained.

Soils within this stream system are dominated by alluvial sands and gravels which are completely devoid of wetland conditions. This is most likely a consequence of the ephemeral flow regime and arid environment. However, vegetation along the stream is dominated by a variety of riparian grasses and shrubs which confirm the presence of riparian conditions. Exotic and invasive plant species are scattered though become more prominent in the downstream sections where agricultural disturbance becomes higher.

Dominant plant species:
Shrub/tree layer: **Prosopis glandulosa, Ziziphus mucronata, Diospyros lycioides, Tapinanthus oleifolius, Searsia pendulina, Lycium bosciifolium, Senegalia mellifera* subsp. *detinens, Parkinsonia africana, Asparagus larcinus.*

Riparian grasses: *Cenchrus ciliaris, Eragrostis rotifer, Cynodon dactylon, Stipagrostis namaquensis, Schmidtia kalahriensis.*

Herbaceous species: **Nicotiana longituba, Boerhavia sp., Chenopodium semibaccatta, Tribulus terrestris, Justicia divaricata.*

Protected plant species:
Aloe gariepensis, Aloe claviflora, Boscia albitrunca.

Soil sample:

The watercourse contains a well-defined main channel with riparian grasses and trees dominating the banks.

Bedrock also becomes exposed in some portions of the watercourse.

A concrete low-water crossing will also affect the watercourse in terms of flow obstruction.

Flood debris (red) also confirms recent flooding of the watercourse. Also note plastic reffuse (blue) originating from the Plangeni settlement.

Watercourse name:	**Coordinates of watercourse:**	**Flow regime:**
#2 Watercourse – Small drainage line situated adjacent to Plangeni settlement (Appendix A: Map 3)	S 28.667742°, E 21.098287°	Ephemeral drainage system

Description of watercourse:

The proposed pipeline route will cross over this small watercourse situated adjacent to the Plangeni settlement. This drainage line does seem to be more heavily affected by the urban settlement in comparison with the southern larger watercourse.

Because this drainage line is so small it is fairly indistinct though a narrow channel remains visible and contains some riparian vegetation in the form of grasses and trees. The drainage line clearly still functions in terms of water transportation.

As indicated, the pipeline route will cross over the drainage line and will result in at least some disturbance. The drainage line will be crossed perpendicularly by the pipeline and the footprint

of disturbance should therefore be small and given the small size of the drainage line the anticipated impacts should remain fairly low. An existing concrete crossing is also already present and therefore the drainage line has already been affected by a similar disturbance. The pipeline construction should however still endeavour to keep disturbance footprint and vegetation clearance to a minimum.

Soils within the drainage line consist of sandy, gravel alluvial soils which are devoid of any wetland characteristics. Likewise, vegetation along this drainage line contain a high degree of terrestrial species although riparian grasses and trees are also prominent. No exotic weeds were noted which confirms the relatively natural condition of this drainage line. Despite being small, this drainage line contain distinct riparian conditions and must therefore be regarded as a watercourse.

Dominant plant species:
Shrub/tree layer: *Asparagus larcinus, Ziziphus mucronata, Cadaba aphylla, Ehretia rigida.*

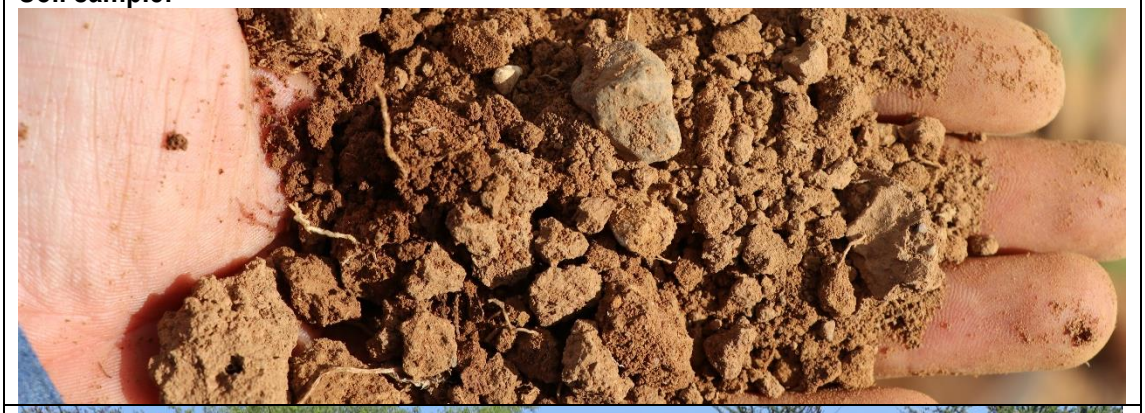
Riparian grasses: *Cenchrus ciliaris.*

Herbaceous species: *Nidorella resedifolia, Barleria obtusa.*

Terrestrial species: *Senegalia melifera* subsp. *detinens, Schmidtia kalahariensis.*

Protected plant species:
Aloe hereroensis.

Soil sample:



The affected drainage line is small and not as distinct though a channel is still visible.

A concrete low-water crossing will also affect the watercourse in terms of flow obstruction.

Watercourse name:	**Coordinates of watercourse:**	**Flow regime:**
#3 Watercourse – Small drainage line situated at northern end of the pipeline route (Appendix A: Map 3)	S 28.665297°, E 21.100246°	Ephemeral drainage system

Description of watercourse:

The proposed pipeline route will cross over this small watercourse situated at the northern end of the pipeline route and also adjacent to the Plangeni settlement. The drainage line seems to be the most heavily affected by the adjacent urban area in comparison to the two southern watercourses.

This is also a fairly small drainage line though is still quite distinct and also contains a visible channel with prominent riparian vegetation. There is also a significant inflow of storm water into this drainage line, originating from the urban area and the source is not readily apparent but may include a borehole, leaking pipelines or leaking sewer. This result in a significant modification of the moisture regime within the drainage line and is also visible as a significant increase in the establishment of exotic weeds and invasive species. The drainage line also clearly still functions in terms of water transportation.

As indicated, the pipeline route will cross over the drainage line and will result in at least some disturbance. The drainage line will be crossed perpendicularly by the pipeline and the footprint of disturbance should therefore be small and given the small size of the drainage line the anticipated impacts should remain fairly low. An existing concrete crossing is also already present and therefore the drainage line has already been affected by a similar disturbance. The pipeline construction should however still endeavour to keep disturbance footprint and vegetation clearance to a minimum.

Soils within the drainage line consist of sandy, gravel alluvial soils which are devoid of any wetland characteristics but which has clearly developed an increased moisture regime which is being fed from the surrounding urban area. As a result, riparian vegetation is abundant and dominates the drainage line while in response to the higher level of modification, the drainage line also contains a significant infestation of exotic weeds and invasive species. Despite being

small, this drainage line contain distinct riparian conditions and must therefore be regarded as a watercourse.

Dominant plant species:
Shrub/tree layer: **Prosopis glandulosa, Lycium bosciifolium, Ziziphus mucronata, Maerua gilgii.*

Riparian grasses: *Cenchrus ciliaris, Stipagrostis namaquensis, Paspalum distichum* (OW), *Paspalum dilatatum* (FW).

Herbaceous species: **Conyza bonariensis, *Argemone ochroleuca, *Nicotiana longituba, Suaeda caespitosa.*

Protected plant species:
None observed.

Soil sample:

Increased discharge into this drainage line from an unknown source results in much denser riparian vegetation with a high degree of invasive species.

An existing crossing (red) also contributes significant impacts on the drainage line (blue) mostly in terms of flow obstruction.

4.4 Risk Assessment Matrix

A Risk Assessment for the proposed pipeline and abstraction works which will affect the Orange River and small watercourses along the pipeline route 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 construction of the abstraction works at the bank of the Orange River can be retained to a low risk, as long as the construction footprint is retained to approximately 100 m^2 for both the abstraction pipeline and pump mountings. Where the construction of the pipeline will cross perpendicularly over the small watercourses the risk will likely be retained as low, especially since infrastructure crossings are already present. However, should the pipeline be located within the main channel and parallel to the direction of flow, the disturbance of the watercourse will be higher and the subsequent risk will be moderate. This scenario is most likely for the southern, larger watercourse, depending on the pipeline alignment that is followed (Appendix A: Map 3). These risk determinations are however subject to the recommended mitigation being implemented.

The proposed bulk water pipeline itself will not result in extensive impacts, especially so when seen in terms of the material being transported by the pipeline being potable water, will have a negligible impact should leaks or spillages occur into watercourses along the route. This is therefore not considered a likely impact.

The water abstraction works and associated structures and infrastructure affecting the banks of the Orange River will result in significant disturbance though given the small extent of the works and limited footprint the impacts may likely be contained to the immediate area preventing any significant impacts on the river itself (Appendix A: Map 3). The construction of the abstraction works will affect the banks of the river where the abstraction pipeline and rock-pack erosion control will be constructed and will affect the floodplain where the pump plinths and infrastructure will be constructed. This disturbance of the banks and floodplain is likely to increase which may contribute toward destabilising of the banks which will also contribute toward sedimentation. It is however anticipated that should the disturbance footprint be retained within 100 m^2 that the risk of impacts on the river will remain low and should this footprint be significantly increased, the risk will increase to moderate. In order to retain the risk to low, disturbance of the banks should be kept to a minimum and erosion remediated where it occurs. Removal of vegetation should also be kept to a minimum. The disturbance caused by construction will also cause susceptible conditions for further establishment of exotics and the

current survey has also indicated this to be the case. It is therefore recommended that weed eradication be initiated at the construction site and maintained until rehabilitation of the abstraction works has been completed. Comprehensive rehabilitation will be required and it is recommended that the design of the abstraction works incorporate erosion structures such as rock-packs or other suitable structures to prevent erosion around the abstraction works. Given the scope of the abstraction works it is unlikely to involve the removal of large volumes of water from the river and should therefore not have any significant impact in terms of flow regime and functioning of the river.

The impacts that the pipeline will have is fairly low, especially in those instances where the pipeline will cross perpendicularly over the small watercourses along the pipeline route (Appendix A: Map 3). However, should the pipeline be located within the channel and parallel to the watercourse (most likely to occur in the southern, large watercourse depending on the alignment of the pipeline) the risk will be higher and is likely to be moderate (Appendix A: Map 3). In all instances, where the pipeline will result in the disturbance of these small watercourses, disturbance should be kept to a minimum and the removal of vegetation should also be kept to a minimum. The disturbance caused by construction will also cause susceptible conditions for further establishment of exotics. It is therefore recommended that weed eradication be initiated where the pipeline will cross over these watercourses and continued until rehabilitation of the pipeline route has been completed. The geomorphology of the small watercourses (channel, banks and bedrock) should also be re-instated as far as possible, which will also speed up the stabilisation of these systems as it will resemble the downstream watercourse morphology. Given that these watercourses drain by means of flash floods, substantial erosion may also occur and where this is found to be problematic, the appropriate structures should also be implemented which may include rock-packs, gabions or contouring. Where excavating through these watercourses the upper 30 cm, or topsoil (even though it may only consist of gravel or sand), should be removed together with any vegetation and stored on the site. This topsoil and any vegetation debris should then be replaced on top of the installed pipeline. Subsoil should be used as backfilling and not as top dressing. Only removed vegetation and topsoil should be utilised to rehabilitate the bed of the affected watercourses. The soil surface should also be re-instated to the virgin soil level and not depressed or elevated as this will promote erosion and cause flow barriers. After rehabilitation any excess soil or material should be removed and disposed of at a registered disposal facility.

Moderate Risks: Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.

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

For the complete risk assessment please refer to Appendix E.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	All Phases	Installation of bulk water transport pipeline.	Perpendicular crossing of small watercourses. Excavation and backfilling of trenches	Excavation of trenches will impede flow while trenches are open. Disturbance of the bed and banks will promote sedimentation. Given the ephemeral flow regime this unlikely to have a large impact.	L	80	Control measures which can be utilised to decrease the risk include the following. Installation of pipelines during winter months when the likelihood of flooding will be minimal. Correct backfilling and using the removed topsoil during rehabilitation.

			Depending on the final pipeline alignment, the south pipeline may occur within and parallel with the larger southern watercourse.	Placement of the pipeline parallel and within the main channel of the southern watercourse will result in significant impacts in terms of construction disturbance, erosion and scouring.	**M**	**80**	Should the alignment of the pipeline be placed within the main channel of the southern watercourse, it will result in significant disturbance which will entail a moderate risk and will require significant mitigation.
			Removal of riparian vegetation	Removal of riparian vegetation will promote erosion and sedimentation of watercourses. Disturbance and removal of vegetation will create conditions susceptible to the establishment of exotic weeds.	**L**	**80**	Adequate rehabilitation and replacement of topsoil to decrease rehabilitation period. Adequate weed control to prevent establishment of weeds and promote establishment of indigenous riparian vegetation.
2		Construction of abstraction works at the Orange River near Plangeni.	Construction of abstraction works in the Orange River and along the banks and floodplain.	Removal of riparian vegetation and disturbance of the banks will promote erosion and sedimentation of the river. Establishment of exotic weeds and invaders due to disturbance caused by construction.	**L**	**80**	Control measures which can be utilised to decrease the risk include the following. Minimising disturbance of the banks and minimal removal of riparian vegetation and keeping the construction footprint within 100 m^2. Adequate design of abstraction structures such as rock-packs in order to minimise erosion. Comprehensive rehabilitation of the disturbed area including judicious weed eradication. Monitoring should also play an important part during both construction and operation.

5. ANTICIPATED IMPACTS

Anticipated impacts that the development will have is primarily concerned with the loss of habitat and species diversity but will also include impacts on the Orange River and small watercourses forming part of the pipeline route (Appendix A: Map 1 - 3).

The following impacts on the ecosystem, ecology and biodiversity will be assessed:

- Loss of vegetation and consequently habitat and species diversity as a result.
- Loss of protected, rare or threatened plant species.
- Impacts on watercourses, wetlands or the general catchment.
- The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.
- Impacts that will result on the mammal population on and around the site.

From the description of the vegetation on the site it is evidently largely natural with significant levels of disturbance, while the western portion is also modified to a significant degree. The species diversity is fairly low while disturbance also promotes an increase in exotic weed establishment in many areas. In general, the pipeline route therefore does not contain elements of high terrestrial importance. In the regional context the area is listed as being a Critical Biodiversity Area 1 & 2 (CBA 1 & 2) due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops (Appendix A: Map 1 & 2). As a consequence, the proposed development may therefore still have significant impacts on the area. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the development should remain feasible. However, adequate mitigation will have to be implemented to ensure the impacts remain as low as possible. This should include keeping the clearance of vegetation and the construction footprint to a minimum and where laydown areas are required, to utilised only previously transformed areas for this. Therefore, in conclusion, the pipeline route is considered to still contain elements of high conservation value though given the small footprint the impact and loss of habitat and vegetation is not anticipated to exceed moderate value.

Endangered or Red Listed species are absent from the site and also considered somewhat unlikely to occur due to significant disturbance in the area. However, as indicated, several protected plant species do occur along the pipeline route (Appendix B). These are all relatively widespread but do still retain a significant conservation value. Furthermore, the footprint of the pipeline should only affect a small proportion of the population of these species in the area. The impact that the loss of these protected plants would have is still anticipated to be significant but can be easily mitigated to ensure a relatively low impact. Where the shrub, *Boscia foetida*, as well as the tree, *Boscia albitrunca* will be affected and will require removal, the necessary permits will have to be obtained to do so. A few protected succulents are so common and widespread that they do not require transplanting though permits will still have to be obtained to remove them. These include *Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium* and *Mesembryanthemum guerichianum.* A few other succulents are considered less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga.* These species transplant easily and the impact on them should be

mitigated by doing a walkthrough survey prior to construction, permits obtained for all affected specimens and those transplanted to adjacent areas where they will remain unaffected.

The proposed abstraction works and pipeline route will affect the Orange River and a few small watercourses and it is therefore inevitable that it will have several impacts on it and a risk assessment (Section 4.4) also provides a more detailed discussion on the likely risks and impacts that the development will have on the Orange River and these small watercourses (Appendix A: Map 3). Unmitigated it is considered likely that the impacts may be moderate-high though provided that adequate mitigation as indicated, is implemented the anticipated impact should not exceed moderate values. Provided that adequate rehabilitation is also undertaken, the development should not result in any long-term impacts on the Orange River and small watercourses.

As a result of disturbance, especially near the Plangeni settlement and where agriculture has affected the floodplain of the Orange River several exotic weeds and invasive species have become established along the pipeline route (Appendix B). Construction activities will also increase disturbance and therefore increase the susceptibility for the establishment of weeds and invasive species and their spread into the surroundings. Monitoring of weed establishment and eradication should form a prominent part of management of the development. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004. Unmitigated this is anticipated to be at least a moderate impact, though should be easily decreased through adequate weed control.

The impact that the proposed pipeline will have on the mammal population is mainly concerned with the loss of habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. However, the survey has indicated that the available habitat is already somewhat disturbed and will most probably support a population of generalist mammals. Large natural areas also occur around the site and any mammals on the site are likely to vacate the site into these adjacent areas should development take place. Furthermore, the footprint of the development will not be extensive and should therefore limit the impact on mammals. The impact would also be mostly temporary as long as adequate rehabilitation is undertaken. Similar pipeline projects have indicated that adequate rehabilitation and topsoil management allows the affected area to return to a close to natural condition which would therefore re-instate the habitat for fauna and minimise the impact on the faunal population.

The impact significance has been determined and without mitigation a few impacts may be moderate, with the loss of protected plant species and impacts on the watercourses in the area also being moderate-high. However, with adequate mitigation which in most cases could be easily applied, all impact can be decreased to at least low-moderate.

Please refer to Appendix F for the impact methodology.

Significance of the impact:

Impact	Severity	Duration	Extent	Consequence	Probability	Frequency	Likelihood	Significance
Before Mitigation								
Loss of vegetation type and clearing of vegetation	3	4	2	3	4	4	4	12
Loss of protected species	4	5	2	3.6	5	4	4.5	16.2
Impact on watercourses	4	4	3	3.6	5	4	4.5	16.2
Infestation with weeds and invaders	3	4	3	3.3	4	3	3.5	11.5
Impact on Terrestrial fauna	2	4	1	2.3	3	3	3	6.9
After Mitigation								
Loss of vegetation type and clearing of vegetation	2	3	2	2.3	3	3	3	6.9
Loss of protected species	3	5	1	3	3	2	2.5	7.5
Impact on watercourses	3	3	2	2.6	3	3	3	7.8
Infestation with weeds and invaders	2	3	1	2	3	2	2.5	5
Impact on Terrestrial fauna	2	3	1	2	3	3	3	6

6. BIODIVERSITY SENSITIVITY RATING (BSR)

Habitat diversity and species richness:
The extent and length of the proposed pipeline route is not large and consequently habitats along it consists mainly of a sandy plain and rocky areas while watercourses and the Orange River also contribute toward habitat diversity. Species diversity is also considered as moderate and when coupled with agricultural transformation, the overall habitat diversity is considered as moderate.

Presence of rare and endangered species:
Endangered or Red Listed species are absent from the site and also considered somewhat unlikely to occur due to significant disturbance in the area. However, as indicated, several protected plant species do occur along the pipeline route (Appendix B). These are all relatively widespread but do still retain a significant conservation value. These protected plants include *Boscia albitrunca, Boscia foetida, Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium, Orbea lutea* subsp. *vaga, Aloe claviflora, Aloe garipensis, Aloe hereroensis* and *Mesembryanthemum guerichianum.*

Ecological function:
The ecological function of the site has been somewhat modified to a degree. The site functions as habitat for fauna, sustains a specific vegetation type, i.e. Lower Gariep Alluvial Vegetation along the riparian zone of the Orange River while the terrestrial portion of the pipeline route consists of Bushmanland Arid Grassland and the site also performs important functions in terms of surface water flow with regards to the Orange River and small watercourses along the pipeline route (Appendix A: Map 1 - 3). The vegetation along the floodplain of the Orange River has been heavily modified while the Plangeni settlement also increases disturbance of natural areas. The pipeline route is however situated in a largely natural area and the degree of modification is therefore considered as moderate overall. The moderate modification of the vegetation in the development area will therefore also result in a moderate modification of the habitat available to the local mammal population. The watercourses and Orange River which will be affected by the development has also been modified to various degrees though in terms of the ecological function that they provide, must be regarded as vital in terms of water transportation, wetland and aquatic habitats and bio-remediation. Overall the ecological function of the development area is therefore regarded as moderately modified.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) and utilising current mapping resources (National Biodiversity Assessment 2018) the site is indicated to consist of Lower Gariep Alluvial Vegetation (Aza 3) along the riparian zone of the Orange River while the terrestrial portion of the pipeline route consists of Bushmanland Arid Grassland (NKb 3) (Appendix A: Map 1). The former is currently listed as an Endangered (EN) ecosystem while the latter is still listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). The Lower Gariep Alluvial Vegetation is associated with the riparian zone or floodplain of the Orange River and this area is being extensively utilised for irrigation which is therefore largely transformed. Any remaining portions of this vegetation type would therefore be considered to have a high conservation value. The Bushmanland Arid Grassland consists of extensive plains dominated by sparse grassland but which is not currently subjected to any pronounced development pressures.

The Northern Cape Critical Biodiversity Areas Plan (2016) has been published in order to identify areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA). The western portion of the pipeline route falls within a Critical Biodiversity Area 1 (CBA 1) while the eastern portion falls within a Critical Biodiversity Area 2 (CBA 2) and these areas are therefore of high conservation value (Appendix A: Map 2). The reason for being listed as CBA 1 and CBA 2 is due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops.

Although modified to varying degrees the watercourses and Orange River which will be affected by the development still plays a vital role in water transport and is therefore considered to have a high conservation value (Appendix A: Map 3).

The area which will be affected by the development therefore still contain several elements of high conservation value.

Percentage ground cover:
Overall, the percentage vegetation cover is regarded as moderately modified. Historical impacts such agricultural land use within the floodplain of the Orange River, disturbance caused by the Plangeni settlement and overgrazing by domestic livestock all contribute toward a decreased vegetation cover.

Vegetation structure:
The natural vegetation structure should vary from a riparian thicket along the Orange River transitioning to a very sparse grass and karroid shrub layer within the surrounding terrestrial areas. This structure has been heavily modified within the floodplain of the Orange River while the majority of the pipeline route still contains a largely natural vegetation structure. Overall, the vegetation structure is therefore regarded as moderately modified.

Infestation with exotic weeds and invader plants:
As a result of disturbance, especially near the Plangeni settlement and where agriculture has affected the floodplain of the Orange River several exotic weeds and invasive species have become established along the pipeline route (Appendix B). These include *Argemone ochroleuca, Lactuca seriola, Conyza bonariensis, Nicotiana longituba, Salsola kali* and *Verbena officinalis*. A few invasive trees have also become established, including *Morus alba* and *Prosopis glandulosa.* Some of these are however known to become problematic, especially in the Northern Cape, such as *Prosopis glandulosa.* Overall the presence of exotic weeds and invasive species are therefore considered high.

Degree of grazing/browsing impact:
The area is utilised as communal grazing and browsing for domestic livestock and can be regarded as a significant impact and is therefore considered as at least moderate.

Signs of erosion:
Although signs of erosion are not prominent, the decrease in vegetation cover and general disturbance of the area will cause at least a moderate level of sheet erosion.

Terrestrial animals:
Tracks and signs of mammals are not abundant along the pipeline route. It is considered highly likely that the mammal population has been affected by the adjacent residential areas and

agricultural activities in the surroundings. As a result it is considered unlikely that species of conservational importance will occur on 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. Extensive natural areas to the south and east of the site should provide adequate habitat and the mammal population will still be largely natural here. It is also considered likely that the area will also contain several other mammal species but these were not observed on the site.

Table 7: Biodiversity Sensitivity Rating for the proposed abstraction and pipeline development.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species			1
Ecological function		2	
Uniqueness/conservation value			1
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		
Sub total	6	12	2
Total		20	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 8: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Plangeni abstraction and bulk water pipeline	20	Good condition	2

8. DISCUSSION AND CONCLUSION (Appendix A: Map 1 - 3)

The site proposed for the abstraction works and bulk water pipeline has been rated as being in an overall good condition. While the floodplain of the Orange River has been heavily affected by agricultural, the majority of the pipeline route is still largely natural. In combination with the presence of elements of high conservation value such as a few small watercourses, the Orange River, several protected plant species and being situated within a Critical Biodiversity Area 1 (CBA 1) also increases the overall condition of the site (Appendix A: Map 1 - 3).

The development consists of a small abstraction works situated on the southern bank of the Orange River near the small settlement of Blaauws Kop which is located approximately 10 km to the east of the town of Keimoes (Appendix A: Map 1). The abstraction works is quite small and will include an abstraction pipeline along the banks, a concrete platform and pump with below ground raw water pipeline. From this abstraction works a bulk water pipeline will be constructed which follows a route of approximately 2 km to the east and providing water to the small settlement of Plangeni (Appendix A: Map 1). The abstraction will undoubtedly affect the banks of the Orange River though the impact should remain limited due to the small size of the proposed works. The pipeline itself will also likely affect a few small watercourses and which will have to be taken into account. The footprint of the proposed pipeline still consists of natural vegetation but which contains moderate levels of disturbance as a result of the activities associated with the surrounding agriculture and residential land uses.

According to Mucina & Rutherford (2006) and utilising current mapping resources (National Biodiversity Assessment 2018) the site is indicated to consist of Lower Gariep Alluvial Vegetation (Aza 3) along the riparian zone of the Orange River while the terrestrial portion of the pipeline route consists of Bushmanland Arid Grassland (NKb 3) (Appendix A: Map 1). The former is currently listed as an Endangered (EN) ecosystem while the latter is still listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). The Lower Gariep Alluvial Vegetation is associated with the riparian zone or floodplain of the Orange River and this area is being extensively utilised for irrigation which is therefore largely transformed. Any remaining portions of this vegetation type would therefore be considered to have a high conservation value. The Bushmanland Arid Grassland consists of extensive plains dominated by sparse grassland but which is not currently subjected to any pronounced development pressures.

The Northern Cape Critical Biodiversity Areas Plan (2016) has been published in order to identify areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA). The western portion of the pipeline route falls within a Critical Biodiversity Area 1 (CBA 1) while the eastern portion falls within a Critical Biodiversity Area 2 (CBA 2) and these areas are therefore of high conservation value (Appendix A: Map 2). The reason for being listed as CBA 1 and CBA 2 is due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the extent and magnitude of the impacts should remain fairly low.

Given the surrounding agricultural land use and the proximity of the Plangeni settlement the natural vegetation also contains significant levels of disturbance in many areas. In the western

portion, the adjacent vineyards and irrigation leads to significant disturbance while the removal of the riparian thicket, runoff from irrigation and historical land use has resulted significant degradation of this area. The eastern portion situated in natural areas are mostly affected by the proximity of the Plangeni settlement in terms of refuse dumping, dirt tracks, overgrazing by domestic livestock and increased runoff from the urban area. This has caused substantial degradation of the natural vegetation though elements of conservation value are clearly still present.

Endangered or Red Listed species are absent from the site and also considered somewhat unlikely to occur due to significant disturbance in the area. However, as indicated, several protected plant species do occur along the pipeline route (Appendix B). These are all relatively widespread but do still retain a significant conservation value. Where the shrub, *Boscia foetida*, as well as the tree, *Boscia albitrunca* will be affected and will require removal, the necessary permits will have to be obtained to do so. A few protected succulents are so common and widespread that they do not require transplanting though permits will still have to be obtained to remove them. These include *Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium,* and *Mesembryanthemum guerichianum.* A few other succulents are considered less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga.* These species transplant easily and the impact on them should be mitigated by doing a walkthrough survey prior to construction, permits obtained for all affected specimens and those transplanted to adjacent areas where they will remain unaffected.

From the description of the vegetation on the site it is evidently largely natural with significant levels of disturbance, while the western portion is also modified to a significant degree. The species diversity is fairly low while disturbance also promotes an increase in exotic weed establishment in many areas. In general, the pipeline route therefore does not contain elements of high terrestrial importance. However, the Orange River itself as well as several small drainage lines and watercourses occurring along the pipeline route will have a very high conservation value but will be discussed in detail within the wetland assessment section of the report (Appendix A: Map 3). In the regional context the area is listed as being a Critical Biodiversity Area 1 & 2 (CBA 1 & 2) due to the Orange River, the associated wetland areas and floodplain with riparian zone, which also contains remnants of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrops (Appendix A: Map 1 & 2). As a consequence, the proposed development may therefore still have significant impacts on the area. However, given the nature of the development, with the pipeline only transporting untreated water and the small footprint of the proposed pipeline, the development should remain feasible. However, adequate mitigation will have to be implemented to ensure the impacts remain as low as possible. This should include keeping the clearance of vegetation and the construction footprint to a minimum and where laydown areas are required, to utilised only previously transformed areas for this.

Tracks and signs of mammals are not abundant along the pipeline route. It is considered highly likely that the mammal population has been affected by the adjacent residential areas and agricultural activities in the surroundings. As a result it is considered unlikely that species of conservational importance will occur on 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.

The impact that the proposed pipeline will have on the mammal population is mainly concerned with the loss of habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. However, the survey has indicated that the available habitat is already somewhat disturbed and will most probably support a population of generalist mammals. Large natural areas also occur around the site and any mammals on the site are likely to vacate the site into these adjacent areas should development take place. Furthermore, the footprint of the development will not be extensive and should therefore limit the impact on mammals. The impact would also be mostly temporary as long as adequate rehabilitation is undertaken. Similar pipeline projects have indicated that adequate rehabilitation and topsoil management allows the affected area to return to a close to natural condition which would therefore re-instate the habitat for fauna and minimise the impact on the faunal population.

The Orange River flows from north east to south west with the abstraction works being situated on the southern banks and floodplain of the river (Appendix A: Map 3). It is a perennial system and flows throughout the year but has been heavily modified in terms of its flow and flooding regime by upstream containment dams. The river is also being used for extensive irrigation and water abstraction will also have a significant impact on it. The river contains a significant floodplain or riparian zone which will be dominated by alluvial soils and riparian vegetation. The floodplain has also been heavily affected by agricultural transformation and activities associated with it.

As indicated, the pipeline route has a gradual slope from the Plangeni settlement toward the river and as a consequence several small watercourses have formed flowing toward the river (Appendix A: Map 3). These watercourses are generally quite small though the larger streams may still attain a channel width of approximately 3 meters. These watercourses originate from the plains approximately 2 km to the east and drain toward the Orange River. They are also ephemeral in terms of flow and will drain by means of flash floods only after heavy rainfall events. This does happen from time to time as evidenced by flood debris deposited within the main channel of these watercourses.

The Orange River and its associated riparian zone were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C). The soil samples taken along the banks of the Orange River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 3). The marginal and lower zones of the Orange River contain distinctive wetland soil indicators with the Marginal Zone showing soil characters of a permanent zone of wetness. The upper zone contains a minimal grey matrix, no mottles and is not considered as being a wetland area.

Several small watercourses will also be crossed by the pipeline which drain from the east toward the Orange River (Appendix A: Map 3). They all contain a fairly well defined main channel with riparian vegetation evident while wetland conditions are completely absent. This was also confirmed by soil samples which are completely devoid of soil wetness indicators.

An Index of Habitat Integrity (IHI) was conducted for the Orange River for the section forming part of the study area (Appendix D). The IHI will be taken as representative of the Present Ecological State (PES) of this system. The Orange River will form the main recipient of impacts

caused by the abstraction works and will also affect the same downstream section of the Orange River. In addition, three smaller ephemeral tributaries will also be affected by the pipeline route and though they also flow into the Orange River and form part of the same system, a separate assessment will also be undertaken for these in order to provide an indication of their relative condition. This will be done by conducting an Index of Habitat Integrity (IHI) for the larger stream which will be affected in order to serve as a representation of these affected watercourses.

The largest impact on the site itself is considered the extensive transformation caused by agriculture and irrigation. This will undoubtedly also have an impact on the ecological functioning of the Orange River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are agriculture, irrigation and construction of containment dams which alter the flooding regime and the functioning and habitat of the river and its floodplains. An Index of Habitat Integrity (IHI) was conducted along the Orange River within the study area (Appendix D). The results of the IHI indicated that the Orange River has an Instream IHI of category C/D: Moderately to Largely Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts such as irrigation and clearance of riparian vegetation for agricultural operations. A summary of these results are included in Appendix D. The EI&S of the floodplains associated with the Orange River has been rated as being Moderate.

The small watercourses which will be affected by the pipeline route are still natural but has been modified to some extent by the urban settlement of Plangeni. An IHI determination was undertaken for the larger watercourse in the southern portion of the pipeline route and will be taken as indication of the overall condition of the three small watercourses that will be affected by the pipeline. The results of the IHI indicated that the affected watercourses an Instream and Riparian IHI of category B/C: Largely Natural to Moderately Modified. This largely corresponds with the on-site observations which indicate largely natural watercourses with a natural catchment but which has been modified to some degree by the Plangeni settlement. A summary of these results are included in Appendix D. The EI&S of the small watercourses along the pipeline route has been rated as being Moderate.

A Risk Assessment for the proposed pipeline and abstraction works which will affect the Orange River and small watercourses along the pipeline route 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 construction of the abstraction works at the bank of the Orange River can be retained to a low risk, as long as the construction footprint is retained to approximately 100 m^2 for both the abstraction pipeline and pump mountings. Where the construction of the pipeline will cross perpendicularly over the small watercourses the risk will likely be retained as low, especially since infrastructure crossings are already present. However, should the pipeline be located within the main channel and parallel to the direction of flow, the disturbance of the watercourse will be higher and the subsequent risk will be moderate. This scenario is most likely for the southern, larger watercourse, depending on the pipeline alignment that is followed (Appendix A: Map 3). These risk determinations are however subject to the recommended mitigation being implemented.

The impact significance has been determined and without mitigation a few impacts may be moderate, with the loss of protected plant species and impacts on the watercourses in the area also being moderate-high. However, with adequate mitigation which in most cases could be easily applied, all impact can be decreased to at least low-moderate (Appendix F).

9. RECOMMENDATIONS

- The following recommendations and mitigation measures should be implemented in order to manage impacts on the Orange River where construction of the abstraction works is taking place (Appendix A: Map 3):
    - The footprint of the abstraction pipeline and pump plinths should be retained, as far as possible, to a footprint of 100 m^2.
    - Disturbance of the banks should be kept to a minimum and erosion remediated where it occurs.
    - Removal of vegetation should also be kept to a minimum.
    - The disturbance caused by construction will also cause susceptible conditions for further establishment of exotics and the current survey has also indicated this to be the case. It is therefore recommended that weed eradication be initiated at the construction site and maintained until rehabilitation of the abstraction works has been completed.
    - The design of the abstraction works should aim to minimise the impact on the flow regime and should incorporate erosion structures such as rock-packs or other suitable structures to prevent erosion around the inlet pipeline.
    - All structures and mitigation measures should be maintained throughout the lifetime of the development.
    - Given the scope of the abstraction works it is unlikely to involve the removal of large volumes of water from the river and should therefore not have any significant impact in terms of flow regime and functioning of the river.
    - The necessary authorisations should be obtained from the Department of Water and Sanitation (DWS).

- Where the proposed bulk water pipeline will cross over the small watercourses along the route, the following additional mitigation measures should be implemented (Appendix A: Map 3, Section 4.3.6: Table 5):
    - The alignment of the pipeline route should attempt to avoid being placed directly within the main channel of the southern drainage system as this will result in significantly higher impacts (Appendix A: Map 3).
    - Where the pipeline will result in the disturbance of these small watercourses, disturbance should be kept to a minimum and the removal of vegetation should also be kept to a minimum.
    - The disturbance caused by construction will also cause susceptible conditions for further establishment of exotics. It is therefore recommended that weed eradication be initiated where the pipeline will cross over these watercourses and continued until rehabilitation of the pipeline route has been completed.
    - The geomorphology of the small watercourses (channel, banks and bedrock) should also be re-instated as far as possible, which will also speed up the stabilisation of these systems as it will resemble the downstream watercourse morphology.
    - Given that these watercourses drain by means of flash floods, substantial erosion may also occur and where this is found to be problematic, the appropriate structures should also be implemented which may include rock-packs, gabions or contouring.
    - Where excavating through these watercourses the upper 30 cm, or topsoil (even though it may only consist of gravel or sand), should be removed

together with any vegetation and stored on the site. This topsoil and any vegetation debris should then be replaced on top of the installed pipeline. Subsoil should be used as backfilling and not as top dressing. Only removed vegetation and topsoil should be utilised to rehabilitate the bed of the affected watercourses.
    - The soil surface should also be re-instated to the virgin soil level and not depressed or elevated as this will promote erosion and cause flow barriers.
    - After rehabilitation any excess soil or material should be removed and disposed of at a registered disposal facility.
    - The necessary authorisations should be obtained from the Department of Water and Sanitation (DWS).

- The pipeline route contains numerous protected plant species which, although widespread, has significant conservation value and will require mitigation (Appendix B).
    - A suitably qualified ecologist or botanist should undertake a walkthrough survey of the pipeline route prior to construction to identify and locate all protected plants that will be affected by construction.
    - Where the two tree species (*Boscia albitrunca, Boscia foetida*) will be affected and will require removal, the necessary permits will have to be obtained to do so.
    - Several widespread and common protected species are of lower conservation value and permits should be obtained to remove any of these that will be affected by the pipeline. These species consist of *Ruschia sp., Ruschia cononotata, Mesembryanthemum coriarium,* and *Mesembryanthemum guerichianum.*
    - A few other succulents are considered less common, has a higher conservation value and it is recommended that permits be obtained where these will be affected by the pipeline construction and then moved to adjacent areas where they will remain unaffected. These species are *Aloe claviflora, Aloe gariepensis, Aloe hereroensis* and *Orbea lutea* subsp. *vaga.*

- The footprint of disturbance and clearance of vegetation must always be kept to a minimum. This is especially relevant where clearance of any riparian vegetation is required along the Orange River or watercourses affected by the pipeline will take place.

- When excavating trenches the upper 30 cm, or topsoil, should be removed together with the vegetation and stored on the site. These should then be replaced on top of the installed pipeline. Subsoil should be used as backfilling and not as top dressing. The soil surface should also be re-instated to the virgin soil level and not depressed or elevated as this will promote erosion and will hamper integration with the surrounding natural areas. After rehabilitation any excess soil or material should be removed and disposed of at a registered disposal facility.

- After construction of the pipeline the area must be rehabilitated. 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 afterwards must be rehabilitated.

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

- The hunting, capturing and trapping of fauna should be prevented by making this a punishable offense during the construction phase of the development.

- Open trenches may act as pitfall traps to mammals, reptiles and amphibians and trenches should be daily monitored for trapped animals which should be removed promptly.

- In the event of poisonous snakes or other dangerous animals encountered on the site an experienced and certified snake handler or zoologist must remove these animals from the site and re-locate them to a suitable area.

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

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

- After construction has ceased all construction materials should be removed from the area.

10. REFERENCES

Adams, J. 1976. Wild flowers of the Northern Cape. The Department of Nature and Environmental Conservation of the Provincial Administration of the Cape of Good Hope, Cape Town.

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

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

Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Cillié, B. 2018. Mammal guide of Southern Africa. Briza Publications CC, Pretoria.

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

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

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

Court, D. 2010. Succulent flora of Southern Africa. Struik Publishers, Cape Town.

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.

Department of Water Affairs and Forestry (DWAF), 2009. Orange River: Assessment of water quality data requirements for planning purposes. Resource Water Quality Objectives (RWQOs): Upper and Lower Orange Water Management Areas (WMAs 13 and 14). Report No. 5 (P RSA D000/00/8009/2). ISBN No. 978-0-621-38691-2, Pretoria, South Africa.

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

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

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

FitzPatrick Institute of African Ornithology (2023). mammalmap Virtual Museum. Accessed at https://vmus.adu.org.za/?vm=mammalmap on 2023-03-30.

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

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

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

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

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

Google Earth V 7.3.6.9285. 2022. Blaauw Se Kop, South Africa. S 28.667065°, E 21.092575°. Eye alt. 2.22 km. Maxar Technologies 2022. http://www.earth.google.com (January 2023).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Smithers, R.H.N. 1983. The mammals of the Southern African Subregion. University of Pretoria, Pretoria.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. South African

Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 2, released on 2018/11/06. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

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

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

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

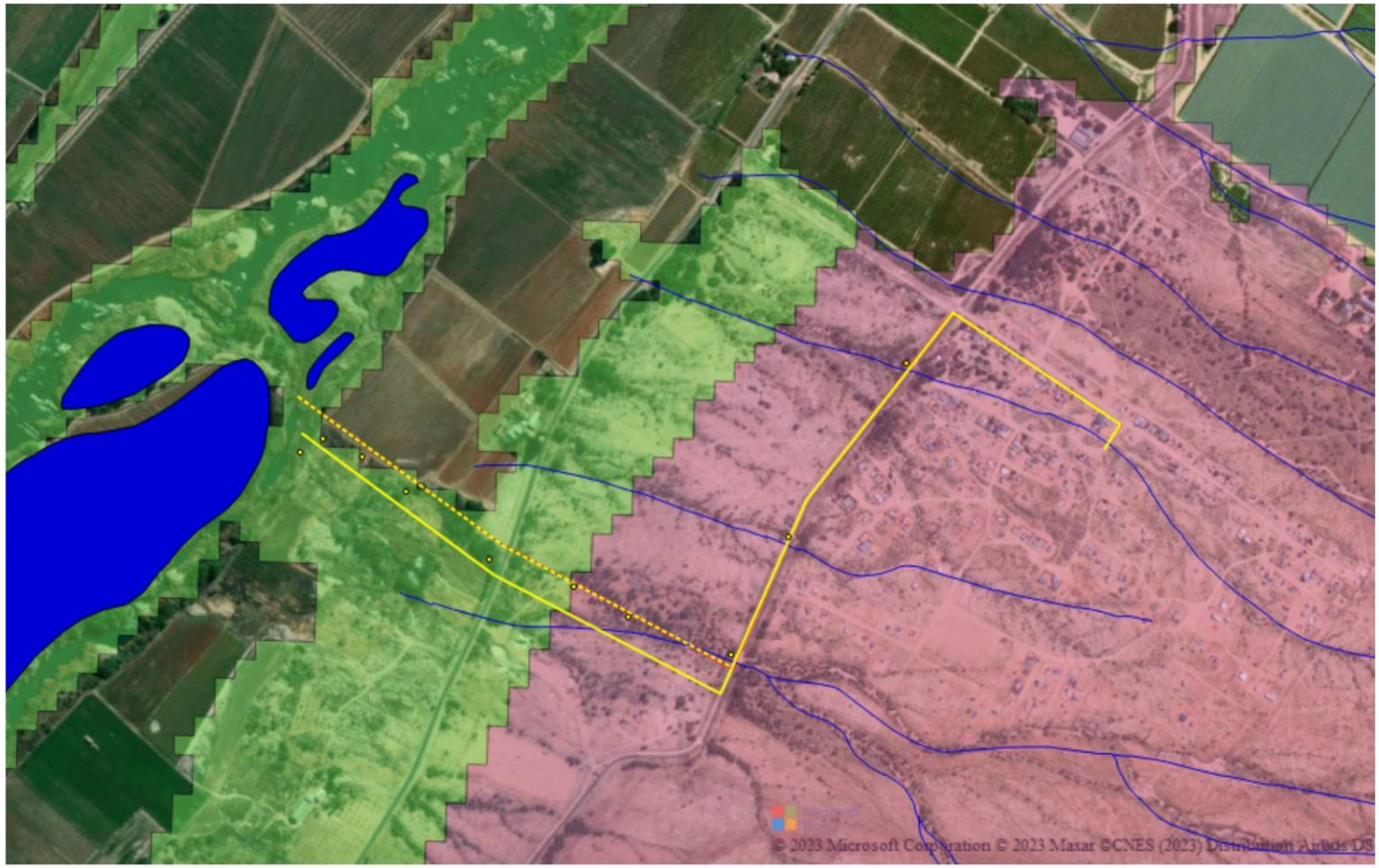
Van Rooyen, N. 2001. Flowering plants of the Kalahari dunes. Ekotrust CC, Lynnwood.

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

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

Annexure A: Maps

General ecology map for the proposed abstraction works in the Orange River near Keimoes and the bulk water pipeline extending to the settlement of Plangeni, Northern Cape Province.



Preparred for:
MDA Environmental Consultants
9 Barnes Street
Westdene
9301

Legend:

- Watercourses
- Approximate pipeline route
- Alternative pipeline route
- Wetland areas
- Lower Gariep Alluvial Veg
- Bushmanland Arid Grassland
- Watercourse sampling sites

Map Information

Spheroid: WGS 84

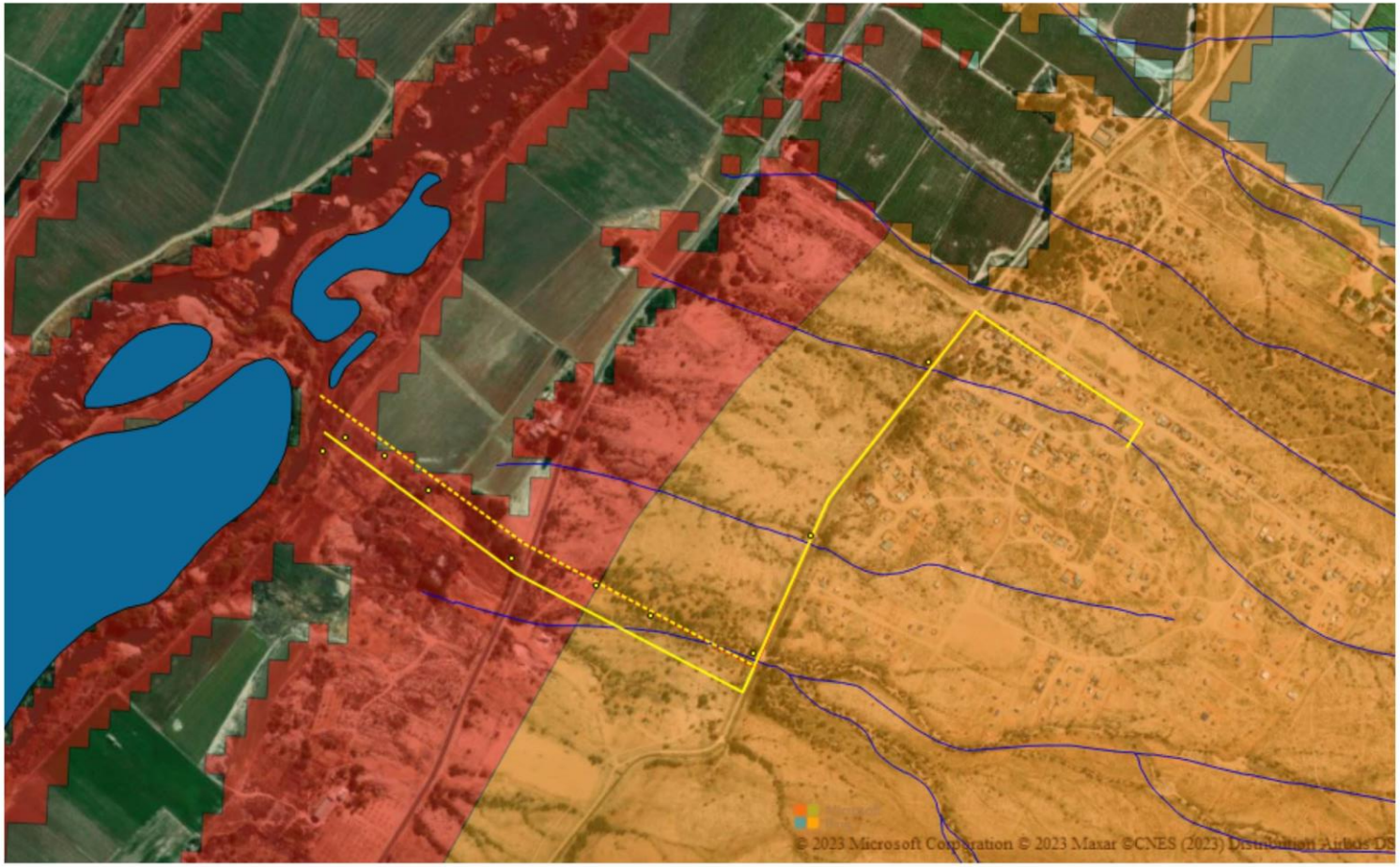
Quantum GIS

Scale: 1:10 000

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

Map 1: General ecology map of the proposed abstraction works and pipeline near Plangeni, Northern Cape Province. Areas consisting of remaining natural vegetation has been indicated and it is clear that while the majority of the pipeline route still consists of natural vegetation while the vegetation within the floodplain of the Orange River has been transformed to a significant degree by agriculture. The Lower Gariep Alluvial vegetation occurring along the Orange River is also listed as an Endangered Ecosystem and will have a high conservation value. The Orange River and smaller watercourses which will be affected by the development is also indicated. Note also the alignment of the proposed pipeline and possible alternative as well as the locations of watercourse sampling points indicated.

Northern Cape Critical Biodiversity Areas map for the proposed abstraction works in the Orange River near Keimoes and the bulk water pipeline extending to the settlement of Plangeni, Northern Cape Province.



Preparred for:
MDA Environmental Consultants
9 Barnes Street
Westdene
9301

Legend:

- Watercourses
- Approximate pipeline route
- Alternative pipeline route
- Wetland areas
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area
- Other Natural Areas

Map Information

Spheroid: WGS 84

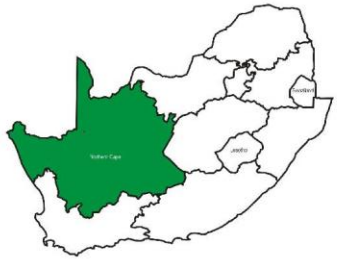
Quantum GIS

Scale: 1:10 000

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

Map 2: Critical Biodiversity Areas map of the proposed abstraction works and pipeline near Plangeni, Northern Cape Province. The pipeline falls within a Critical Biodiversity Area 1 and 2 due to the Orange River, associated wetlands and floodplain with riparian zone which also contains elements of Endangered Lower Gariep Alluvial Vegetation and landscape features such as rocky outcrop. However, given the small footprint of the pipeline and abstraction works, should not compromise the CBA and ecosystem that it preserves.

Wetland and riparian delineation map for the proposed abstraction works in the Orange River near Keimoes and the bulk water pipeline extending to the settlement of Plangeni, Northern Cape Province.



Preparred for:
MDA Environmental Consultants
9 Barnes Street
Westdene
9301

Legend:

- Approximate pipeline route
- Alternative pipeline route
- Wetland areas
- Riparian zone
- Watercourse sampling sites

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:10 000

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

Map 3: Wetland and riparian delineation map of the proposed abstraction works and pipeline near Plangeni, Northern Cape Province. Wetland conditions are confined to the banks of the Orange River at the proposed abstraction works while riparian conditions occur over the entire floodplain of the river as well as along all three smaller watercourses which will be affected by the pipeline route. Note that the pipeline will also follow the southern larger watercourse while an alternative will also be placed within the main channel of the watercourse which will result in higher anticipated impacts. The alignment should therefore endeavor to avoid, as far as possible the main channel of this southern watercourse. The locations of watercourse sampling points have also been indicated.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Argemone ochroleuca*	Herb
**Conyza bonariensis*	Herb
**Lactuca seriola*	Herb
**Melilotus alba*	Herb
**Morus alba*	Tree
**Nicotiana longituba*	Herb
**Prosopis glandulosa*	Tree
**Salsola kali*	Herb
**Sorghum halapense*	Grass
**Verbena officinalis*	Herb
Aloe claviflora	Succulent
Aloe gariepensis	Succulent
Aloe hereroensis	Succulent
Aptosimum spinescens	Dwarf shrub
Asparagus larcinus	Shrub
Barleria obtusa	Herb
Boerhavia sp.	Herb
Boscia albitrunca	Tree
Boscia foetida	Tree
Cadaba aphylla	Shrub
Cenchrus ciliaris	Grass
Chenopodium album	Herb
Chenopodium semibaccatta	Herb
Convolvulus sagittatus	Climber
Cynodon dactylon	Grass
Cyphocarpa angustifolia	Herb
Diospyros lycioides	Shrub
Ehretia rigida	Shrub
Eragrostis rotifer	Grass
Gomphocarpus fruticosus	Herb
Justicia australis	Herb
Justicia divaricata	Herb
Kleinia longiflora	Succulent
Limeum aethiopicum	Herb
Lycium bosciifolium	Shrub
Maerua gilgii	Shrub
Mesembryanthemum coriarium	Succulent
Mesembryanthemum guerichianum	Succulent
Monsonia salmoniflorum	Succulent

Nidorella resedifolia	Herb
Orbea lutea subsp. *vaga*	Succulent
Paspalum dilatatum	Grass
Paspalum distichum	Grass
Phragmites australis	Reed
Portulaca kermesina	Succulent
Rhigozum trichotomum	Shrub
Ruschia cononotata	Succulent
Ruschia sp.	Succulent
Salix mucronata	Tree
Schmidtia kalahariensis	Grass
Searsia pendulina	Tree
Senegalia mellifera subsp. *detinens*	Tree
Stipagrostis namaquensis	Grass
Suaeda caespitosa	Dwarf shrub
Talinum arnotii	Geophyte
Tapinanthus oleifolius	Parasite
Tetraena decumbens	Dwarf shrub
Tetraena microcarpa	Dwarf shrub
Tetraena simplex	Succulent
Tribulus terrestris	Herb
Ziziphus mucronata	Tree

Appendix C: Soil Samples

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions along the Orange River. Soil samples were taken at approximately 10 meter intervals. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

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

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots 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 are 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 become in the soil matrix.

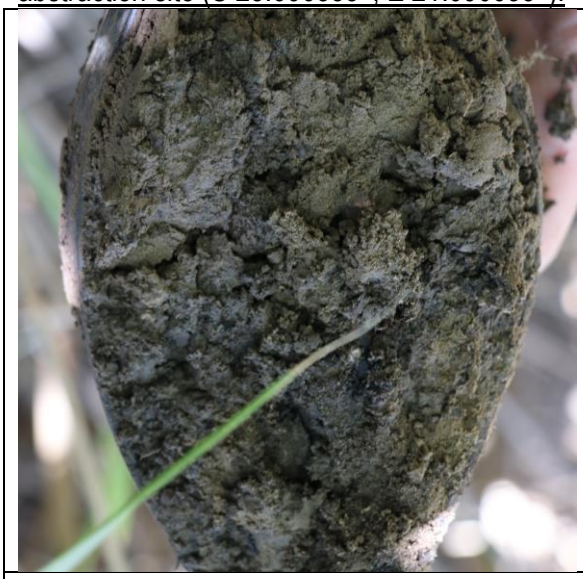
Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness

is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell).

According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Table 1: Soil samples taken along a lateral transect of the Orange River at the proposed abstraction site (S 28.666588°, E 21.090633°).

	
Soil sample taken in the marginal zone of the river. A prominent grey matrix (>10%) is clear and feint mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the lower zone of the river bank. A grey matrix (<10%) is present with a few prominent mottles and can only be regarded as a seasonal zone of wetness. Wetland conditions are therefore present though not prominent.
	
Soil sample taken in the upper zone of the river bank. A grey matrix and mottling is clearly absent and wetland conditions are not present. A high silt content does indicate it still forming part of the floodplain.	Soil sample taken in the floodplain or riparian zone of the river. A grey matrix and mottling is clearly absent and wetland conditions are not present. A high silt content does indicate it still forming part of the floodplain.

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

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

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Plangeni Abstraction Works
UPPER LATITUDE	
UPPER LONGITUDE	
UPPER ALTITUDE	
LOWER LATITUDE	
LOWER LONGITUDE	
LOWER ALTITUDE	
SURVEY SITE (if applicable)	Orange River
SITE LATITUDE (if applicable)	S 28.667065°
SITE LONGITUDE (if applicable)	E 21.092575°.
SITE ALTITUDE (if applicable)	764 m
WMA	Low er Orange
QUATERNARY	D73F
ECOREGION 2	26_5
DATE	22/03/2023
RIVER	Orange River
TRIBUTARY	
PERENNIAL (Y/N)	Y
GEOMORPH ZONE	LOWLAND
WIDTH (m)	>15

	MRU
INSTREAM IHI	
Base Flows	-3.0
Zero Flows	1.0
Floods	-3.5
HYDROLOGY RATING	2.3
pH	2.0
Salts	3.0
Nutrients	2.0
Water Temperature	1.0
Water clarity	1.5
Oxygen	1.0
Toxics	1.5
PC RATING	1.7
Sediment	2.0
Benthic Growth	2.0
BED RATING	2.0
Marginal	2.0
Non-marginal	2.0
BANK RATING	2.0
Longitudinal Connectivity	2.0
Lateral Connectivity	1.0
CONNECTIVITY RATING	1.6
INSTREAM IHI %	61.4
INSTREAM IHI EC	C/D
INSTREAM CONFIDENCE	2.8

	MRU
RIPARIAN IHI	
Base Flows	-3.0
Zero Flows	1.0
Moderate Floods	-3.0
Large Floods	-3.0
HYDROLOGY RATING	2.5
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	1.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	3.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.0
Physico-Chemical (non-marginal)	2.0
Marginal	2.0
Non-marginal	3.0
BANK STRUCTURE RATING	2.5
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	1.5
RIPARIAN IHI %	54.2
RIPARIAN IHI EC	D
RIPARIAN CONFIDENCE	3.7

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Plangeni Bulk Water Pipeline
UPPER LATITUDE	S 28.669381°
UPPER LONGITUDE	E 21.097447°
UPPER ALTITUDE	774 m
LOWER LATITUDE	S 28.668062°
LOWER LONGITUDE	E 21.093675°
LOWER ALTITUDE	769 m
SURVEY SITE (if applicable)	Plangeni Watercourses
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Low er Orange
QUATERNARY	D73F
ECOREGION 2	26_5
DATE	22/03/2023
RIVER	Ephemeral stream
TRIBUTARY	Orange River
PERENNIAL (Y/N)	**N**
GEOMORPH ZONE	**FOOTHILL**
WIDTH (m)	**2-15**

	MRU
INSTREAM IHI	
Base Flows	-1.0
Zero Flows	0.0
Floods	1.0
HYDROLOGY RATING	**0.7**
pH	0.0
Salts	1.0
Nutrients	1.5
Water Temperature	0.0
Water clarity	1.0
Oxygen	0.0
Toxics	1.0
PC RATING	**0.7**
Sediment	1.0
Benthic Growth	1.0
BED RATING	**1.0**
Marginal	1.0
Non-marginal	1.0
BANK RATING	**1.0**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.5**
INSTREAM IHI %	**81.0**
INSTREAM IHI EC	**B/C**
INSTREAM CONFIDENCE	**2.8**

	MRU
RIPARIAN IHI	
Base Flows	-1.0
Zero Flows	0.0
Moderate Floods	1.0
Large Floods	1.0
HYDROLOGY RATING	**0.8**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	1.0
Invasive Alien Vegetation (marginal)	1.0
Invasive Alien Vegetation (non-marginal)	1.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	1.0
Physico-Chemical (non-marginal)	1.0
Marginal	1.0
Non-marginal	1.0
BANK STRUCTURE RATING	**1.0**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.0
CONNECTIVITY RATING	**1.3**
RIPARIAN IHI %	**79.5**
RIPARIAN IHI EC	**B/C**
RIPARIAN CONFIDENCE	**3.7**

Appendix E: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity																		
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
1	All Phases	Installation of bulk water transport pipeline.	Perpendicular crossing of small watercourses. Excavation and backfilling of trenches	Excavation of trenches will impede flow while trenches are open. Disturbance of the bed and banks will promote sedimentation. Given the ephemeral flow regime this unlikely to have a large impact.	2	2	2	1	1.75	2	2	5.75	2	2	5	2	11	63.25	L	80	Control measures which can be utilised to decrease the risk include the following. Installation of pipelines during winter months when the likelihood of flooding will be minimal. Correct backfilling and using the removed topsoil during rehabilitation.	N/A	PES: B/C - Largely Natural to Moderately Modified EI&S: C - Moderate
			Depending on the final pipeline alignment, the south pipeline may occur within and parallel with the larger southern watercourse.	Placement of the pipeline parallel and within the main channel of the southern watercourse will result in significant impacts in terms of construction disturbance, erosion and scouring.	3	3	3	2	2.75	3	3	8.75	3	3	5	2	13	113.75	M	80	Should the alignment of the pipeline be placed within the main channel of the southern watercourse, it will result in significant disturbance which will entail a moderate risk and will require significant mitigation.	N/A	PES: B/C - Largely Natural to Moderately Modified EI&S: C - Moderate
			Removal of riparian vegetation	Removal of riparian vegetation will promote erosion and sedimentation of watercourses. Disturbance and removal of vegetation will create conditions susceptible to the establishment of exotic weeds.	1	1	0	1	0.75	1	2	3.75	1	1	5	1	8	30	L	80	Adequate rehabilitation and replacement of topsoil to decrease rehabilitation period. Adequate weed control to prevent establishment of weeds and promote establishment of indigenous riparian vegetation.	N/A	PES: B/C - Largely Natural to Moderately Modified EI&S: C - Moderate
2		Construction of abstraction works at the Orange River near Plangeni.	Construction of abstraction works in the Orange River and along the banks and floodplain.	Removal of riparian vegetation and disturbance of the banks will promote erosion and sedimentation of the river. Establishment of exotic weeds and invaders due to disturbance caused by construction.	1	2	1	1	1.25	1	2	4.25	2	3	5	2	12	51	L	80	Control measures which can be utilised to decrease the risk include the following. Minimising disturbance of the banks and minimal removal of riparian vegetation and keeping the construction footprint within 100 m2. Adequate design of abstraction structures such as rock-packs in order to minimise erosion. Comprehensive rehabilitation of the disturbed area including judicious weed eradication. Monitoring should also play an important part during both construction and operation.	N/A	PES: C/D - Moderately to Largely Modified EI&S: C - Moderate Darius van Rensburg Pr. Sci. Nat. SACNASP Reg. Nr. 400284/13 

Appendix F: Impact methodology

The environmental significance assessment methodology is based on the following determination:
Environmental Significance = Overall Consequence x Overall Likelihood

Determination of Consequence

Consequence analysis is a mixture of quantitative and qualitative information and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: **Severity/Intensity, Duration and Extent/Spatial Scale.** Each factor is assigned a rating of 1 to 5, as described below and in tables 6, 7, 9 and 10.

Determination of Severity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment.
Table 7 will be used to obtain an overall rating for severity, taking into consideration the various criteria.

Table 7: Rating of severity

Type of criteria	**Rating**				
	1	**2**	**3**	**4**	**5**
Quantitative	0-20%	21-40%	41-60%	61-80%	81-100%
Qualitative	Insignificant / Non-harmful	Small / Potentially harmful	Significant / Harmful	Great / Very harmful	Disastrous Extremely harmful
Social/ Community response	Acceptable / I&AP satisfied	Slightly tolerable / Possible objections	Intolerable/ Sporadic complaints	Unacceptable / Widespread complaints	Totally unacceptable / Possible legal action
Irreversibility	Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance / Easily reversible	Low cost to mitigate	Substantial cost to mitigate / Potential to mitigate impacts / Potential to reverse impact	High cost to mitigate	Prohibitive cost to mitigate / Little or no mechanism to mitigate impact Irreversible
Biophysical (Air quality, water quantity and quality, waste production, fauna and flora)	Insignificant change / deterioration or disturbance	Moderate change / deterioration or disturbance	Significant change / deterioration or disturbance	Very significant change / deterioration or disturbance	Disastrous change / deterioration or disturbance

Determination of Duration
Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table 8: Rating of Duration

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Determination of Extent/Spatial Scale
Extent refer to the spatial influence of an impact be local (extending only as far as the activity, or will be limited to the site and its immediate surroundings), regional (will have an impact on the region), national (will have an impact on a national scale) or international (impact across international borders).

Table 9: Rating of Extent / Spatial Scale

Rating	Description
1: Low	Immediate, fully contained area
2: Low-Medium	Surrounding area
3: Medium	Within Business Unit area of responsibility
4: Medium-High	Within Mining Boundary area
5: High	Regional, National, International

Determination of Overall Consequence
Overall consequence is determined by adding the factors determined above and summarised below, and then dividing the sum by 4.

Table 10: Example of calculating Overall Consequence

Consequence	Rating
Severity	Example 4
Duration	Example 2
Extent	Example 4
SUBTOTAL	10
TOTAL CONSEQUENCE:(Subtotal divided by 4)	3.3

Likelihood
The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below and in Table 11 and Table 12.

Determination of Frequency
Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Table 11: Rating of frequency

Rating	Description
1: Low	Once a year or once/more during operation/LOM
2: Low-Medium	Once/more in 6 Months
3: Medium	Once/more a Month
4: Medium-High	Once/more a Week
5: High	Daily

Determination of Probability
Probability refers to how often the activity/even or aspect has an impact on the environment.

Table 12: Rating of probability

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Overall Likelihood
Overall likelihood is calculated by adding the factors determined above and summarised below, and then dividing the sum by 2.

Table 13: Example of calculating the overall likelihood

Consequence	Rating
Frequency	Example 4
Probability	Example 2
SUBTOTAL	6
TOTAL LIKELIHOOD (Subtotal divided by 2)	3

Determination of Overall Environmental Significance
The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of LOW, LOW-MEDIUM, MEDIUM, MEDIUM, MEDIUM-HIGH or HIGH, as shown in the table below.

Table 14: Determination of overall environmental significance

Significance or Risk	Low	Low-Moderate	Moderate	Moderate-High	High
Overall Consequence X Overall Likelihood	1 - 4.9	5 - 9.9	10 - 14.9	15 – 19.9	20 - 25

Qualitative description or magnitude of Environmental Significance
This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritisations and decision making process associated with this event, aspect or impact.

Table 15: Description of the environmental significance and the related action required.

Significance	Low	Low-Moderate	Moderate	Moderate-High	High
Impact Magnitude	Impact is of very low order and therefore likely to have very little real effect. Acceptable.	Impact is of low order and therefore likely to have little real effect. Acceptable.	Impact is real, and potentially substantial in relation to other impacts. Can pose a risk to the company	Impact is real and substantial in relation to other impacts. Pose a risk to the company. Unacceptable	Impact is of the highest order possible. Unacceptable. Fatal flaw.
Action Required	Maintain current management measures. Where possible improve.	Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve	Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible.	Improve management measures to reduce risk.	Implement significant mitigation measures or implement alternatives.