Appendix 4:

Specialist Reports and Declarations

Environmental Management Group (Pty) Ltd

Specialists in Environmental Management Integrating Industry and Infrastructure with the Environment

Wetland Assessment for the proposed new Waste Water Treatment Works (WWTW) and associated sewer network situated in the town of Warrenton, Northern Cape Province.

November 2025

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DECLARATION OF INDEPENDENCE

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

Report Version	**Final 1.0**		
Title	**Wetland Assessment for the proposed new Waste Water Treatment Works (WWTW) and associated sewer network situated in the town of Warrenton, Northern Cape Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Nov'25**

Executive Summary

The proposed new Waste Water Treatment Works (WWTW) will be situated approximately 2 km to the west of the town of Warrenton (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 20 hectares. The footprint of the proposed WWTW will be situated in a largely natural area and approximately 200 metres south of the Vaal River. The current layout and design will avoid impacts on the Vaal River, with the system not designed to have any overflow, discharge or outfall into the river. The assessment will also determine the proximity of the river and the likelihood that the WWTW may still have an impact on it (Appendix A: Map 2). A new main sewer network and associated pump stations will also be constructed, which will connect the WWTW to the sewer network of the town. The sewer network will be extensive, though the area contains only a few scattered watercourses and wetlands, and the main focus of the assessment will therefore be the Vaal River and the impact that the development will have on it. The existing WWTW is also defunct and large volumes of sewer overflow result in the formation of extensive, but completely artificial, wetland areas, which will also be assessed in overview. The assessment will therefore be based on both the WWTW and associated new main sewer network.

The surface water of the study area is dominated by the Vaal River, which is situated north of the study area. The WWTW and associated sewer network will be situated largely outside the riparian zone or floodplain of the river, though a few sections of the sewer network will occur in close proximity or encroach into the floodplain of the river and will therefore be relevant to the assessment (Appendix A: Map 1 & 2).

The Vaal River flows from east to west, immediately to the north of the town of Warrenton where the WWTW and sewer network will be constructed (Appendix A: Map 1 & 2). It is a perennial system which 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 therefore have a significant impact on it. The river contains a significant floodplain or riparian zone, and it was also notable that floodplain wetland areas were also associated with the floodplain. The floodplain has also been affected and modified by the town itself, which has, in many instances, encroached into the floodplain, transforming it. Other significant impacts include abstraction, extensive surrounding agricultural centre-pivot irrigation, as well as mining activities associated with alluvial diamond mining operations. The sewer network will not cross over the river, while the WWTW will also not be situated in close proximity to it. However, a few sections may occur in close proximity, or encroach into the floodplain of the river and given the nature of the development, are therefore still likely to affect it.

The interior of the study area does not contain many watercourses or wetlands, given the local topography. As a result, only one small drainage line will be affected by the sewer network, with the new lift pump station being proposed for this drainage line, most likely because it forms a low point in the landscape, requiring additional pumping (Appendix A: Map 2). This drainage line forms a tributary of the Vaal River, flowing into it immediately to the north of the site. It therefore forms part of the Vaal system, will be affected by the proposed sewer network and will also influence the functioning of the Vaal River. The drainage line will therefore also need to be included in this assessment. The drainage line is quite small, but does still contain a defined channel. Despite its small size, wetland conditions are present, which can also be a consequence of increased storm water discharge from the urban area upstream or also sewage effluent discharging into it. It is therefore considered to be modified to a large degree.

As indicated, large areas of artificial wetlands have formed, associated with sewage effluent discharge from the existing, but defunct WWTW, as well as increased storm water runoff from the urban areas (Appendix A: Map 2). These areas contain extensive wetland conditions and will likely remain saturated throughout the year. They have however been confirmed to be completely artificial, not part of the remnants of any natural system and also not providing any significant ecosystem functions. They will therefore be noted in the report to confirm that they were surveyed but found to be artificial and therefore not part of the natural surface water resources of the area.

The Vaal River and its associated wetland conditions 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 Vaal River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 2). Two small drainage lines were identified within the study area, though only one of these will be affected by the sewer network, in particular the new lift pump station which has developed seasonal wetland conditions, both in terms of soil wetness indicators and obligate wetland vegetation.

An Index of Habitat Integrity (IHI) was conducted along the Vaal River within the study area (Appendix D). The results of the IHI indicated that the Vaal River has an Instream IHI of category D: 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 urban development, centre-pivot irrigation and previous mining operations upstream of the study area. A summary of these results is included in Appendix D. The EI&S of the floodplains associated with the Vaal River has been rated as being Moderate.

A Risk Assessment for the proposed new WWTW and associated sewer network which will affect the Vaal River and associated floodplain, drainage lines and other wetland areas 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) (Appendix A: Map 2):

- The proposed WWTW will be situated further than 200 metres away from the delineated riparian zone of the Vaal River and is therefore unlikely to have any direct impacts on it (Appendix A: Map 2). However, should leakages or seepage from the oxidation ponds occur, this may contaminate groundwater, which will then eventually seep into the Vaal River, thus affecting its water quality. The extent of the impact is however anticipated to remain limited, and the risk is therefore anticipated to remain Low.
- The construction of the sewer network will likely cause disturbance of the Vaal River floodplain (Warrenvale Pump Station) and a small drainage line of the river (new lift pump station), during the construction phase (Appendix A: Map 2).
- During operation of the sewer network, it will transport raw sewage to the Waste Water Treatment Works (WWTW). During the operation and maintenance of the sewer network spillages of raw sewage may likely occur into the affected watercourses, which will be most applicable to the Vaal River at the Warrenvale pump station and the small drainage line tributary at the new lift pump station. This impact has been rated as moderate.

Table of contents

Wetland Assessment

1. Introduction

1.1 Background

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

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

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

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

Making use of our water resources for our daily needs, we are degrading the quality of our water resources. Thus, it is vital to improve the quality of the water effluent before it is returned to our waterways. It is therefore necessary to construct sewage plants and sewer networks in strategic locations to, on a daily basis, transport and treat waste water generated in residential and industrial areas. These waste plants and sewer networks must also be maintained and expanded as necessitated by the growing population. The layout of these sewer networks should be such that they avoid sensitive areas and where wetlands and watercourses will be affected, the necessary mitigation should be implemented.

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

The proposed new Waste Water Treatment Works (WWTW) will be situated approximately 2 km to the west of the town of Warrenton (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 20 hectares. The footprint of the proposed WWTW will be situated in a largely natural area and approximately 200 metres south of the Vaal River. The current layout and design will avoid impacts on the Vaal River, with the system not designed to have any

overflow, discharge or outfall into the river. The assessment will also determine the proximity of the river and the likelihood that the WWTW may still have an impact on it (Appendix A: Map 2). A new main sewer network and associated pump stations will also be constructed, which will connect the WWTW to the sewer network of the town. The sewer network will be extensive, though the area contains only a few scattered watercourses and wetlands, and the main focus of the assessment will therefore be the Vaal River and the impact that the development will have on it. The existing WWTW is also defunct and large volumes of sewer overflow result in the formation of extensive, but completely artificial, wetland areas, which will also be assessed in overview. The assessment will therefore be based on both the WWTW and associated new main sewer network.

A site visit was conducted on 15 October 2025. The study area includes the new WWTW site and the entire sewer network, associated pump stations and any watercourse or wetland which may be affected by the development. The study focused on the Vaal River system, since it is the most prominent water source in the area, although smaller watercourses were also surveyed. The study was focused on the location and condition of watercourses within this area. The survey was undertaken during early spring and though the rainy season had started, it remains likely that some species were overlooked. The Vaal River is a large perennial river system, and its hydrology allows for accurate delineation throughout the year, while surrounding areas are heavily affected by sewage overflow and the formation of extensive artificial wetland areas, which did complicate accurate delineation of the natural wetland boundaries.

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

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

1.2 The value of biodiversity

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

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

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

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

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

1.3 Value of wetlands and watercourses

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

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

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

1.4 Details and expertise of specialist

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

Membership with relevant societies and associations:
- South African Society of Aquatic Scientists (SASAQS0091)
- South African Association of Botanists
- South African Wetlands Society (3SLY4IG4)

Expertise:

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

  2017: Kimberley Biodiversity Symposium.
  2018: South African Association of Botanists annual conference.
  2018: National Wetland Indaba Conference.
  2019: SASS5 Aquatic Biomonitoring Training.
  2019: Society for Ecological Restoration World Congress 2019.
  2019: Wetland rehabilitation: SER 2019 training course.
  2020: Tools For Wetlands (TFW) training course.
  2022: National Wetland Indaba Conference.
  2025: National Wetland Indaba Conference.

2. Scope and limitations

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

2.1 Riparian Vegetation

Aspects of the riparian vegetation that will be assessed include:

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

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

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

2.2 Wetlands and watercourses

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

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

2.3 Limitations

- Although a comprehensive survey of the site was done, it is still likely that several species were overlooked.
- Due to high levels of overgrazing, several grass species may have been overlooked, as they would be unidentifiable without inflorescences.
- Due to time constraints, only limited surveys of watercourses were done.

- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- Severe sewage overflow occurs into natural wetlands and watercourses and as a result, the accurate delineation of the natural wetland borders is being compromised.

3. Methodology

3.1 Several reference works were used for additional information.

General ecology:

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

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- Field guides used for vegetation and riparian species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al.* 2015, Gerber *et al.* 2004, Gibbs Russel *et al.* 1990, Grifiths & Picker 2015, Manning 2009, Retief & Meyer 2017, Van Ginkel *et al.* 2011, Van Ginkel & Cilliers 2020, Van Oudtshoorn 2004, Van Rooyen 2001, Van Rooyen & Van Rooyen 2019, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997).

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al.* 2008, Marnewecke & Kotze 1999, Macfarlane, Ollis & Kotze 2020, Ollis *et al.* 2013, Nel *et al.* 2011, SANBI 2009.

3.2 Survey

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.3 Criteria used to assess sites

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

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats, and the overall ecological importance.

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

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

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

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

3.3.2 Vegetation condition

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

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

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

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

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

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

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

3.3.3 Faunal characteristics

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

3.4 Biodiversity sensitivity rating (BSR)

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

Table 1: Biodiversity sensitivity ranking

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

4. Wetland Assessment

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

4.1 Ecology and description of the study area

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

The proposed new Waste Water Treatment Works (WWTW) will be situated approximately 2 km to the west of the town of Warrenton (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 20 hectares. The footprint of the proposed WWTW will be situated in a largely natural area and approximately 200 metres south of the Vaal River. The current layout and design will avoid impacts on the Vaal River, with the system not designed to have any overflow, discharge or outfall into the river. The assessment will also determine the proximity of the river and the likelihood that the WWTW may still have an impact on it (Appendix A: Map 2). A new main sewer network and associated pump stations will also be constructed, which will connect the WWTW to the sewer network of the town. The sewer network will be extensive, though the area contains only a few scattered watercourses and wetlands, and the main focus of the assessment will therefore be the Vaal River and the impact that the development will have on it. The existing WWTW is also defunct and large volumes of sewer overflow result in the formation of extensive, but completely artificial, wetland areas, which will also be assessed in overview. The assessment will therefore be based on both the WWTW and associated new main sewer network.

The urban areas associated with the town have been completely transformed from their natural condition. This is confirmed, for the most part, by the National Biodiversity Assessment (2018), which indicates the urban area to be transformed from its natural condition (Appendix A: Map 1). The surrounding area, including the location of the WWTW, is still considered to consist of natural vegetation, although, the survey has also indicated that areas surrounding the town are characterised by high levels of disturbance, particularly associated with high levels of trampling and overgrazing by domestic livestock. Much the same is also true for the Vaal River, where the riverfront within the town is heavily modified, while the sections in the surroundings remain largely natural, however also with significant disturbance, caused by the discharge of raw sewage affecting the instream habitat, as well as extensive overgrazing by domestic livestock affecting the riparian vegetation. High levels of disturbance and degradation within the area are mostly the consequence of urban areas associated with Warrenton. Therefore, although natural vegetation is still present in the surrounding areas, albeit not within the urban area itself, they retain high levels of disturbance, including prominent infestation by exotic weeds and invasive species. Rubbish dumping is extensive and although contributing to the degradation of the vegetation condition, the main source of disturbance for surrounding natural areas is caused by them being utilised for communal grazing by domestic livestock, consequently leading to extensive overgrazing and trampling of the natural vegetation. This results in a decrease in vegetation cover, which combined with high levels of trampling, leads to significant erosion. From the above, it should be clear that the general ecology of the area is degraded from its natural condition.

The topography of the site and surroundings is dominated by fairly flat plains, which gradually slope toward the Vaal River, which forms the lowest point in the landscape. Due to the flat topography, watercourses and wetlands are not prominent in the landscape, though smaller drainage lines may form in the areas in closer proximity to the Vaal River (where the slope

gradient increases and runoff toward the river results in the forming of concentrated flowpaths) (Appendix A: Map 1). The flat topography does however contribute to the formation of pans or depression wetlands in the landscape, though none were found within the study area. Within the urban area, the natural surface topography has been modified to a large degree, with surface runoff patterns and storm water flow especially being heavily modified.

Warrenton on average receives 310 mm of rain per annum. The area falls within a summer rainfall region, therefore resulting in the lowest rainfall (0mm) in July/August and the highest rainfall (64mm) in February/March. Midday temperatures in the area can range from as low as 18°C to as high as 32°C, dependent upon the time of year and season. Alternatively, nightly temperatures can drop to lows of 0.1°C on average during colder months (such as July). Humidity (atmospheric moisture) in the area is calculated to 30% on average. Precipitation in the form of rainfall occurs on average between 300-400mm annually. Given the high temperature and low rainfall variation, evaporation rates in the region are high, as annual evaporation reaches between 2200 - 2600 mm/a. The site and the surrounding area are situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers.

The geology underlying the study area consists mainly of Andesitic lavas of the Allanridge formation, with fine-grained sediments of the Karoo Supergroup also being common. Soils are considered sandy to loamy, belonging to the Hutton soil formation and can be fairly deep (0.6 to 1.2m). In addition, land types are identified as Ae and Ah and occur on slightly undulating plains.

As indicated, the urban area itself is considered to be largely transformed, while surrounding natural areas also contain a high level of disturbance, mostly associated with trampling and overgrazing by domestic livestock. Weeds and pioneer species are abundant and are also prominent along the Vaal River. The vegetation in the surrounding terrestrial areas is dominated by a sparse grass layer with scattered to dense tree layer. Main causes of disturbance include intensive and sustained overgrazing and other activities associated with a human settlement of high density.

According to Mucina & Rutherford (2006) the vegetation in the area and along the Vaal River consists of Highveld Alluvial Vegetation (AZa 5), while the surrounding area consists of Kimberley Thornveld (SVk 4). Both of these vegetation types are currently listed as being of Least Concern (LC) (National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)) (Map 1). They are not currently subjected to any significant development pressures. As indicated, they are also affected by significant levels of disturbance.

The Northern Cape Critical Biodiversity Areas Plan (2016) has recently been updated (2024) and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e., Critical Biodiversity Areas. Almost the entire sewer network area is indicated as being transformed and is therefore no longer of any significant conservation value. The site for the new WWTW is however regarded as a Critical Biodiversity Area 1 (CBA), as it is considered important to meeting conservation targets for the local vegetation type, supporting the functioning of the Vaal River and providing habitat to endangered bird species.

Figure 1: Aerial view of the recent condition of the study area (Google Earth 2023) which indicates extensive transformation as a result of urban surroundings. The Vaal River is clearly visible as the main watercourse in the area, with the proposed WWTW and sewer network also indicated (red).

Figure 2: The surrounding terrestrial areas are dominated by a fairly flat topography, with vegetation affected by high levels of overgrazing by domestic livestock, resulting in a significant decrease of the grass layer and an increase in the tree layer.

Figure 3: The Vaal River is the main surface water feature of the study area and contains extensive wetland areas.

4.2 Wetland and Watercourses Assessment

4.2.1 Introduction

The surface water of the study area is dominated by the Vaal River, which is situated north of the study area. The WWTW and associated sewer network will be situated largely outside the riparian zone or floodplain of the river, though a few sections of the sewer network will occur in close proximity or encroach into the floodplain of the river and will therefore be relevant to the assessment (Appendix A: Map 1 & 2). The assessment will therefore focus on the Vaal River, especially those areas where the sewer network may have an impact on it. A single small drainage line will also be affected by the sewer network, also draining into the Vaal River. Extensive artificial wetland areas have also formed, associated with the existing WWTW and storm water discharge form the urban area. These all form part of the same drainage system, which is the Vaal River. The system will therefore be assessed as a whole, while separate descriptions of these components will also be provided.

The Vaal River flows from east to west, immediately to the north of the town of Warrenton where the WWTW and sewer network will be constructed (Appendix A: Map 1 & 2). It is a perennial system which 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 therefore have a significant impact on it. The river contains a significant floodplain or riparian zone, and it was also notable that floodplain wetland areas were also associated with the floodplain. The floodplain has also been affected and modified by the town itself, which has, in many instances, encroached into the floodplain, transforming it. Other significant impacts include abstraction, extensive surrounding agricultural centre-pivot irrigation, as well as mining activities associated with alluvial diamond mining operations. The sewer network will not cross over the river, while the WWTW will also not be situated in close proximity to it. However, a few sections may occur in close proximity, or encroach into the floodplain of the river and given the nature of the development, are therefore still likely to affect it.

As indicated in previous sections (See Section 4.1), the interior of the study area does not contain many watercourses or wetlands, given the local topography. As a result, only one small drainage line will be affected by the sewer network, with the new lift pump station being proposed for this

drainage line, most likely because it forms a low point in the landscape, requiring additional pumping (Appendix A: Map 2). This drainage line forms a tributary of the Vaal River, flowing into it immediately to the north of the site. It therefore forms part of the Vaal system, will be affected by the proposed sewer network and will also influence the functioning of the Vaal River. The drainage line will therefore also need to be included in this assessment. The drainage line is quite small, but does still contain a defined channel. Despite its small size, wetland conditions are present, which can also be a consequence of increased storm water discharge from the urban area upstream or also sewage effluent discharging into it. It is therefore considered to be modified to a large degree.

As indicated, large areas of artificial wetlands have formed, associated with sewage effluent discharge from the existing, but defunct WWTW, as well as increased storm water runoff from the urban areas (Appendix A: Map 2). These areas contain extensive wetland conditions and will likely remain saturated throughout the year. They have however been confirmed to be completely artificial, not part of the remnants of any natural system and also not providing any significant ecosystem functions. They will therefore be noted in the report to confirm that they were surveyed but found to be artificial and therefore not part of the natural surface water resources of the area.

Figure 4: Aerial view of the WWTW and sewer network area. Historically (Top – National Geospatial Database 1956), the Vaal River remains prominent, though current artificial wetlands are completely absent (Bottom – Google Earth 2023), confirming that they are a consequence of the urban expansion over time.

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

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.

- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The Vaal River, being a large lowland system, is considered a fifth order system, while the small drainage line, which will be affected by the sewer network, is considered to be a first order system, indicating its small size and being situated at the origin. The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

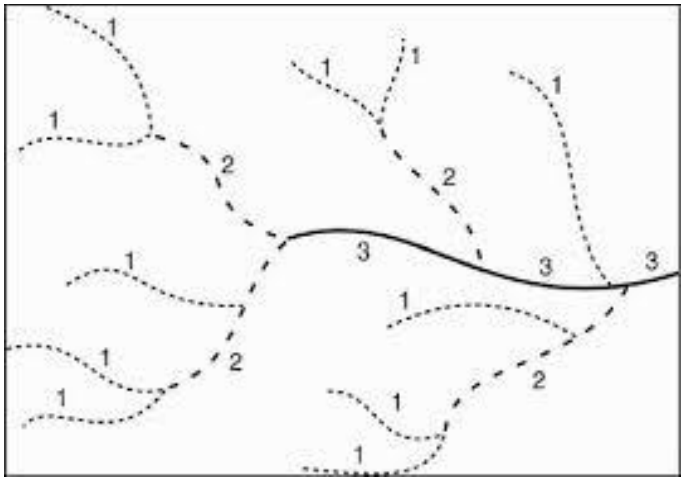


Figure 5: The classification of stream orders from 1 to 3 (Strahler 1952).

4.2.2 Wetland and riparian indicators

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

The Vaal River and its associated wetland conditions 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 borders of wetlands. Soil samples were used to determine the borders and also to confirm the presence of wetland soils along the banks of the Vaal River, as well as the associated drainage line, which will also be affected (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 Vaal River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 2). The marginal and lower zones of the Vaal River contain distinctive wetland soil indicators with the marginal zone showing soil characteristics 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. Soil samples taken at the site reliably indicated that wetland conditions along the Vaal River are confined to the marginal and lower zones, with perennial zones of wetness being present at the water's edge and the marginal zone, decreasing into a seasonal zone of wetness in the lower zone and with wetland conditions being absent from the upper zone of the river (Appendix A: Map 2). This was also clearly reflected within the vegetation composition along the banks. The Vaal River and its banks are clearly defined and easily identifiable. The boundary between the terrestrial surroundings and the floodplain could be accurately determined, though was hampered in some areas within the urban area of Warrenton, where cultivation of the floodplain, encroachment and residences have resulted in the transformation of the floodplain. However, the main areas of concern (the WWTW site and Warrenvale pump station), still contain an intact floodplain and can be differentiated from the adjacent terrestrial areas. Furthermore, where the riparian vegetation is still intact, it can also be used to differentiate between the riparian zone and adjacent terrestrial areas. Within the urban area, the proposed sewer network will be situated approximately 100 metres from the river and outside the determined floodline of the river and here accurate delineation is not possible, nor considered relevant to the development. The survey and aerial photographs also confirmed that the sewer network will not be relevant in terms of the impact on the Vaal River, while the WWTW and Warrenvale pump station will be the main areas of possible impact and detailed delineation was undertaken in these areas. In these areas, an extensive floodplain, including backwater wetland areas, was prominent. Here the soil samples and vegetation composition confirmed that the floodplain forms part of the riparian zone of the river with flooding taking place fairly frequently on a seasonal basis.

Two small drainage lines were identified within the study area, though only one of these will be affected by the sewer network, in particular the new lift pump station. This drainage line drains from the terrestrial interior into the Vaal River (Appendix A: Map 2). This drainage line originates a short distance to the south, approximately 800 metres, within the urban area of Ikhutseng, and is also affected by storm water discharging from it. It is a small drainage line, containing a main channel which may be obscured or very small in some sections. The drainage line has developed clear wetland conditions, considered a consequence though of storm water generated by the urban areas upstream. The drainage line will most probably discharge periodically on a seasonal basis after rainfall events from runoff generated in the surrounding catchment but is also being affected by increased storm water discharge from the upstream urban areas. As a result, the drainage line has developed seasonal wetland conditions, both in terms of soil wetness indicators and obligate wetland vegetation.

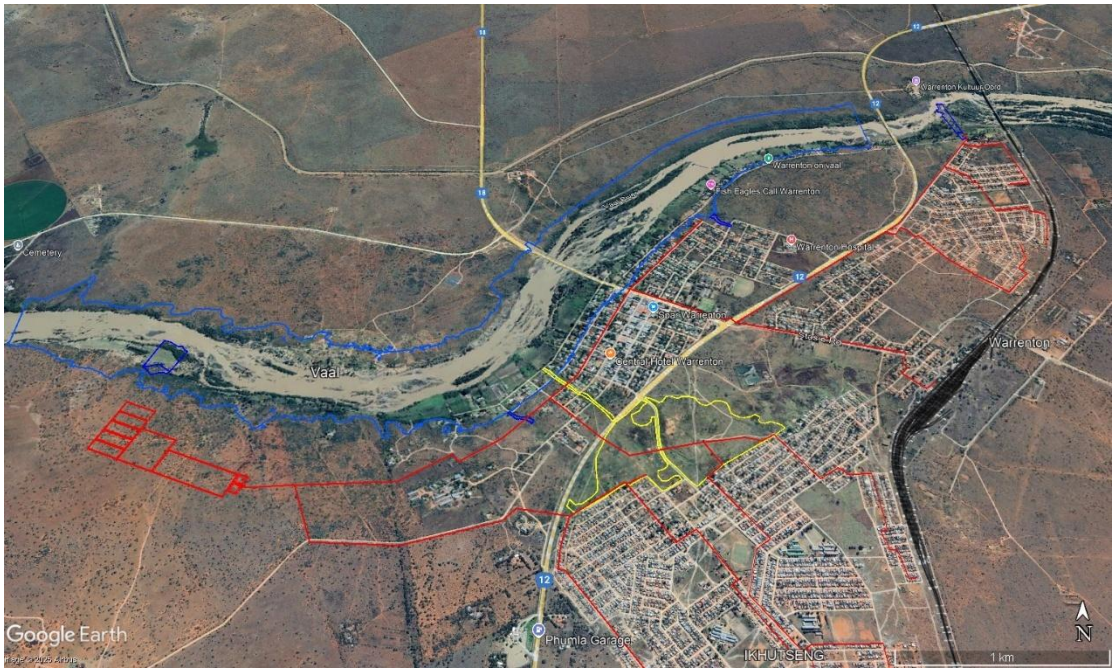


Figure 6: Delineation of wetland and watercourses and especially the riparian zone of the Vaal River, which was also combined with a floodline determination. The proposed WWTW and sewer network (red) is indicated, while the floodline and delineated sections of the Vaal River and associated drainage line (blue) will be largely avoided by it. However, note some sections of the Vaal River and small drainage line which will be encroached by the development. Artificial wetland areas are also indicated and will be taken into account (yellow) (Google Earth 2023).

4.2.3 Classification of wetland systems

As indicated in the previous section, the Vaal River, its floodplain and the associated small drainage line are considered clearly indicative of containing wetland conditions and can therefore be classified as the following separate wetland types (Appendix A: Map 2).

The wetland conditions associated with the banks of the Vaal River and the small lateral drainage line 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 banks of the Vaal River, as well as the small lateral drainage line flowing into it. The wetland conditions are confined to the main channel of these systems which experience surface flow either seasonally or perennially. Here wetland conditions are most prominent along the main channel and decrease in distance from the channel.

Figure 7: The Vaal River contains a clearly defined, active channel and well-defined channel banks (red). Flow also occurs as unidirectional flow within the channel (arrow).

The Vaal River is also associated with extensive wetland areas which can be regarded as a floodplain wetland system (SANBI 2009):

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

This accurately describes the wetland conditions which occur in the floodplain of the river. Floodplain and channelled valley-bottom wetlands are easily confused and do look similar but can be differentiated mainly by a floodplain wetland being associated with a lowland watercourse, while channelled valley-bottom systems are associated with the upper reaches where hills and valley-bottoms are present.

Figure 8: The Vaal River contains prominent floodplains where backwater flooding areas and extensive wetland areas are prominent. Water input is mainly from the overtopping of the main channel (arrow).

4.2.4 Description of the Vaal River

The Vaal River was surveyed at two separate locations where it is most likely to be affected by the development, i.e. adjacent to the proposed WWTW and at the Warrenvale pump station (Appendix A: Map 2). The Vaal River, though well known to be degraded and modified, still performs several vital ecosystem services, as well as services rendered to downstream users. The river in the study area, especially the floodplain, is quite variable in terms of geomorphology, though the main channel, vegetation structure and species composition remain relatively similar.

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 marginal zone is situated from the water level at low flow, if present, up to the features that are hydrologically activated for most of the year (Figure 12). The marginal zone within the Vaal River as it occurs within the study area is well defined and easily identifiable by the presence of a dense riparian and sedge layer which is inundated annually. The width of the marginal zone at the site is relatively extensive as a result of the braided nature of the main channel. The marginal zone constitutes perennial wetland areas. It will be modified to some degree as a result of upstream impacts, as well as the existing urban areas in the study area.

Figure 9: View of the banks of the Vaal River in the study area, indicating an extensive marginal zone (red) with an abundance of wetland areas.

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 12). The lower zone along the Vaal River is clearly defined and is easily visible. The lower zone is exceedingly steep with a sudden increase in slope over a short distance whereafter it levels off into the upper zone. In portions of the river and especially where the marginal zone is extensive, the lower zone extends over a larger distance and the increase in slope and elevation is more gradual. The boundaries between the zones in these areas are more difficult to discern. The lower zone is inundated infrequently and only during larger flooding events.

Figure 10: The lower zone is characterised by a steep bank between the marginal zone along the water's edge and the upper zone dominated by riparian thicket.

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 12). The upper zone along the Vaal River is clearly visible as a decrease in slope and an increase in the woodland component. The border between the upper- and lower zones is clearly

visible as a drastic decrease in slope gradient with the upper zone having a much more gradual slope. The tree species are able to attain height and age due to their deep root systems still being able to access the higher moisture levels and as flood disturbance in the upper zone is much less, the trees are allowed to grow old without being removed by flood damage. The riparian tree species within the upper zone are dominated by *Vachellia karroo* (Sweetthorn), *Searsia lancea* (Karee), *Ziziphus mucronata* (Buffalo Thorn) and *Diospyros lycioides* (Bluebush), which then also indicate the border of the upper zone.

Figure 11: The upper zone is most obviously discernible as a decrease in the slope gradient and a significant increase in the riparian thicket component.

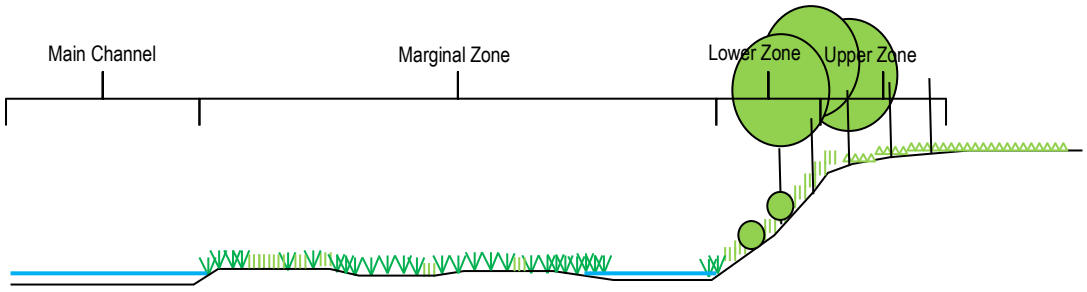


Figure 12: Illustration showing the different riparian zones of the Vaal River at the site. Note the extensive marginal and lower zones which occur in portions of the site.

4.2.5 Description of watercourses and wetlands

A description for the Vaal River zonation and its banks has been provided in previous sections. However, as indicated, an extensive floodplain is also present, with prominent wetland conditions, while a small lateral drainage line will also be affected by the development (Appendix A: Map 2). A short description of each of these will be provided below (Table 2). Note that due to the length of these watercourses, only sample survey sites were undertaken for each where they are most likely to be affected by the development.

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 2: Description of the individual watercourses and wetlands which form part of the study area (Appendix A: Map 1 & 2) (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#1 Vaal River – North of the proposed WWTW site	S 28.114511°, E 24.819702°	Perennial lowland river

Description of watercourse:

The Vaal River will be situated to the north of the proposed WWTW site, the nearest point being further than 200 metres away from the edge of the determined riparian zone of the river. Here the river is broad, with extensive wetland and backwater floodplain areas, flowing from east to west. The flow regime is perennial with a modified flow and flooding regime as a result of upstream impacts affecting it. As a result of the extensive floodplain, the banks of the river are not as steep and with a gradual slope. As a result, the riparian thicket associated with the upper zone is scattered and not as dense as in most other areas. Riparian trees are however still present in the upper zone and absent in the lower zone, which is dominated by a short grass layer. The slope of the lower zone is also much less steep. As a result of the gradual slope and the large floodplain, the marginal zone can also become much more extensive, dominated by hygrophilous grasses and sedges. Wetland conditions are abundant, being especially prominent along the marginal zone and any backwater wetland areas within the floodplain.

As indicated, wetland conditions which also include a prominent backwater system are extensive within the floodplain. This is visible as a longitudinal system situated parallel to the river and in close proximity to it (approximately 40 metres from the main channel) and within the floodplain. The vegetation is dominated by a grass layer with obligate wetland herbs and sedges also being abundant. Trees and shrubs are largely absent. The backwater wetland contains a few Facultative- and one Obligate Wetland species. Soil samples also indicate a low grey matrix without distinctive mottling, which is considered indicative of a seasonal zone of wetness. The system as a whole should be considered as highly sensitive, with the floodplain and backwater wetland system also playing a vital role in terms of flooding and the functioning of the floodplain.

The river at this site is affected by very high levels of overgrazing by domestic livestock, which have clearly affected the composition and condition of the riparian vegetation. As a result, a low species diversity was recorded, with invasive species also being abundant.

The proposed WWTW will be situated approximately 200 metres away from the edge of the riparian zone of the river and is therefore unlikely to have any direct impact on it. The design of the WWTW will also make use of oxidation and evaporation ponds, without any discharge or outfall from the WWTW taking place. The only likely impact remains an indirect impact, due to groundwater seepage which may then affect the water quality of the river.

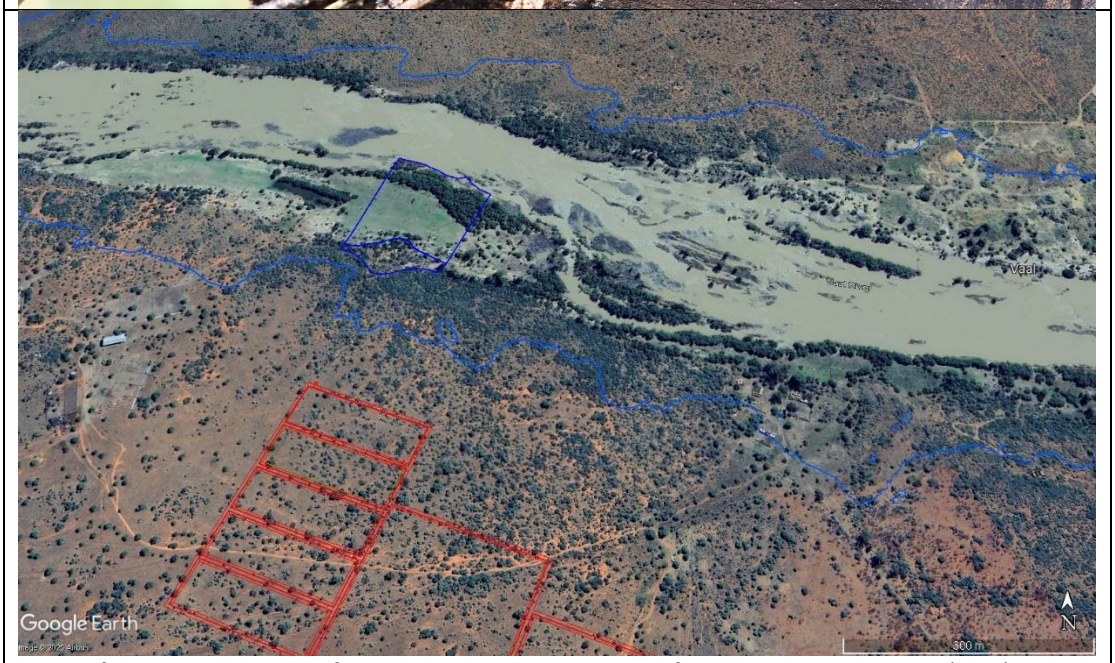
Dominant plant species:

Riverbanks and backwater floodplain – *Phyla nodiflora, Cynodon dactylon, Arctotis arctotoides, Cyperus marginatus* (OW), **Argemone ochroleuca, Phragmites australis* (OW), *Salix mucronata, Cyperus sp.*

Upper zone and riparian thicket – *Gymnosporia buxiifolia, *Eucalyptus camaldulensis, Cynodon dactylon, Diospyros lycioides, *Opuntia humifusa, Vachellia karroo, Asparagus larcinus, Searsia lancea.*

Protected plant species:
None observed.

Soil sample:



View of the Vaal River, its floodplain, riparian zone and floodline determination (blue), which indicates extensive wetland areas and a backwater floodplain wetland system. The proposed

WWTW is also indicated (red), which will be located further than 200 metres from the riparian zone of the river.

View of the main channel of the Vaal River, which can contain extensive wetland areas in this section.

The river also contains a prominent backwater wetland system within the floodplain, visible as a shallow depression, devoid of trees. Note also riparian thicket in the bakcground, associated with the upper zone of the river.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#2 Vaal River – Warrenvale pump station site	S 28.094841°, E 24.872727°	Perennial lowland river

Description of watercourse:

The Warrenvale pump station is situated at the westernmost point of the proposed sewer network and is located at the edge of the floodplain of the Vaal River, clearly encroaching into the riparian zone of the river. Here the river is broad, with extensive wetland and backwater floodplain areas, flowing from east to west. The flow regime is perennial with a modified flow and flooding regime as a result of upstream impacts affecting it. As a result of the extensive floodplain, the banks of the river are not as steep and with a gradual slope. As a result, the riparian thicket associated with the upper zone is scattered and not as dense as in most other areas. Riparian trees are however still present in the upper zone and absent in the lower zone, which is dominated by a grass and sedge layer. The slope of the lower zone is also much less steep. As a result of the gradual slope and the large floodplain, the marginal zone can also become much more extensive, dominated by hygrophilous grasses and sedges. Wetland

conditions are abundant, being especially prominent along the marginal zone and any backwater wetland areas within the floodplain.

The river at this site is less affected by overgrazing by domestic livestock, though other disturbances are still present, and consequently the vegetation composition and condition is in a better state (compared to site #1). Exotic and invasive species are however still present, being indicative of disturbances and the modified condition of the river overall.

The Warrenvale pump station will be situated within the floodplain, at the edge of the upper zone, and is highly likely to still have an impact on the river here. Current sewer overflow, which flows into the river at the site also confirms this and will result in significant impacts on the water quality of the river.

Dominant plant species:

Riverbanks and floodplain – *Cynodon dactylon, Arctotis arctotoides, Cyperus marginatus* (OW), *Cyperus sexangularis* (OW), **Pennisetum clandestinum, Ranunculus multifidus* (OW), *Juncus rigidus* (OW), **Emex australis, Sonchus oleraceus, Moraea simulans, Cynodon transvaalensis, Arctotis arctoptoides, Typha caopensis* (OW).

Upper zone and riparian thicket –**Eucalyptus camaldulensis, Cynodon dactylon, Diospyros lycioides, Vachellia karroo, Asparagus larcinus, Searsia lancea, Searsia pendulina.*

Protected plant species:
None observed.

Soil sample:

View of the Vaal River, its floodplain and riparian zone (blue), which indicates extensive wetland areas. The proposed sewer network (red) and warrenvale pump station are indicated, which will clearly encroach into the floodplain of the river.

View of the main channel of the Vaal River, which can contain extensive wetland areas in this section.

The river also contains extensive wetland conditions within the floodplain, with obligate wetland vegetation being prominent.

Sewage overflow (red) from the existing pump station is currently ongoing and will have a significant impact on the river. This also indicates the risk involved with construction of a pump station within the floodplain of the river.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#3 Small drainage line – affected by the new lift pump station	S 28.119089°, E 24.841062°	Seasonal drainage line

Description of watercourse:

This is a small drainage line in the central portion of the study area which drains into the Vaal River, approximately 350 metres downstream of the site. The drainage line will be affected by the proposed sewer line crossing and construction of the new lift pump station. The drainage line, which originates near the urban area of Ikhutseng to the west of the site, has a length of approximately 100 metres. Under natural conditions the drainage line is fed by runoff from the terrestrial catchment. Given the arid environment and size of this drainage line, it will function as an ephemeral or episodic watercourse whereby continuous flow will only take place during large rainfall events which will flush through this drainage line. Flow will also only occur for short periods and only during the rainy season. However, in this instance, the hydrology and flow regime of the drainage line are being heavily modified by the storm water and effluent generated by the urban area at its origin. As a result, wetland conditions have begun forming in the drainage line, which is clearly a substantial modification from its natural condition.

As a consequence of more continuous effluent discharging into the drainage line, soil wetness indicators have formed and mottling is clearly present. In addition, an abundance of obligate wetland vegetation has started establishing, also indicating the modification that is occurring in terms of the hydrology and flow regime of the drainage line. The main channel of the drainage line is not clear over its entire course and varies from a narrow, defined channel to a broad, indistinct channel.

The sewer line will cross over the drainage line, while the new lift pump station will be constructed within it and therefore, despite its small size, is still anticipated to be affected to a significant degree.

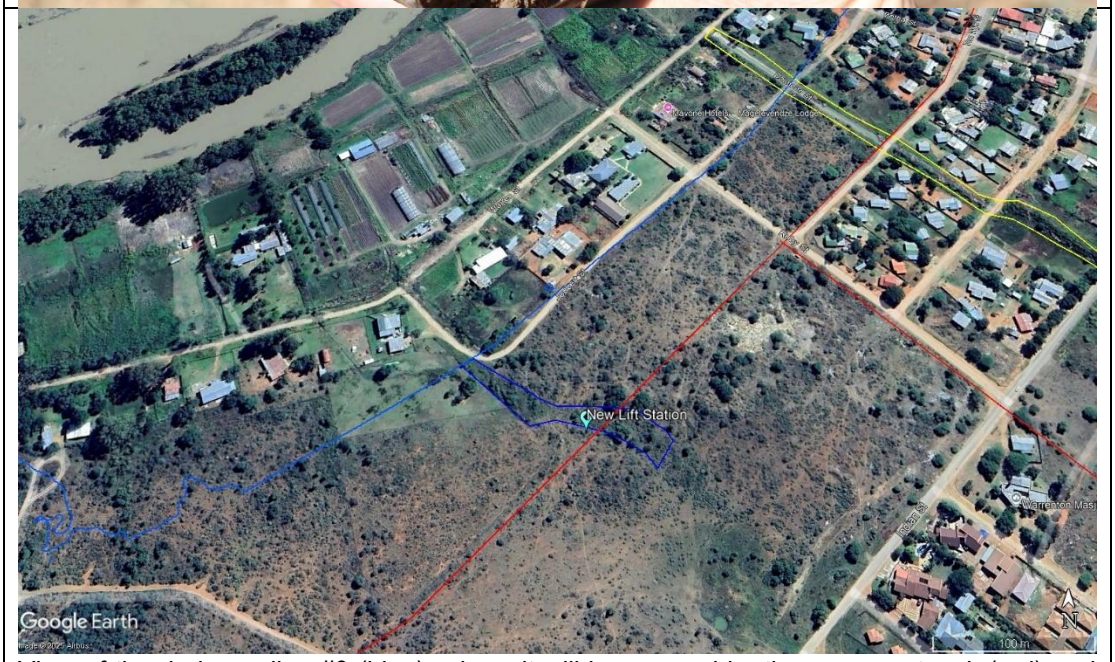
Dominant plant species:

Riparian banks – *Themeda triandra, Vachellia karroo, Vachellia tortillis, Searsia lancea, Diospyrosw lycioides, *Opuntia humifusa, Ziziphus mucronata, Menodora africana, *Morus alba.*

Main channel – *Cyperus marginatus* (OW), *Alternanthera sesillis* (OW), *Eragrostis curvula, Vahlia capensis.*

Protected plant species:
None observed.

Soil sample:



View of the drainage line #3 (blue), where it will be crossed by the sewer network (red) and the new lift pump station. Note also the Vaal River to the north which it flows into.

The drainage line is quite small, but contains a defined channel (red), which has developed prominent wetland vegetation, while riparian species are also abundant along the channel.

Though the drainage is quite small, it has developed prominent wetland conditions, especially downstream of the site, indicating at least seasonal saturation, which is however most probably also a consequence of the upstream discharge of storm water and effluent from the urban areas.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#4 Artificial wetlands	S 28.117019°, E 24.843614° S 28.120412°, E 24.848825°	Artificial

Description of watercourse:

Several large wetland areas have been identified and confirmed as having been formed by artificial, human induced modifications in the landscape and are not regarded as either natural watercourses or wetlands. Due to modifications, they contain surface water for long periods which has formed artificial wetland conditions, though they are not considered to play any role

in the surface drainage pattern of the area and are therefore not considered to be of consequence to the development. Where the sewer network will cross over these, it will therefore not have a large impact. However, these areas still drain toward the Vaal River and any leakages from the sewer lines into them, could possibly also affect the Vaal River, which should therefore be taken into account by the development:

- The existing WWTW situated to the west of the N12 National Road is currently in disrepair and not functioning well, therefore overflowing into the adjacent terrestrial areas, which has subsequently led to the formation of fairly extensive artificial wetland areas.
- In addition to the above, storm water and effluent discharge from the adjacent urban areas are significant, also flowing into the adjacent terrestrial areas, further increasing the formation of artificial wetland areas.
- These sources of artificial surface water flow slowly northwards, toward the N12 National Road, where they flow into a fairly large artificial canal. This canal can also, with high level of confidence, be regarded as completely artificial and not a remnant of a natural drainage system. This canal then allows for the discharge of effluent into the Vaal River to the north.

Artificial wetland areas as listed above, will be crossed at several locations by the proposed sewer network, which may then entail spillages of untreated sewage, that may eventually flow into the Vaal River. The impact should therefore be low, given the artificial nature of these areas, but should still be taken into account, in terms of the residual impact on the Vaal River.

Aerial view of the artificial wetland areas (yellow) in the study area, the result of sewage overflow, storm water and effluent discharge form the urban areas. These feed into an artificial canal (yellow), which eventually flows into the Vaal River to the north. Note also the existing and defunct WWTW to the north east.

Discharge from the existing WWTW and effluent generated by the urban area, lead to the formation of extensive wetland areas, which can be confirmed to be completely artificial and not associated with any natural surface water system.

Discharge from the existing WWTW and effluent from the urban area then enter an artificial canal, flowing toward, and eventually into, the Vaal River.

4.2.6 Condition and importance of the affected watercourses

An Index of Habitat Integrity (IHI) was conducted for the Vaal 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 Vaal River will form the main recipient of impacts caused by the proposed WWTW and sewer network with all other drainage lines and artificial canals flowing into it and which will also affect the same downstream section of the Vaal River. Therefore, one IHI will be conducted for the Vaal 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 Vaal River system within

the study area. The IHI will be taken as representative of the Present Ecological State (PES) of this system.

Table 3 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

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

Table 3: Ecological categories for Present Ecological Status (PES).

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

Table 4: Ecological importance and sensitivity categories.

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

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

According to a desktop assessment by Kleynhans (2000), the Vaal River in the study area which will be affected by the WWTW and sewer network is considered to have a PES of Category D: Largely Modified. More recent desktop assessments (Van Deventer *et al.* 2018) also confirm this assessment. On-site observation indicates that this is relatively accurate, as this study has also calculated the river as having a PES of Category D: Largely Modified. A large loss of natural habitat, biota and basic ecosystem function has occurred. Despite this, the system still provides vital services, including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and the development, particularly any possible sewage spillages, should endeavour to keep impacts to a minimum (Appendix A: Map 2).

The section of the Vaal 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 Bloemhof- and Vaal Dam has influenced the frequency and magnitude of flooding, which is part of the natural system. 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 is no longer able to clear reedbeds which essentially start to choke the flow of the river, causing a significant decrease in species diversity. Extensive alluvial diamond mining takes place in several areas upstream and downstream of the site. This will undoubtedly contribute to the sediment load of the river. The impact of historical mining has diminished to some extent, as the environment rehabilitates itself, although the change in topography and geomorphology is not able to rehabilitate through succession of the environment itself. These areas are clearly quite degraded and transformed. This has not only caused the clearance of vegetation but also the transformation of the natural soil profile and topography, which results in the complete transformation of the natural ecosystem in these areas. In these areas a pioneer vegetation layer has been able to re-establish, which is however not a good representation of the natural vegetation in this area. Centre-pivot irrigation is the main land use in the surrounding area and is particularly abundant upstream of Warrenton. 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. Other impacts on the river at the site include polluted storm water runoff entering the river from the urban area of Warrenton and abundant littering.

The Vaal River and its associated floodplain is considered a fifth order watercourse (Appendix D). This is also due to the river being a large lowland river. The quaternary catchment of this area is C91D. The largest impact on the site itself is considered urban transformation and the consequent runoff affecting the river. This will undoubtedly also have an impact on the ecological functioning of the Vaal River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are centre-pivot irrigation, alluvial diamond mining 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 Vaal River within the study area (Appendix D). The results of the IHI indicated that the Vaal River has an Instream IHI of category D: 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 urban development, centre-pivot irrigation and previous mining operations upstream of the study area. A summary of these results is included in Appendix D.

The EI&S of the floodplains associated with the Vaal 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 is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

According to DWAF (2016) the Recommended Ecological Class (REC) for WMA C91D, which forms part of Resource Unit 8, which is situated in the Lower Vaal downstream of the Bloemhof Dam, is Category D: Largely Modified. This requires that the instream habitat must be in a largely modified condition or better. The riparian habitat integrity must be in a largely modified or better condition to support the ecosystem purposes and to maintain property and recreational values. The Present Ecological State is given as Category D, while the REC is also given as Category D and this indicates that its current state must be maintained, while the development should not result in a further decrease of this condition, which should therefore remain within the REC for this specific WMA.

4.2.7 Risk Assessment

A Risk Assessment for the proposed new WWTW and associated sewer network which will affect the Vaal River and associated floodplain, drainage lines and other wetland areas 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) (Appendix A: Map 2). Aspects likely to be associated with the WWTW and which will likely affect the Vaal River and associated floodplain are limited, but may still include residual impacts associated with groundwater contamination. Aspects of the sewer network and associated pump stations which may have an impact on the Vaal River and its associated tributaries are largely associated with the construction phase, where construction will occur near or through these watercourses, as well as the operation and maintenance of the sewer network, when spillages into the watercourses may occur (this is also quite evident to be likely, given the occurrence of current spillages).

The WWTW will be located further than 200 metres away from the Vaal River, while the sewer network will encroach directly into the floodplain of the Vaal River or will cross over tributaries, and therefore a buffer zone between the WWTW, sewer network and affected watercourses will not be applicable.

Factors concerning the proposed new WWTW and sewer network which have been taken into account for the assessment, include that the existing sewer network, including sewer pump stations, as well as the existing WWTW, has reached capacity and is continuously overflowing, resulting in significant impacts, and consequently the proposed WWTW and sewer network should aid in alleviating some of these current impacts.

The following risks, activities and impacts which have been identified regarding the proposed WWTW and sewer network are likely to affect the Vaal River and associated tributaries:

- The proposed WWTW will be situated further than 200 metres away from the delineated riparian zone of the Vaal River and is therefore unlikely to have any direct impacts on it (Appendix A: Map 2). However, should leakages or seepage occur from the oxidation ponds, this may contaminate groundwater, which will then eventually seep into the Vaal River, thus affecting its water quality. The extent of the impact is however anticipated to remain limited, and the risk is therefore anticipated to remain Low. This is however also subject to adequate maintenance undertaken by the WWTW.
- Currently the design of the WWTW will make use of oxidation ponds, without any outfall or discharge being included in the facility. Treated water will be utilised for irrigation, which is therefore irrelevant to the Vaal River. This activity has therefore not been included in this assessment. However, should any overflow occur, discharge take place or any similar emergency release of treated or untreated sewage take place, additional water use application will have to be undertaken.
- The construction of the sewer network will likely cause disturbance of the Vaal River floodplain (Warrenvale Pump Station) and a small drainage line of the river (new lift pump station), during the construction phase (Appendix A: Map 2). This in turn will promote erosion, prevent the watercourses from stabilising and lead to increased sedimentation of the downstream areas. As a result, disturbance should be kept to a minimum and erosion remediated where it occurs. Removal of vegetation should also be kept to a minimum.
- As can be deduced from the discussion of the affected watercourses, they already contain significant levels of disturbance and are heavily modified from their natural condition and consequently, the removal of wetland vegetation will have a limited impact on their functioning and loss of diversity. However, vegetation stabilises the watercourse and therefore it is important that vegetation be re-established where it was removed. This can most easily be attained by implementing adequate topsoil management. The upper 30 cm, or topsoil, should be removed together with the vegetation and stored on the site. This topsoil should then be placed on top of the installed sewer pipeline. Where topsoil is perceived to be absent, a seedbank will still be present, even if this may only be a few centimetres thick and should still be retained, as this will greatly aid in successful rehabilitation. Subsoil should be used as backfilling and not as top dressing. Only removed topsoil should be utilised to rehabilitate the watercourse crossing.
- The disturbance caused by construction will also create susceptible conditions for further establishment of exotics. The area is also known to be susceptible to several invasive species, especially the tree, *Prosopis glandulosa*, and it is therefore recommended that weed eradication be initiated at the construction site prior to construction and continued until rehabilitation of the sewer network has been completed (Appendix B).
- During operation of the sewer network, it will transport raw sewage to the Waste Water Treatment Works (WWTW). During the operation and maintenance of the sewer network spillages of raw sewage may likely occur into the affected watercourses, which will be

most applicable to the Vaal River at the Warrenvale pump station and the small drainage line tributary at the new lift pump station. Such spillages will have a significant impact on these watercourses, especially the Vaal River. As a result, this impact has been rated as moderate. In addition, according to the General Authorisation regulations as contained within the National Water Act (Act 36 of 1998), the installation of sewer networks cannot be authorised under the General Authorisation regulations and the anticipated risk is therefore substantiated as being moderate. This is also affirmed by the current spillage of sewage into the Vaal River at the Warrenvale pump station, as well as overflow into the artificial wetland areas and canal, flowing into the Vaal River. This was also indicative of the large impact that this has, also indicating the urgent need to replace the existing WWTW and sewer network.

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

Moderate Risks: Risk and impact on watercourses are notable and require mitigation measures on a higher level.

Mitigation as recommended, as well as any additional mitigation recommended by other specialist studies should be implemented in order to alleviate the risks on the Vaal River, associated drainage lines tributaries, as well as artificial wetland areas, flowing into the Vaal River.

For the complete risk assessment please refer to Appendix E.

Phases	Activity	Impact	Risk Rating	Confidence level
Construction/ Operation	WWTW and possible groundwater contamination.	The proposed WWTW will be situated further than 200 metres from the delineated riparian zone of the Vaal River and is therefore unlikely to have any direct impacts on it. However, should leakages or seepage occur from the oxidation ponds, this may contaminate groundwater, which will then eventually seep into the Vaal River, thus affecting its water quality.	**L**	**High**
Construction	Excavation and backfilling of trenches.	Excavation of trenches will impede flow while trenches are open. Disturbance of the bed and banks will promote sedimentation. Use of concrete casing may also affect the Vaal River floodplain and associated small drainage line.	**L**	**High**
	Removal of wetland vegetation.	Removal of riparian and wetland vegetation will promote erosion and sedimentation of the watercourses. Disturbance and removal of vegetation will create conditions susceptible to the establishment of exotic weeds.		

Operational	Operation of sewer network.	The sewer network will transport raw sewage to the Waste Water Treatment Works (WWTW). During the operation and maintenance of the sewer network it is likely that spillages of raw sewage may occur, into the affected watercourses, which will be most applicable to the Vaal River at the Warrenvale pump station and the small drainage line tributary at the new lift pump station. Such spillages will have a significant impact on these watercourses, especially the Vaal River.	**M**	**High**

5. Biodiversity Sensitivity Rating (BSR)

Habitat diversity and species richness:
Habitat diversity within the study area is considered moderate. The river and associated bed and banks and varying vegetation structure contribute to habitat diversity. The vegetation type on the site is not known for high diversity levels but the varied habitats nonetheless contribute to diversity. The site is considered to have a moderate habitat and species diversity.

Presence of rare and endangered species:
The site does not contain any protected, rare or endangered species and due to the degraded condition of the site, it is considered unlikely that such species would occur. These species are often habitat specific and only occur in areas where the disturbance is still relatively low.

Ecological function:
The Vaal River, associated wetlands and floodplains within the study area play a vital role in the continued functioning of the river in terms of water transport and drainage of the area. The habitat provided by the river and associated habitats support a varied faunal component and are considered to perform an important ecological function in this regard. The flow and flooding regime has been altered but the river is nonetheless still considered sensitive.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the vegetation on the site and along the Vaal River consists of Highveld Alluvial Vegetation (AZa 5), while the surrounding area consists of Kimberley Thornveld (SVk 4). Both of these vegetation types are currently listed as being of Least Concern (LC) (National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)) (Appendix A: Map 1). They are not currently subjected to any significant development pressures and can therefore not be considered to have a high conservation value.

As previously mentioned, the Vaal River, together with the associated wetland areas and floodplain areas, is considered a sensitive ecosystem and its conservation value must therefore be considered as relatively high (Appendix A: Map 2).

Percentage ground cover:
The region is in an arid area with a low annual rainfall. As a result, the percentage ground cover within the terrestrial environment is relatively low. This is natural to the area. However, the urban developments and in particular high levels of overgrazing in communal areas, result in a significant decrease in the natural vegetation cover, which is therefore considered to be modified to a significant degree.

Vegetation structure:
The site is situated within the Savanna Biome and therefore contains a well-developed tree layer with grass and dwarf shrub understorey. The vegetation along the Vaal River is varied and contains amongst others a riparian thicket, grass, sedge, herb reed layers. This is considered largely natural, although the modified nature of the Vaal River would undoubtedly also have caused some modification of the vegetation structure. The overgrazing of terrestrial areas has also resulted in a notable increase in the tree component.

Infestation with exotic weeds and invader plants:
Exotic weed and invader species are abundant and can form dominant clumps.

Degree of grazing/browsing impact:
The area forms part of the commonage of the town and surrounding natural areas are subjected to very high levels of overgrazing and trampling by domestic livestock. This was notable in terrestrial areas but also along the banks of the Vaal River.

Signs of erosion:
Erosion is considered moderate. Overgrazing and trampling by domestic livestock will result in at least a moderate level of sheet erosion, while the Vaal River is also affected by several infrastructure crossings, such as bridges and pipelines, which will contribute to some erosion or scouring of the riverbed.

Terrestrial animals:
Along the Vaal River the mammal activity is relatively high, although the proximity of urban developments will dissuade a lot of mammals from frequenting the area. The occurrence of species of conservation significance is relatively low, as these species would prefer undisturbed areas.

Table 5: Biodiversity Sensitivity Rating for the proposed Warrenton WWTW and sewer network.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species	3		
Ecological function			1
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Subtotal	15	8	1
Total		24	

6. Biodiversity sensitivity rating (BSR) interpretation

Table 6: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Warrenton WWTW and sewer network	24	Degraded	3

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

The area proposed for the new Warrenton WWTW and sewer network has been rated as being Degraded. This is mostly a result of the urban surroundings and already heavily modified condition, though elements of high conservation value, in particular the Vaal River, are still present.

The proposed new Waste Water Treatment Works (WWTW) will be situated approximately 2 km to the west of the town of Warrenton (Appendix A: Map 1). The proposed footprint of the WWTW will be approximately 20 hectares. The footprint of the proposed WWTW will be situated in a largely natural area and approximately 200 metres south of the Vaal River. The current layout and design will avoid impacts on the Vaal River, with the system not designed to have any overflow, discharge or outfall into the river. The assessment will also determine the proximity of the river and the likelihood that the WWTW may still have an impact on it (Appendix A: Map 2). A new main sewer network and associated pump stations will also be constructed, which will connect the WWTW to the sewer network of the town. The sewer network will be extensive, though the area contains only a few scattered watercourses and wetlands, and the main focus of the assessment will therefore be the Vaal River and the impact that the development will have on it. The existing WWTW is also defunct and large volumes of sewer overflow result in the formation of extensive, but completely artificial, wetland areas, which will also be assessed in overview. The assessment will therefore be based on both the WWTW and associated new main sewer network.

The urban areas associated with the town have been completely transformed from their natural condition. This is confirmed, for the most part, by the National Biodiversity Assessment (2018), which indicates the urban area to be transformed from its natural condition (Appendix A: Map 1). The surrounding area, including the location of the WWTW, is still considered to consist of natural vegetation, although the survey has also indicated that areas surrounding the town are characterised by high levels of disturbance, particularly associated with high levels of trampling and overgrazing by domestic livestock. Much the same is also true for the Vaal River, where the riverfront within the town is heavily modified, while the sections in the surroundings remain largely natural, however also with significant disturbance, caused by the discharge of raw sewage affecting the instream habitat, as well as extensive overgrazing by domestic livestock affecting the riparian vegetation. High levels of disturbance and degradation within the area are mostly a consequence of urban areas associated with Warrenton. Therefore, although natural vegetation is still present in the surrounding areas, albeit not within the urban area itself, they retain high levels of disturbance, including prominent infestation by exotic weeds and invasive species. Rubbish dumping is extensive and although contributing to the degradation of the vegetation condition, the main source of disturbance for surrounding natural areas is caused by them being utilised for communal grazing by domestic livestock, consequently leading to extensive overgrazing and trampling of the natural vegetation. This results in a decrease in vegetation cover, which combined with high levels of trampling, leads to significant erosion. From the above, it should be clear that the general ecology of the area is degraded from its natural condition.

The surface water of the study area is dominated by the Vaal River, which is situated north of the study area. The WWTW and associated sewer network will be situated largely outside the riparian zone or floodplain of the river, though a few sections of the sewer network will occur in close proximity or encroach into the floodplain of the river and will therefore be relevant to the assessment (Appendix A: Map 1 & 2). The assessment will therefore focus on the Vaal River, especially those areas where the sewer network may have an impact on it. A single small

drainage line will also be affected by the sewer network, also draining into the Vaal River. Extensive artificial wetland areas have also formed, associated with the existing WWTW and storm water discharge form the urban area. These all form part of the same drainage system, which is the Vaal River. The system will therefore be assessed as a whole, while separate descriptions of these components will also be provided.

The Vaal River flows from east to west, immediately to the north of the town of Warrenton where the WWTW and sewer network will be constructed (Appendix A: Map 1 & 2). It is a perennial system which 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 therefore have a significant impact on it. The river contains a significant floodplain or riparian zone, and it was also notable that floodplain wetland areas were also associated with the floodplain. The floodplain has also been affected and modified by the town itself, which has, in many instances, encroached into the floodplain, transforming it. Other significant impacts include abstraction, extensive surrounding agricultural centre-pivot irrigation, as well as mining activities associated with alluvial diamond mining operations. The sewer network will not cross over the river, while the WWTW will also not be situated in close proximity to it. However, a few sections may occur in close proximity, or encroach into the floodplain of the river and given the nature of the development, are therefore still likely to affect it.

As indicated in previous sections (See Section 4.1), the interior of the study area does not contain many watercourses or wetlands, given the local topography. As a result, only one small drainage line will be affected by the sewer network, with the new lift pump station being proposed for this drainage line, most likely because it forms a low point in the landscape, requiring additional pumping (Appendix A: Map 2). This drainage line forms a tributary of the Vaal River, flowing into it immediately to the north of the site. It therefore forms part of the Vaal system, will be affected by the proposed sewer network and will also influence the functioning of the Vaal River. The drainage line will therefore also need to be included in this assessment. The drainage line is quite small, but does still contain a defined channel. Despite its small size, wetland conditions are present, which can also be a consequence of increased storm water discharge from the urban area upstream or also sewage effluent discharging into it. It is therefore considered to be modified to a large degree.

As indicated, large areas of artificial wetlands have formed, associated with sewage effluent discharge from the existing, but defunct WWTW, as well as increased storm water runoff from the urban areas (Appendix A: Map 2). These areas contain extensive wetland conditions and will likely remain saturated throughout the year. They have however been confirmed to be completely artificial, not part of the remnants of any natural system and also not providing any significant ecosystem functions. They will therefore be noted in the report to confirm that they were surveyed but found to be artificial and therefore not part of the natural surface water resources of the area.

The Vaal River and its associated wetland conditions 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 Vaal River are clearly indicative of wetland conditions on a perennial basis (Appendix A: Map 2). The marginal and lower zones of the Vaal River contain distinctive wetland soil indicators with the marginal zone showing soil characteristics of a permanent zone of wetness. Two small drainage lines were identified within the study area, though only one of these will be affected by the sewer network, in particular the new lift pump station. This drainage line drains from the terrestrial interior and into the Vaal River (Appendix A: Map 2). The drainage line will most probably discharge periodically on a seasonal basis after

rainfall events from runoff generated in the surrounding catchment but is also being affected by increased storm water discharge from the upstream urban areas. As a result, the drainage line has developed seasonal wetland conditions, both in terms of soil wetness indicators and obligate wetland vegetation.

The wetland conditions associated with the banks of the Vaal River and the small lateral drainage line can be characterised as a channel wetland system. The wetland conditions are confined to the main channel of these systems which experiences surface flow either seasonally or perennially. Here wetland conditions are most prominent along the main channel and decrease in distance from the channel. The Vaal River is also associated with extensive wetland areas which can be regarded as a floodplain wetland system (SANBI 2009).

The Vaal River and its associated floodplain is considered a fifth order watercourse (Appendix D). This is also due to the river being a large lowland river. The quaternary catchment of this area is C91D. The largest impact on the site itself is considered urban transformation and the consequent runoff affecting the river. This will undoubtedly also have an impact on the ecological functioning of the Vaal River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are centre-pivot irrigation, alluvial diamond mining 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 Vaal River within the study area (Appendix D). The results of the IHI indicated that the Vaal River has an Instream IHI of category D: 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 urban development, centre-pivot irrigation and previous mining operations upstream of the study area. A summary of these results is included in Appendix D. The EI&S of the floodplains associated with the Vaal River has been rated as being Moderate.

A Risk Assessment for the proposed new WWTW and associated sewer network which will affect the Vaal River and associated floodplain, drainage lines and other wetland areas 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) (Appendix A: Map 2). The following risks, activities and impacts which have been identified regarding the proposed WWTW and sewer network are likely to affect the Vaal River and associated tributaries:

- The proposed WWTW will be situated further than 200 metres away from the delineated riparian zone of the Vaal River and is therefore unlikely to have any direct impacts on it (Appendix A: Map 2). However, should leakages or seepage occur from the oxidation ponds, this may contaminate groundwater, which will then eventually seep into the Vaal River, thus affecting its water quality. The extent of the impact is however anticipated to remain limited, and the risk is therefore anticipated to remain Low. This is however also subject to adequate maintenance undertaken by the WWTW.
- Currently the design of the WWTW will make use of oxidation ponds, without any outfall or discharge being included in the facility. Treated water will be utilised for irrigation which is therefore irrelevant to the Vaal River. This activity has therefore not been included in this assessment. However, should any overflow occur, discharge take place or any similar emergency release of treated or untreated sewage take place, additional water use application will have to be undertaken.
- The construction of the sewer network will likely cause disturbance of the Vaal River floodplain (Warrenvale Pump Station) and a small drainage line of the river (new lift

pump station), during the construction phase (Appendix A: Map 2). This in turn will promote erosion, prevent the watercourses from stabilising and lead to increased sedimentation of the downstream areas. As a result, disturbance should be kept to a minimum and erosion remediated where it occurs. Removal of vegetation should also be kept to a minimum.

- As can be deduced from the discussion of the affected watercourses, they already contain significant levels of disturbance and are heavily modified from their natural condition and consequently, the removal of wetland vegetation will have a limited impact on their functioning and loss of diversity. However, vegetation stabilises the watercourse and therefore it is important that vegetation be re-established where it was removed. This can most easily be attained by implementing adequate topsoil management. The upper 30 cm, or topsoil, should be removed together with the vegetation and stored on the site. This topsoil should then be placed on top of the installed sewer pipeline. Where topsoil is perceived to be absent, a seedbank will still be present, even if this may only be a few centimetres thick and should still be retained, as this will greatly aid in successful rehabilitation. Subsoil should be used as backfilling and not as top dressing. Only removed topsoil should be utilised to rehabilitate the watercourse crossing.
- The disturbance caused by construction will also create susceptible conditions for further establishment of exotics. The area is also known to be susceptible to several invasive species, especially the tree, *Prosopis glandulosa*, and it is therefore recommended that weed eradication be initiated at the construction site prior to construction and continued until rehabilitation of the sewer network has been completed (Appendix B).
- During operation of the sewer network, it will transport raw sewage to the Waste Water Treatment Works (WWTW). During the operation and maintenance of the sewer network spillages of raw sewage may likely occur into the affected watercourses, which will be most applicable to the Vaal River at the Warrenvale pump station and the small drainage line tributary at the new lift pump station. Such spillages will have a significant impact on these watercourses, especially the Vaal River. As a result, this impact has been rated as moderate. In addition, according to the General Authorisation regulations as contained within the National Water Act (Act 36 of 1998), the installation of sewer networks cannot be authorised under the General Authorisation regulations and the anticipated risk is therefore substantiated as being moderate. This is also affirmed by the current spillage of sewage into the Vaal River at the Warrenvale pump station, as well as overflow into the artificial wetland areas and canal, flowing into the Vaal River. This was also indicative of the large impact that this has, also indicating the urgent need to replace the existing WWTW and sewer network.

8. Recommendations

- After construction of the sewer network 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 must afterwards be rehabilitated.

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

- The following mitigation should be implemented to prevent or decrease the anticipated impacts on the Vaal River and associated tributaries where they will be affected by the WWTW and sewer network (Appendix A: Map 2):

    - An adequate storm water management system must be implemented for the WWTW, which should mainly consist of a low berm around the perimeter of the WWTW. This is also a standard management practice at WWTWs. This berm should then enable contaminated water to be retained within the operational area and keep it separate from clean water around the site.
    - Monitoring and eradication of exotic weeds and invasive species on and around the WWTW should be implemented and maintained throughout the operation of the WWTW. This should also specifically target the highly invasive *Prosopis glandulosa* trees in the area.
    - The sewer network will largely affect the floodplain of the Vaal River (Warrenvale pump station) and a small drainage line associated with the river (New lift pump station) (Appendix A: Map 2).
    - In order to stabilise the watercourses after construction and to prevent long-term disturbance, wetland vegetation must be re-established where it was removed. This can most easily be attained by implementing adequate topsoil management.
    - When excavating through watercourses, the upper 30 cm, or topsoil, should be removed together with the vegetation and stored as sods on the site. These should then be placed in disturbed areas requiring rehabilitation. This topsoil should then be placed on top of the installed sewer pipeline. Where topsoil is perceived to be absent, a seedbank will still be present, even if this may only be a few centimetres thick, and should still be retained, as this will greatly aid in successful rehabilitation. Subsoil should be used as backfilling and not as top dressing. Only removed topsoil should be utilised to rehabilitate the watercourse crossing.
    - The watercourse morphology (banks and channel) should be re-instated as far as possible, which will also speed up the stabilisation of the affected area.
    - Where concrete is utilised, the detrimental impacts of uncured cement on surface water and watercourses must be taken into consideration.
    - The timeframe for construction through the watercourses should also be kept to a minimum.
    - The construction footprint along the watercourses should be kept to a minimum.
    - Removal of vegetation within any of the watercourses should also be kept to a minimum.
    - Monitoring of construction and compliance with recommended mitigation measures must take place.

- Construction of the sewer network through any of the watercourses should preferably be undertaken during the winter months when the groundwater level will be at its lowest (June to September).
- The necessary authorisations must be acquired from the Department of Water and Sanitation (DWS) for the construction of the main sewer line that will affect the watercourses being crossed (Table 2) (Appendix A: Map 2).

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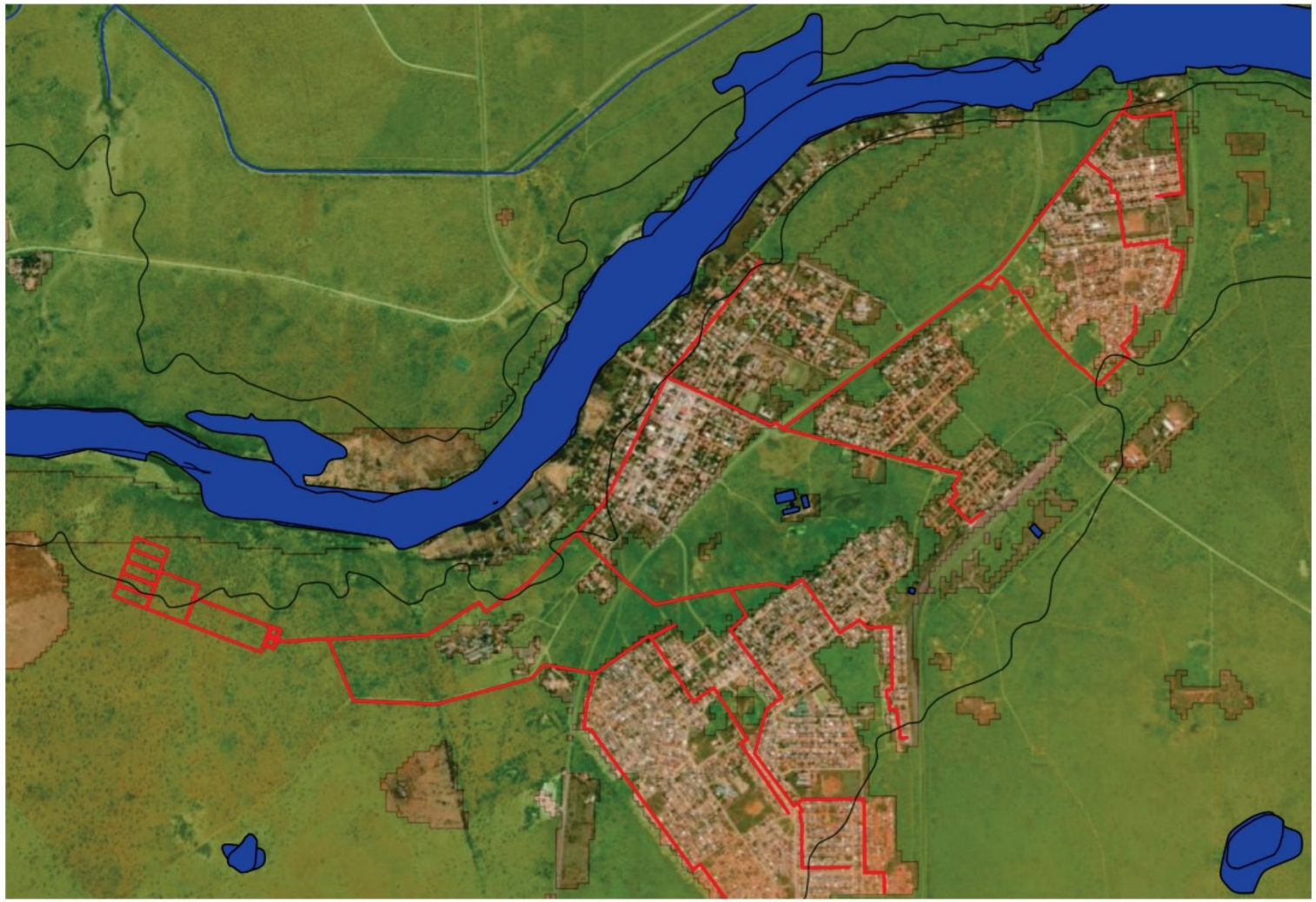
Appendix A: Maps

Locality map for the proposed new Waste Water Treatment Works (WWTW) and associated sewer network situated in the town of Warrenton, Northern Cape Province.



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9310

Legend:

- Proposed WWTW and sewers
- Watercourses
- Remaining natural vegetation
- Wetlands and impoundments
- Surface contours

Map Information

Spheroid: WGS 84

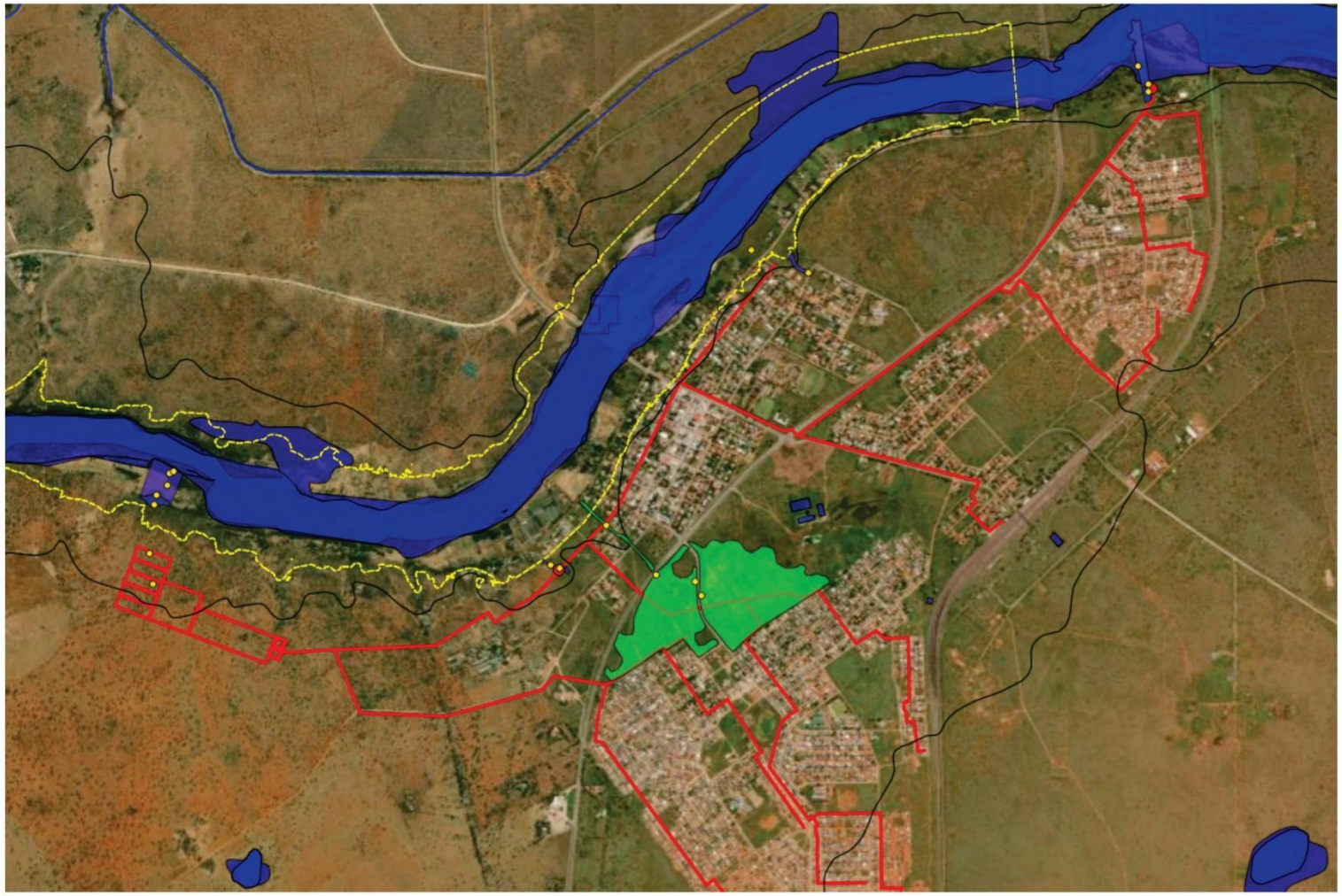
Quantum GIS

Scale: 1:35 000

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

Map 1: General ecology map of proposed new WWTW and sewer network in Warrenton. The approximate extent of remaining natural vegetation is indicated (National Biodiversity Assessment 2018) and indicates the urban areas to be transformed, while extensive natural areas remain in the surroundings. The National Biodiversity Assessment 2018: Wetland Map 5 and National Freshwater Ecosystems Priority Areas also indicates the extensive wetland conditions associated with the Vaal River and its floodplain, while the surroundings only contain a few pan systems, being largely devoid of wetland systems. Where the Vaal River or associated wetland areas could be affected by the development, their delineation was also refined by on-site delineation (refer to Map 2).

Wetland and riparian delineation map for the proposed new Waste Water Treatment Works (WWTW) and associated sewer network situated in the town of Warrenton, Northern Cape Province.



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P.O. Box 28242
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Legend:

- Proposed WWTW and sewers
- Vaal River Floodline
- Wetlands and riparian zone
- Artificial wetland areas
- Surface contours
- Wetland sample sites

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:35 000

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Map 2: Wetland and riparian delineation map of proposed new WWTW and sewer network in Warrenton. Delineation was undertaken for the Vaal River at the WWTW site, but confirmed to be completely removed from the site, while the Warrenvale pump station (north east), will be situated within the floodplain of the river. A small drainage line situated centrally within the study area, will be affected by the sewer network and new lift pump station. Note the extensive artificial wetland areas which are associated with the existing WWTW and urban areas, which also discharges via an artificial canal, into the Vaal River. These will also be crossed by the sewer network at several locations, though will only have an impact where any sewage spillage can affect the downstream Vaal system.

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
**Emex australis*	Herb
**Eucalyptus cmaldulensis*	Tree
**Morus alba*	Tree
**Opuntia humifusa*	Succulent
**Pennisetum clandestinum*	Grass
Alternanthera sessilis	Herb
Arctotis arctotoides	Herb
Asparagus larcinus	Shrub
Cynodon dactylon	Grass
Cynodon transvaalensis	Grass
Cyperus marginatus	Sedge
Cyperus sexangularis	Sedge
Cyperus sp.	Sedge
Diospyros lycioides	Tree
Eragrostis curvula	Grass
Gymnosporia buxiifolia	Shrub
Juncus rigidus	Rush
Menodora africana	Herb
Moraea simulans	Geophyte
Phragmites australis	Reed
Phyla nodiflora	Herb
Ranunculus multifidus	Herb
Salix mucronata	Tree
Searsia lancea	Tree
Searsia pendulina	Tree
Senegalia mellifera subsp. *detinens*	Tree
Sonchus oleraceus	Herb
Tarchonanthus camphoratus	Shrub
Themeda triandra	Grass
Typha capensis	Bulrush
Vachellia karroo	Tree
Vachellia tortillis	Tree
Vahlia capensis	Herb
Ziziphus mucronata	Tree

Appendix C: Soil Samples Methodology

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

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

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

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

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

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

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

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

and sulphuric odour (rotten egg smell). According to convention, hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Appendix D: Index of Habitat Integrity (IHI)

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

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	Warrenton WWTW and Sewer lines
UPPER LATITUDE	S 28.094841°
UPPER LONGITUDE	E 24.872727°
UPPER ALTITUDE	1173m
LOWER LATITUDE	S 28.114511°
LOWER LONGITUDE	E 24.819702°
LOWER ALTITUDE	1165m
SURVEY SITE (if applicable)	Vaal River Warrenton
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Lower Vaal
QUATERNARY	C91D
ECOREGION 2	29_2
DATE	2025/10/15
RIVER	Vaal River
TRIBUTARY	
PERENNIAL (Y/N)	**Y**
GEOMORPH ZONE	**LOWLAND**
WIDTH (m)	**>15**

	MRU
INSTREAM IHI	
Base Flows	-3.0
Zero Flows	2.0
Floods	-4.5
HYDROLOGY RATING	**3.0**
pH	3.0
Salts	2.5
Nutrients	2.0
Water Temperature	3.0
Water clarity	2.0
Oxygen	1.5
Toxics	2.5
PC RATING	**2.4**
Sediment	2.0
Benthic Growth	2.0
BED RATING	**2.0**
Marginal	2.5
Non-marginal	2.5
BANK RATING	**2.5**
Longitudinal Connectivity	3.0
Lateral Connectivity	2.5
CONNECTIVITY RATING	**2.8**
INSTREAM IHI %	**48.7**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**2.8**

	MRU
RIPARIAN IHI	
Base Flows	-3.0
Zero Flows	-2.0
Moderate Floods	-4.0
Large Floods	-4.0
HYDROLOGY RATING	**3.3**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	1.0
Invasive Alien Vegetation (marginal)	3.0
Invasive Alien Vegetation (non-marginal)	3.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	2.5
Physico-Chemical (non-marginal)	1.0
Marginal	3.0
Non-marginal	3.0
BANK STRUCTURE RATING	**3.0**
Longitudinal Connectivity	2.0
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.0**
RIPARIAN IHI %	**42.2**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.7**

Appendix E: Risk Assessment Matrix

PROJECT:	**Proposed new Waste Water Treatment Works (WWTW) and associated sewer network situated in the town of Warrenton, Northern Cape Province.**

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

Name of Assessor:	Darius van Rensburg	**Signature:**	
SACNASP Registration Number:	400284/13		
Date of assessment:	15/10/2025		

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

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
			Name/s	PES	Overall Watercourse Importance	Abiotic Habitat (Drivers)			Biota (Responses)											
						Hydrology	Water Quality	Geomorph	Vegetation	Fauna										
CONSTRUCTION	WWTW and possible groundwater contamination.	The proposed WWTW will be situated further than 200 metres from the delineated riparian zone of the Vaal River and is therefore unlikely to have	Vaal River	D	Moderate	0	3	0	0	1	**6**	1	4	**11**	**3**	**33**	80%	**0.264**	**L**	High
		any direct impacts on it. However, should leakages or seepage occur from the oxidation ponds, this may contaminate groundwater, which will then																		
		Ueventually seep into the Vaal River, thus affecting its water quality.																		
	Excavation and backfilling of trenches	Excavation of trenches will impede flow while trenches are open.	Vaal River - Warrenvale pump station	D	Moderate	2	3	2	3	1	**6**	2	2	**10**	**3**	**30**	80%	**0.24**	**L**	High
		Disturbance of the bed and banks will promote sedimentation.	Drainage line - new lift pump station	D	Moderate	2	3	2	3	1	**6**	2	2	**10**	**3**	**30**	80%	**0.24**	**L**	High
		Use of concrete casing may also affect the Vaal River floodplain and associated small drainage line.																		
	Removal of riparian vegetation	Removal of riparian and wetland vegetation will promote erosion and sedimentation of the watercourses.	Vaal River - Warrenvale pump station	D	Moderate	2	3	2	3	1	**6**	2	2	**10**	**3**	**30**	80%	**0.24**	**L**	High
		Disturbance and removal of vegetation will create conditions susceptible to the establishment of exotic weeds.	Drainage line - new lift pump station	D	Moderate	2	3	2	3	1	**6**	2	2	**10**	**3**	**30**	80%	**0.24**	**L**	High
OPERATIONAL	Operation of sewer network.	The sewer network will transport raw sewage to the Waste Water Treatment Works (WWTW). During the operation and maintenance of the	Vaal River - Warrenvale pump station	D	Moderate	3	4	1	2	2	**8**	5	2	**15**	**3**	**45**	80%	**36**	**M**	High
		sewer network it is likely that spillages of raw sewage may occur, into the affected watercourses, which will be most applicable to the Vaal River at the	Drainage line - new lift pump station	D	Moderate	3	4	1	2	2	**8**	5	2	**15**	**3**	**45**	80%	**36**	**M**	High
		Warrenvale pump station and the small drainage line tributary at the new lift pump station. Such spillages will have a significant impact on these watercourses, especially the Vaal River.	Artificial wetlands - associated with existing WWTW and effluent discharge	n/a (artificial)	Low / Very low	1	4	1	2	1	**8**	5	2	**15**	**none**	**#VALUE!**	80%	**#VALUE!**	**#VALUE!**	High

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Proposed Relocation of the Warrenton WWTW and Associated Bulk Infrastructure.

2. Details of the specialist:

Project Specialist:	Aquatic Ecologist		
Trading name (if any):	DPR Ecologists and Environmental Services		
Business reg. no./ID. no.:	2011/097199/23		
Contact person:	Darius van Rensburg		
Physical address:	61 Topsy Smith Street Langenhoven Park, 9300		
Postal address:	PO Box 12726, Brandhof		
Postal code:	9324	**Cell:**	083 410 0770
Telephone:	-	**Fax:**	-
E-mail:	darius@deprecologists.co.za		
Qualifications:			
Professional affiliation (s) (if any)	SACNASP Eco Sci 400284/13		

3. Details of the consultant

Project consultant/firm:	Environmental Management Group		
Business reg. no./ID. no.:	2017/077689/07		
Contact person:	Ivan Victor Coertze		
Postal address:	PO Box 37473, Langenhovenpark		
Postal code:	9330	**Cell:**	071 371 8825
Telephone:	051 412 6350	**Fax:**	-
E-mail:	ivan@envmgp.com		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, Darius van Rensburg, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

DPR Ecologists and Environmental Services

Name of company (if applicable):

11/06/2026

Date:

Signature of the Commissioner of Oaths:

11/06/2026

Date:

Professional Accountant

Designation:

Official stamp (below):

COMMISSIONER OF OATHS (RSA)
DALTON MAURITZ BAKKES
Professional Accountant (S.A.) ex officio
SAIPA NO: 35354
P.O. BOX 1703. MONTANA PARK, 0159