Riverglades Estate
Aquatic Assessment of the
Klein-Jukskei River

January 2017

CLIENT

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Report Name	**Riverglades Estate Aquatic Assessment of the Klein-Jukskei River**	
Reference		
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Non-Technical Summary

The Biodiversity Company carried out a baseline aquatic (ecological) assessment of the Klein-Jukskei River on the 5th of January 2017. The aim of the assessment was to provide information with respect to the current state of the Klein-Jukskei River, particularly for the river reach adjacent to the Riverglades Estate.

River	Catchment	Quaternary catchment	Setting
Klein-Jukskei Ephemeral reach	Crocodile West and Marico WMA	A21C	The study area is surrounded by urban developments
Sub-Quaternary Reach (SQR) A21C-1211 (Based on desktop data only)	PES (Health)	Ecological Importance	Ecological Sensitivity
	Seriously modified	Low	Moderate
	Loss of habitat, altered flows and impaired water quality	Low fish diversity and migration links	Species tolerant to water level changes

River reach findings		
Water Quality (*in situ*)	Adequate	Water quality can sustain aquatic life. (This does not include metal, chemical or nutrient analysis).
Habitat Integrity	Good	A good variety of habitat and flows to support aquatic life.
Macroinvertebrates	Seriously Modified	Low diversity and the sampled “insects” are mostly tolerant to water quality changes, suggesting impaired water quality.
Fish Assemblage	Moderately Modified	Two fish or five expected species were sampled, the remaining species are known to be in the river.
Overall Condition	**Largely Modified**	**A large loss of natural habitat, biota and basic ecosystem functions has occurred.**

The Klein-Jukskei River is expected to be modified due to the location of the system being surrounded by developments. The water quality (*in situ*) and habitat findings suggest that the physical structure of the system is suitable to sustain aquatic life. However, the invertebrates and fish findings suggest that the water quality may be an issue. The water quality will be inspected further to confirm this, in order to establish if metals, chemical or nutrients (sewerage) are impacting on the water quality.

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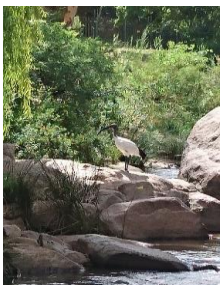
1 INTRODUCTION



The Biodiversity Company carried out a baseline aquatic (ecological) assessment of the Klein-Jukskei River on the 5th of January 2017. The aim of the assessment was to provide information with respect to the current state of the Klein-Jukskei River, particularly for the river reach adjacent to the Riverglades Estate. This was achieved through the characterisation of the current state of biotic (living) and abiotic (non-living) attributes of the system.

The assessment of a river system primarily uses biological indicators (responders) such as fish communities, riparian (bank-side) vegetation and aquatic macroinvertebrates (insects) to assess the current state or health of the system in support of the rational management of these natural resources. The use of biological indicators provides a direct, complete and integrated measure of the current ecological state of the river (DWAF, 2005).

2 PROJECT AREA

The Klein-Jukskei River flows through the Jukskei Park Area, with its origin in Florida on the west rand, Johannesburg. The Klein-Jukskei River forms one of three major tributaries of the larger Jukskei River, which then flows in a northerly direction into the Crocodile River and Hartbeespoort Dam. Jukskei Park is situated in the quaternary catchment A21C, within the Crocodile West and Marico Water Management Areas (WMA 3).

The Crocodile West and Marico WMA lies adjacent to the Botswana border to the north-west, predominantly within Limpopo. It is situated in a semi-arid part of the country with a mean annual precipitation of 400 to 800 mm. Its main rivers, the Crocodile and Marico Rivers, give rise to the Limpopo River at their confluence. The area is characterised by the urban and industrial complexes of northern Johannesburg and Pretoria and platinum mining north-east of Rustenburg, and activities include extensive irrigation development along the main rivers with grain, livestock and game farming. A substantial portion of the WMA water is transferred from the Vaal River with small transfers out of the WMA to Gaborone in Botswana and to Modimolle in the Limpopo WMA. Increasing quantities of effluent return flow from urban and industrial areas is a major cause of pollution in some rivers (StatsSA, 2010).

The aquatic assessment study area is located in the middle reaches of the Klein-Jukskei River. The focus for the study was a section of the river that flows adjacent to the Riverglades Estate comprising a variety of aquatic habitats including pools, runs and riffles (Figure 1). The area surrounding the study site consists of urban and residential activities. The activities in the area both at site and further upstream together with the local land uses have had impacts on the aquatic system and visible disturbances were notable.

According to desktop information, the Klein-Jukskei River system as a whole is regarded as seriously modified. A river system is regarded as seriously modified when the loss of natural habitat, biota (living organisms) and basic ecosystem functions are extensive. The Klein-

Jukskei River, much like the Jukskei River is prone to flash flooding as a result of increased hardened surfaces (roads, paving, buildings and parking lots) and surface runoff (stormwater). The current trend shows urbanisation to continue that may lead to the increase in the number and size of flash flood events. Flooding can have two effects on a river. Firstly, the large volumes of water can have a flushing effect cleaning out sediment and debris build-up while alternatively, it can wash and dump large volumes of sediment and debris into the river with erosive forces cutting away unprotected river banks and removing riparian vegetation, damaging anything in its way.

Stormwater washes large volumes of sediment, debris (plastics, synthetics, polystyrene, etc.), hydrocarbons (fuels, oils and other substances) and pollutants (sewage, herbicides and pesticides) into stormwater drains and subsequently the rivers, having adverse effects on aquatic life and the general health of the river.

A site description, photographs and GPS coordinates for the sampled river section is presented in Table 1.

Table 1: Photos, co-ordinates and descriptions for the reach sampled

Upstream	Downstream
	
GPS coordinates	26° 1'51.86"S 27°58'54.99"E
Reach description	The reach is characterized by medium to slow flowing waters over stones, bedrock and sandy substrate with adequate marginal vegetation. The reach had a series of runs with areas of riffles and eddies situated between pools of varying depth. Undercut banks with exposed root wads were present. Water clarity was considered good with upwards of 40cm visibility.
Onsite impacts	Large amounts of solid waste, debris from floods and erosion were noted.

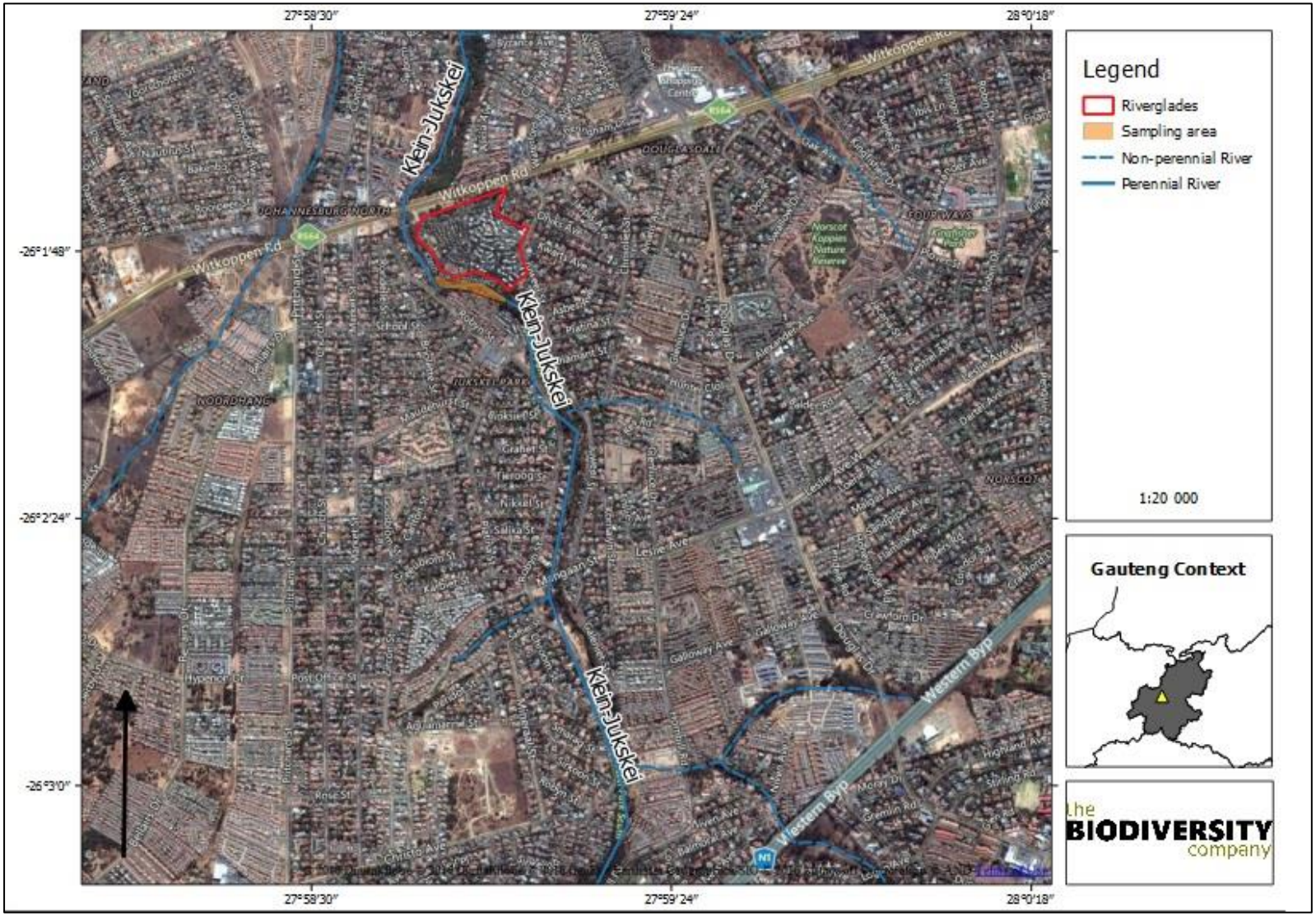


Figure 1: Locality map of the Klein-Jukskei River in relation to Riverglades Estate

3 DESKTOP ASSESSMENT

3.1 National Freshwater Ecosystem Priority Area (NFEPA) Status

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel et al. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel et al., 2011).

3.2 NFEPA's for sub-quaternary catchment A21C-1211

The Sub-Quaternary Catchment (SQR) has no freshwater priority areas designated to it. This may be due to the scale of impacts present within the Klein-Jukskei River catchment area, consisting mostly of urban and industrial areas (Figure 2).

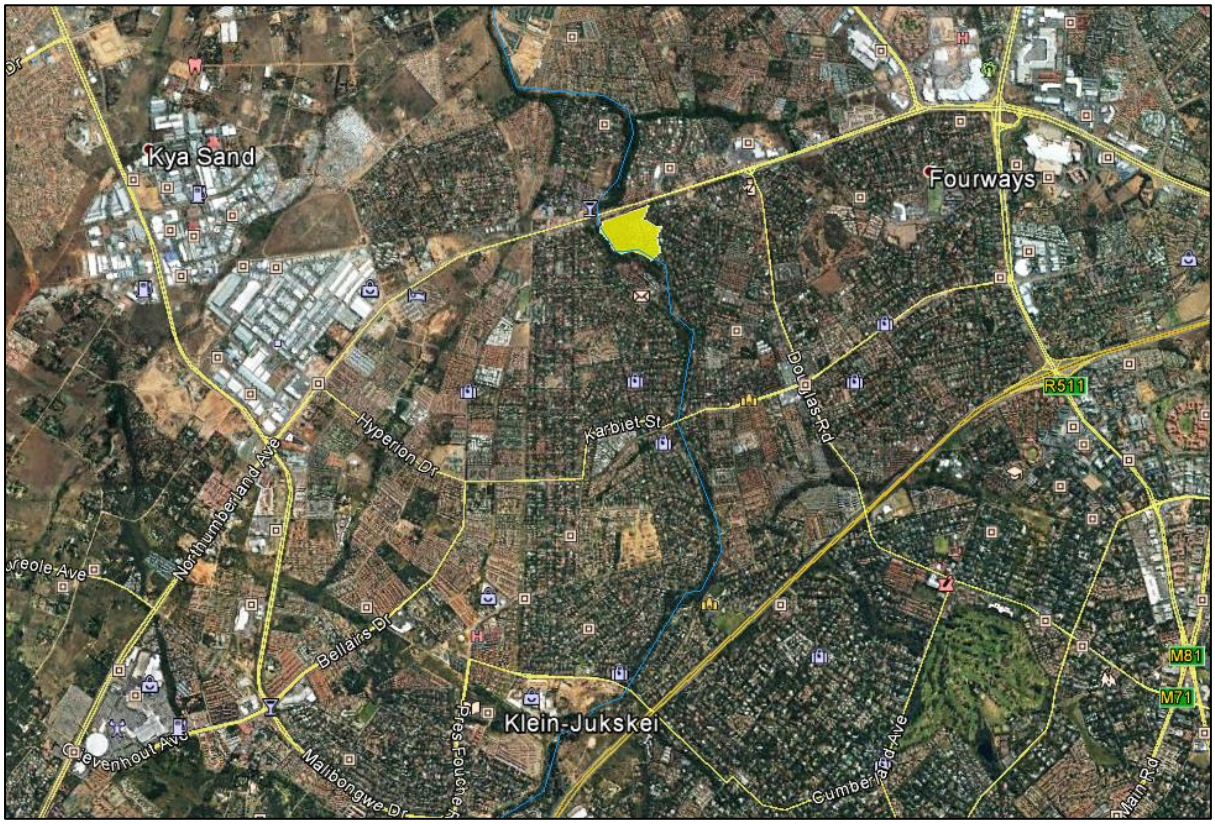


Figure 2: Catchment area of the Klein-Jukskei River depicting the extent of development. Yellow area highlights the Riverglades Estate

3.3 Present Ecological Status (PES)

3.3.1 Status of SQR A21C-1211

Desktop information was obtained from DWS, 2013. The study area falls under the Klein-Jukskei SQR. The reach spans 28.5 km of the Klein-Jukskei River. The PES category of the reach is classed as seriously modified (Class E). The seriously modified state of the reach is attributed to large to serious impacts to instream habitat, wetland and riparian zone continuity, flow modifications and potential impacts on physico-chemical conditions (water quality).

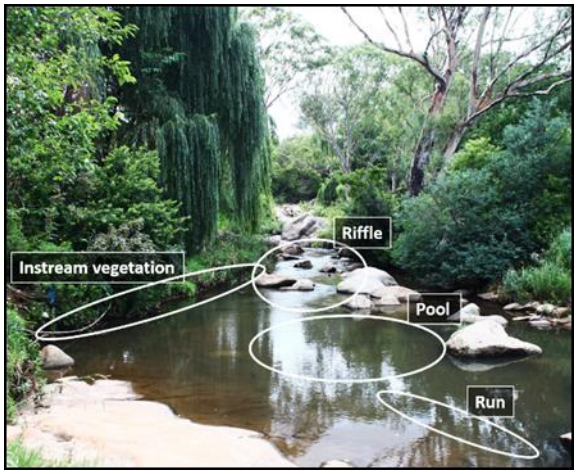
The Ecological Importance (EI) of the reach is classified as low due to the low fish diversity, rarity of fish is considered very low, low instream migration class, and low riparian-wetland zone migration link class. Biodiversity and species richness is considered to be low. Habitat diversity and integrity are classed as low. Adverse conditions within the reach are due to bed and channel disturbance, alien vegetation, increased flows, sedimentation and erosion and runoff/effluent from urban areas and industry.

The Ecological Sensitivity (ES) is categorised as moderate due to wetland-riparian vertebrates (excluding fish) intolerance to water level changes. However, fish have a low sensitivity while and macroinvertebrate taxa, are considered to be highly sensitive to flow and physico-chemical water modifications, respectively.

4 METHODOLOGY

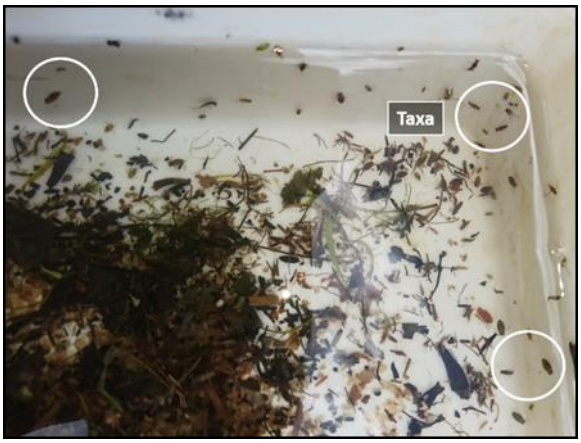
Various assessments conducted during the survey are illustrated in Figure 5. Full methodology can be requested from The Biodiversity Company.

***In situ* water quality analysis**



Habitat Assessments (IHAS)

Various fishing techniques (e.g. electrofishing and cast nets)



Macroinvertebrate sampling, SASS5 (South African Scoring System Version 5)

Figure 3: Methodologies applied during the aquatic assessment

5 RESULTS & DISCUSSIONS

5.1 *In situ* water quality

In situ water quality analysis was assessed during sampling. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. The results of the survey are presented in Table 2.

Table 2: *In situ* water quality results for the high flow survey

Site	pH	Conductivity (µS/cm)	DO (mg/l)	DO Saturation (%)	Temperature (°C)
TWQR*	**6.5-9.0**	**<700**	**>5.00**	**80-120**	**5-30**
Riverglades	8.42	333	7.14	94.90	19.10

* Target Water Quality Range for Aquatic Ecosystems

5.1.1 Water Quality in Summary

The water quality values measured in the Klein-Jukskei River were within the recommended guideline levels. The pH, Electrical Conductivity, Dissolved Oxygen and Temperature readings were considered adequate and able to sustain aquatic life. This suggests that the recorded parameter levels did not have a limiting effect on local aquatic life at the time of the survey.

5.1.2 Water Quality and Rivers

- Most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6.5 to 8.5, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (Barbour et al, 1996). The pH target for fish health is presented as ranging between 6.5 and 9.0.
- Electrical Conductivity is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge.
- The maintenance of adequate Dissolved Oxygen (DO) is critical for the survival of aquatic biota as it is required for the respiration of all aerobic organisms (DWS, 1996). Therefore, DO concentration provides a useful measure of the health of an ecosystem (DWS, 1996). The median guideline for DO for the protection of freshwater fish, determined by a variety of fish species is > 5 mg/ℓ (Doudoroff & Shumway, 1970 and DWS, 1996).
- Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (DWS, 1996). Temperature affects the rate of development, reproductive periods and emergence time of organisms (DWS, 2005). Temperature varies with season and the life cycles of many aquatic macroinvertebrates are cued to temperature (DWS, 2005).

5.2 Habitat assessment

The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a river; therefore assessment of the habitat is key to any assessment of ecological integrity. The Invertebrate Habitat Assessment System (IHAS, version 2) was applied in the Klein-Jukskei River in order to assess the availability of the different habitat types for macroinvertebrates (insects). The sampling habitat is broken down into three sub-sections namely Stones-In-Current (SIC), Vegetation (VEG), Gravel Sand & Mud (GSM) and other habitat/ general. It is presently thought that a total IHAS score of over 65% represents good habitat conditions, while a score of over 55% indicates adequate/fair habitat conditions (McMillan, 1998) The IHAS results for the survey are presented in Table 3.

Table 3: IHAS Score at each site during the wet season survey

Site	Riverglades
Score	74
Suitability	Good

According to the IHAS results, habitat availability for aquatic macroinvertebrates was Good at the site (Table 3). The site was characterized by medium to slow flowing waters over stones, bedrock and sandy substrate with adequate marginal vegetation. The site had a series runs with areas of riffles and eddies situated between pools of varying depth. A number of undercut banks with exposed root wads were present. Water clarity was considered good with upwards of 40cm visibility. The site was heavily sedimented due to urban activities.

5.3 Aquatic macroinvertebrates

The monitoring of aquatic macroinvertebrates forms an integral part of the monitoring of the health of an aquatic ecosystem as they are relatively sedentary and enable the detection of localised disturbances. Their relatively long life histories (±1 year) allow for the integration of pollution effects over time. Field sampling is non-intensive and since the communities are heterogeneous and several phyla are usually represented, response to environmental impacts is normally detectable in terms of the community as a whole (Hellawell, 1977).

Macroinvertebrate Sensitivity

Macroinvertebrates are assigned a sensitivity scoring between 1 and 15 according to their tolerances to pollution (Dickens & Graham, 2002). These scores are broadly:

- 1-5 Highly tolerant to pollution
- 6-10 Moderately tolerant to pollution
- 11-15 Very low tolerance to pollution

These scores are totalled and provide an indication of the state of the system according to reference conditions of a specific ecoregion.

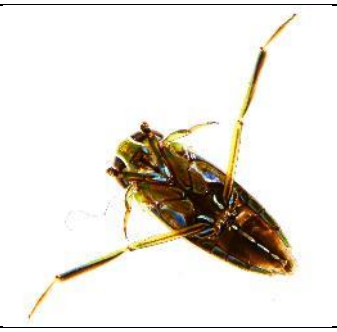
The aquatic macroinvertebrate results are presented in

Table **4**.

Table 4: Macroinvertebrate assessment results

SASS Score	**48**
No. of Taxa (Species)	13
ASPT*	3.69
Category	**Seriously modified**

During the survey a low diversity of macroinvertebrates were collected. Pictures below illustrate examples of what was found in the Klein-Jukskei River.

	
Coenagrionidae (Sprites & Blues) Predator Sensitivity: 4 (low) **Habitat:** Vegetation Edges of slow streams	**Notonectidae*** (Backswimmers) Predator Sensitivity: 3 (low) **Habitat:** Pools Backwaters of streams
	
Baetidae (Mayfly) Scraper Sensitivity: 4 (low) **Habitat:** Rocks, plants or coarse sand Moderately fast streams	**Potamonautidae** (Crabs) Predator Sensitivity: 3 (low) **Habitat:** Under or amongst rocks, banks

5.4 Biotic Integrity based on Insect Results

Reference conditions reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time. These reference conditions are used as a benchmark against which field data can be compared. Modelled reference conditions for the Highveld - Lower Ecoregion were obtained from Dallas (2007) (Table 5). The biological bands for the Highveld - Lower Ecoregions are presented in Figure 4. Biological bands represent different categories to illustrate what health the river is in at the time of sampling.

Table 5: Modelled reference conditions for the Highveld - Lower Ecoregion based on SASS5 and ASPT scores (adapted from Dallas, 2007)

Class	Ecological Category	Description
A	Natural	Unimpaired. High diversity of insects with numerous sensitive species.
B	Largely natural	Slightly impaired. High diversity of insects, but with fewer sensitive species.
C	Moderately modified	Moderately impaired. Moderate diversity of insects.
D	Largely modified	Considerably impaired. Mostly tolerant species present.
E/F	Seriously Modified	Severely impaired. Only tolerant species present.

** Average Score per Taxa (Species)*

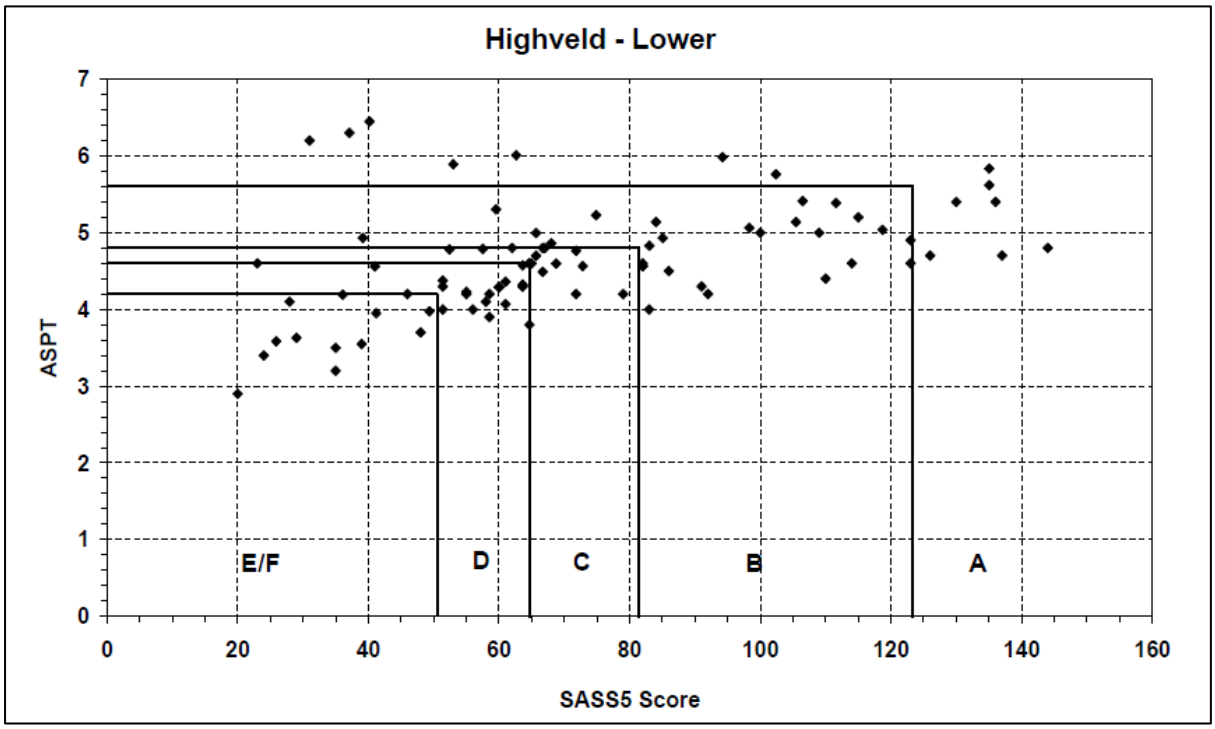


Figure 4: Biological Bands for the Highveld - Lower Ecoregion, calculated using percentiles

Biotic integrity of the river section sampled was categorised as seriously modified (PES Class E/F) (

Table **4**). This indicates that the macroinvertebrate assemblage is in an impacted state. The low diversity of aquatic insect species indicates that the quality of the river water is of poor condition and unable to sustain the more sensitive species. It should be noted that although modified, the river is capable of sustaining aquatic life. The good instream habitat diversity, availability, and habitat quality was not a limiting and is capable of sustaining a greater species diversity should the water quality increase over time. The ASPT score indicates a high percentage of tolerant species were recorded at the time of sampling. The macroinvertebrate assemblage indicates that the biotic integrity of the Klein-Jukskei River system is seriously modified due to its location in the urban environment.

5.5 Fish

5.5.1 Expected Fish Species

The list of expected fish species is presented in Table 6 (Skelton, 2001; DWS, 2013). Based on this, a total of 5 fish species are expected to occur in the Klein-Jukskei River.

It should be noted that these expected species lists are compiled on a river catchment basis and not on a site specific basis. It is therefore highly unlikely that all of the expected species will be present at every site in the Klein-Jukskei River, with habitat type and availability being the main reason for the presence of species. Therefore, Table 6 should be viewed as a list of potential species rather than an expected species list.

The species richness within the Klein-Jukskei River is considered low, and furthermore the species within the river are generally considered to be tolerant of modified physico-chemical (water quality) conditions and survive and breed under these conditions (DWAF, 2013).

Table 6: Expected species list for the Klein Jukskei River

Scientific name	Common name	IUCN Status
Enteromius anoplus	Chubbyhead barb	Least Concern
Enteromius paludinosus	Straightfin barb	Least Concern
Clarias gariepinus	Sharptooth catfish (Barbel)	Least Concern
Pseudocrenilabrus philander	Southern mouthbrooder	Least Concern
Tilapia sparrmanii	Banded tilapia	Least Concern
Total number of expected species		**5**

5.5.2 Presence of Species of Conservation Concern

The conservation status of the indigenous fish species was assessed in terms of the IUCN Red List of Threatened Species (IUCN, 2016). Based on this assessment there are no fish species of special concern within the Klein-Jukskei River.

5.5.3 Fish Results

Fish sampling was conducted on Klein-Jukskei River using an electroshocker to temporarily stun fish (Figure 5). Predominantly rifles and runs with sand, cobbles and bedrock were sampled with this technique, while the deeper pools were sampled with a cast net (Figure 6). Limited marginal vegetation was available to serve as cover for fish. Cover features included stones, bedrock, undercut banks, marginal vegetation and water column. Numerous Sharptooth catfish and Chubbyhead barbs were collected in the river.

Figure 5: Electroshocker in action and a Barbel (centre) and a Barb (right)

Figure 6: Cast netting in one of the pools

Fish have different sensitivities or levels of tolerance to various aspects that they are subjected to within the aquatic environment. These tolerance levels are rated with a sensitivity score as presented in Table 7. These tolerance levels are scored to show each fish species sensitivity to flow and physicochemical modifications.

Table 7: Intolerance rating and sensitivity of fish species

Sensitivity Score	Tolerance/Sensitivity Level
0-1	Highly tolerant = Very low sensitivity
1-2	Tolerant = Low sensitivity
2-3	Moderately tolerant = Moderate sensitivity
3-4	Moderately intolerant = High sensitivity
4-5	Intolerant = Very high sensitivity

Table 8: Fish species recorded during the survey

Scientific name	Common name	IUCN status	No. of Individuals	Sensitivity	
				No-flow	Phys-chem
Clarias gariepinus	Sharptooth catfish	LC	16	**1.7**	**1**
			Occurs in any habitat but favours large floodplains, sluggish rivers, lakes and dams. Completely omnivorous and eats available organic food source. Breeds in summer after rains. Grows to 1.4 meters, and more than 30 kg.		
Enteromius anoplus	Chubbyhead barb	LC	7	2.3	2.6
			Prefers cooler waters in a variety of habitats. Associated with cover. Omnivore. Breeds in summer. Grows to 12 cm.		

The results from the fish assessment indicate that the community structure in the Klein-Jukskei River reach is in a fair condition with 2 of the 5 expected fish species collected in good abundances (Table 8). Expected species that were not collected included *Enteromius paludinosus* (Straightfin barb), *Pseudocrenilabrus philander* (Southern mouthbrooder) and *Tilapia sparrmanii* (Banded tilapia). These 3 absent species are highly tolerant to tolerant of impacts showing a low sensitivity to pollution, and are likely to occur within the river. Although not all of the expected fish species were recorded during the January 2017 survey, it should be noted that the results are based on a single survey of relatively short duration. It is likely that some more of the expected fish species will be recorded with additional sampling effort.

6 CURRENT IMPACTS

The river is currently in a modified condition. This is largely due to poor instream habitat of the system. Impacts observed at site included erosion, solid waste disposal, livestock activities and indigenous vegetation clearing (Figure 7).

Figure 7:Solid waste and debris found along the river banks throughout the Klein-Jukskei River

7 CONCLUSIONS

According to desktop information, the Klein-Jukskei River system associated with the Riverglades Estate is in a seriously modified state. After assessing the river section adjacent to the Riverglades Estate, it was apparent that conditions in this river section were better than that of the entire rivers state. The Klein-Jukskei River faces a variety of impacts that generally have large and cumulative effects on a river system. However, the sampled section has been subjected to moderate levels of modification to the riparian and instream habitat and biotic integrity within the reach resulting in a largely modified state. During the site visit, several modifications were observed. These include extensive exotic vegetation encroachment into the riparian and marginal zones, as well as direct impacts to instream habitat due to solid waste and sedimentation.

Aquatic Assessment Results for the 2017 baseline assessment

Site	Riverglades
Water Quality (*in situ*)	**Adequate**
Habitat Integrity	**Good**
Macroinvertebrates	**Seriously Modified**
Fish Assemblage	**Moderately Modified**
Overall Condition	**Largely Modified**

Water quality (*in situ*) was considered adequate enough to sustain aquatic life and not of major concern. Five species of fish are expected to occur within the Klein-Jukskei River, none of which are of conservation importance. Sampling resulted in two fish species that are considered to be common and tolerant of modified conditions. The aquatic macroinvertebrate assemblage is in an impacted state with a low diversity of insect species tolerant of pollution. Based on the findings of the aquatic assessment, the Klein-Jukskei River is in a largely modified condition maintaining basic ecosystem functions and is home to aquatic biota of low sensitivity.

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