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AQUATIC ASSESSMENT REPORT FOR THE PROPOSED ADAMAYVIEW OUTFALL SEWER PIPELINE UPGRADE FOR THE CITY OF MATLOSANA MUNICIPALITY, NORTH WEST PROVINCE

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Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as information available at the time of study. Therefore the author reserves the right to modify aspects of the report, including the recommendations, if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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ACRONYMS

ACRONYM	DESCRIPTION
ASPT	Average Score per Taxa
BDI	Biological Diatom Index
CBA	Critical Biodiversity Area
CI	Conservation Importance
COD	Chemical Oxygen Demand
CRS	Catchment Resource Strategy
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEMC	Default Ecological Management Classes
DL	Detection Limit
DO	Dissolved Oxygen
DO%	Percentage Saturation
DWA	Department of Water Affairs (previously known as DWAF)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation (previously known as DWA)
EA	Environmental Authorisation
EC	Electrical Conductivity
ECA	Environmental Conservation Act (ECA; Act 73 of 1989).
ECO	Environmental Control Officer
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Categories
EMPR	Environmental Management Programme
EN	Endangered
ES	Ecological Sensitivity
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Areas
FAII	Fish Assemblage Integrity Index
FFGs	Functional Feeding Groups
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurrence
FSA	Fish Support Area
GPS	Global Positioning System
GSM	Gravel, Sand and Mud
ICP-MS	Inductive Coupled Plasma Mass Spectrometry
IDW	Inverse Distance Weighted
IHASv.2	Integrated Habitat Assessment System Version 2
IHI	Index of Habitat Integrity
LC_{50}	Lethal Concentrations 50

ACRONYM	DESCRIPTION
MAPE	Mean Annual Potential Evaporation
MAP	Mean Annual Precipitation
MAT	Mean Annual Temperature
MFD	Mean Frost Days
NAEHMP	National Aquatic Ecosystem Monitoring Programme
NRF	National Research Foundation
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resource Strategy
MIRAI	Macro-Invertebrate Response Assessment Index
PE	Percentage Effect
PES	Present Ecological State
%PTV	Percentage of Pollution Tolerant Valves
REC	Recommended Ecological Category
RDM	Reserve Determination
REMP	River Ecosystem Monitoring Plan
RHP	River Health Programme
RWQO	Resource Water Quality Objectives
SAIAB	South African Institute for Aquatic Biodiversity
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAR	Sodium Absorption Ration
SASS5	South African Scoring System Version 5
SPI	Specific Pollution Index
SS	Suspended Solids
SQ	Sub Quaternary Catchment
TUa	Acute Toxicity Units
PE	Percentage Effect
PSD	Particle Size Distribution
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
VEGRAI	Vegetation Response Assessment Index
WMA	Water Management Area
WRC	Water Research Commission
WQ	Water Quality
WULA	Water Use License Application
WUL	Water Use Licence
WWF	Worldwide Fund for Nature

1. INTRODUCTION

The City of Matlosana Municipality requested an aquatic assessment for a non-perennial stream, Palmietspruit. This is in relation with the proposed Adamayview Outfall Sewer Upgrade in the City of Matlosana Municipality, North West Province. This assessment is to feed into a BAR and WULA process.

This document will report on the results for the project, namely the present ecological state (PES) of the three identified sites per the macro-invertebrate and fish data collected. The assessments were undertaken on 25 June 2017.

2. STUDY AREA

The study area is located in the North-West Province, South Africa. Below (Table 1), is a table that shows the site details including co-ordinates and catchment area. In Table 2, the catchment information is stated as well as surrounding impacts as stipulated by RQS, DWS.

Table 1 The site location, river names, co-ordinates and catchment area

Site Number:	Co-ordinates		River Name	Site Description
	Longitude	Latitude		
PS 1	S 26.83853°	E -26.70484°	Palmietspruit	Upstream of proposed activities
PS 2	S 26.84892	E -26.69738	Palmietspruit	Area of proposed activities
PS 3	S 26.86167	E -26.67604	Palmietspruit	Area of proposed activities

Table 2: Catchment information, PES-EIS information on each of the sites

Quaternary Catchment	WMA	PES	EI	ES	Surrounding impacts
C24H	**WMA 9:** Middle Vaal	**E:** Seriously Modified	**C:** Moderate	**C:** Moderate	**SERIOUS**: Urbanization, **LARGE**: Bed and Channel disturbance, WWTW, roads **SMALL**: **Runoff/effluent**: Urban area

3. METHODOLOGY

More than a century ago, people recognised that human activities produced pollution harmful to the biota. They therefore tried to track the extent of biological degradation; biological degradation was even considered an indicator for the presence of human activities. So began biological monitoring (Karr & Chu, 2006). In the past, water quality monitoring focused on physical and chemical measurements. It has, however, become

recognised that by using other indicators in addition to traditional water quality measurements, it can enhance the assessment and management of water resources (Hohls, 1996). Biomonitoring can thus be defined as the use of living organisms as biological indicators of ecosystem or environmental health. It is further stated that animals and plants can provide a long-term integrated reflection of water quality, quantity, habitat quality and other environmental conditions.

The Present Ecological State (PES) of each biophysical attribute of the river/s being assessed was determined and categorized during field surveys. The health of the river was assessed based on the response of the biota (macro-invertebrates and fish) to changes of the physical drivers (habitat, physico-chemical variables).

EcoClassification - the term used for the Ecological Classification process - 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, 2007a).

3.1 Water Quality (*in situ)*

The *in situ* physico-chemical variables that were sampled during the current survey included temperature, pH, dissolved oxygen concentration (DO) and saturation (DO%), total dissolved solids (TDS) and electrical conductivity (EC). This *in situ* analysis was undertaken using an EXTEXH II handheld multimeter.

3.2 Integrated Habitat Assessment System (IHAS)

Habitat availability and diversity are the major determining factors in the overall community structure of macro-invertebrates. It is therefore very important to evaluate habitat quality when applying biomonitoring methodologies to assess river health. The habitat quality and diversity were assessed using the Integrated Habitat Assessment System Version 2 (IHASv.2) (McMillan, 1998).

The IHAS was used to assess the integrity of the in-stream habitat on which macro-invertebrates depend. The scoring system is split into two sections: Sampling Habitat (55 points) and Stream Condition/Characteristics (45 points), resulting in a total score of 100 points. The Sampling Habitat section is further divided into three sub-sections: Stones-in-Current (20 points), Vegetation (15 points), and Other Habitat (20 points). The Stream Condition section provides an evaluation of the physical characteristics of a site and the degree of disturbance present at the site. The Total IHAS scores are interpreted according to the descriptions provided in the Table below (McMillan, 1998).

Table 2: IHAS score interpretation

%	Description
<65%:	Inadequate for supporting a diverse aquatic macro-invertebrate community
65%-75%	Adequate for supporting a diverse aquatic macro-invertebrate community
>75%	Highly suitable for supporting a diverse macro-invertebrate community

3.3 Macro-Invertebrate Assessment

Macro-invertebrates are adapted to live within certain environmental conditions, and changes within this environment may adversely affect their community composition. Resident aquatic macro-invertebrates are good short-term indicators of ecological integrity as they integrate (respond to) the effects of physical and chemical changes. The ecological health for the macro-invertebrate community was assessed by implementing the SASS5 protocol (Dickens & Graham, 2002) at selected sites. This included the sampling of three main biotopes (where available), namely:

- Stones: refers to stones (>2cm) in and out of the current as well as bedrock.
- Vegetation: refers to aquatic and marginal vegetation in and out of current.
- Gravel, Sand and Mud: refers to fine stones (<2cm), silt or sand and mud.

Results are expressed as an index score (SASS score), an average score per taxon (ASPT) as well as the number of taxa. Each taxon is allocated a sensitivity value between 1 and 15, per its perceived sensitivity to changes in water quality. A score of 1-5 is allocated for taxa highly tolerant to pollution, 6-10 for those moderately tolerant to pollution and 11-15 for those taxa with a very low tolerance to pollution (Gerber & Gabriel, 2002). The abundance of individuals per taxon was estimated and recorded using the following intervals:

- 1 = Single individual;
- A = 2-10 individuals;
- B = 10 – 100 individuals;
- C = 100 – 1000 individuals;
- D > 1000 individuals.
-

The standard SASS5 sampling protocol was employed by an accredited practitioner to record the number of species/taxa present and their abundance at each site. Interpretation of monitoring results mainly consists of the determination of the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS). The division and description of the ecological categories that were used is provided in the Figure 1 below.

SASS5 results were analysed based on the biological bands method developed by (H. Dallas, 2007). It was established that the selected sites fall within the Highveld Lower

zone and the biological bands as indicate in Figure 1were used to determine the Present Ecological State of the invertebrate communities.

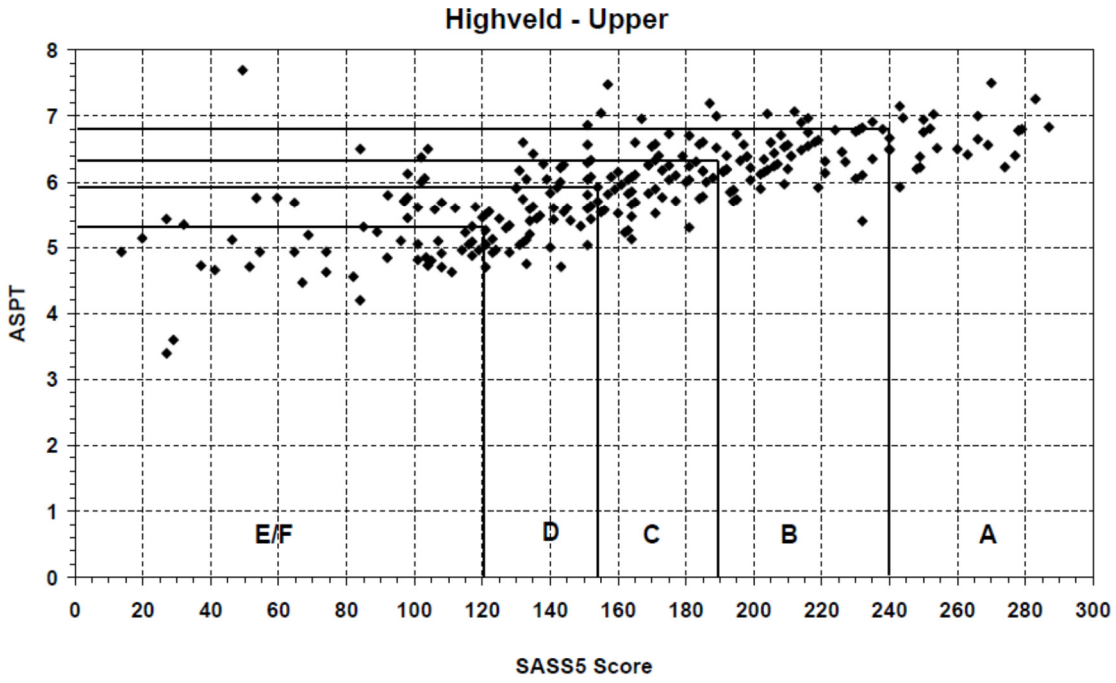


Figure 1: Biological Bands for the Highveld – Upper zone, calculated using percentiles

3.4 Fish Community Assessment

The Fish Response Assessment Index (FRAI) (Kleynhans, 2007b) sampling methodologies were used to assess the fish populations in the study area. The technique used to sample was electro-shocking (Meador, Cuffney, & Gurtz, 1993). A Samus battery-operated electro-shocking equipment was used to sample fish in the available habitat at each site. The electro-shocking technique was implemented for between 20 to 30 minutes depending on the site and habitat availability. All the fish caught were identified and returned to the water.

The current index of choice to determine the fish community integrity for the RHP and Reserve determinations is the FRAI (Kleynhans, 2007) as developed within the Eco-Classification methodology (Kleynhans & Louw, 2007). Eco-Classification is a rule-based method that aims to integrate the biophysical components of a river to provide a realistic and reproducible result of the EcoStatus of a river (Kleynhans & Louw, 2007). FRAI is based on the responses of fish species and the fish community to various stressors within the ecosystem. These stressors can vary from the lack of natural environmental requirements of the fish, or the effects of driver changes, to the habitat conditions within the ecosystem. The ecological category for the fish community was determined by comparing the environmental requirements and the responses to modified habitat conditions of the observed (in some cases derived) fish communities to a reference fish community (Kleynhans, 2007).

3.5 Eco-status modules

EcoClassification is the term used for the Ecological Classification process and refers to the determination and categorisation of the Present Ecological State of various biophysical attributes of rivers relative 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.

These categories range over a continuum of impacts, from natural (Category A) to critically modified (Category F) and are represented by characteristic colours defined by Kleynhans & Louw (2008) in Table 3 below**.** In the current study, the ECs were assigned to the results obtained from the index scores of the IHAS measuring instream habitat, FRAI scores measuring fish integrity.

Table 3 Ecological Category codes and description with standardised colour coding

ECOLOGICAL CATEGORY	FRAI & VEGRAI (%)	SASS5	ASPT	SHORT DESCRIPTION	LONG DESCRIPTION
A	90 – 100	>/=123	>/=5.6	**Natural**	**Natural** – Unmodified state with no impacts, conditions natural.
B	80 – 89	>/=82<123	>/=4.8<2.6	**Largely natural**	**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	60 – 79	>/=64<82	>/=4.6<4.8	**Moderately modified**	**Moderately modified** – loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40 – 59	>/=51<64	>=4.2<4.6	**Largely modified**	**Largely modified** – a large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20 – 39	<51	<4.2	**Seriously modified**	**Seriously modified** – the loss of natural habitat, biota and basic ecosystem functions are extensive.
F	< 20	<51	<4.2	**Critically modified**	**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

ECOLOGICAL CATEGORY	FRAI & VEGRAI (%)	SASS5	ASPT	SHORT DESCRIPTION	LONG DESCRIPTION
					ecosystem functions have been destroyed and the changes are irreversible.

Source: Adapted from Kleynhans & Louw (2008)

In some cases, there is an uncertainty as to which category a particular entity belongs. This situation falls within the concept of a "fuzzy" boundary, where a particular entity may potentially have membership of both classes. For practical purposes these situations are referred to as boundary categories and are denoted as for example B/C as depicted in Figure 2 below.



Figure 2: Illustration of the distribution of categories on a continuum as shown in Kleynhans & Louw (2008)

4. RESULTS AND DISCUSSION

On the 25th of June 2017, the field assessment was undertaken along the study area. Due to the low flow season, the river was found to be dry at most areas. A few isolated pools were identified and assessed. This section will show the findings of the aquatic assessments.

4.1 Visual Assessment

Table 4: The visual assessment of PS1



Figure 3: Algal bed observed at PS1



Figure 4: Downstream view of PS1



Figure 5 The upstream view of PS1



Figure 6: Evidence of tyre tracks at PS1

The PS1 site (Figure 3 to Figure 6) was found to be at extremely low flow condition and an isolated pool was identified. The water was discoloured. The site was dominated by algae. The water had an unpleasant odour. There has been no significant rain in the study area. Slight erosion was observed as well as tyre tracks in the riparian zone.

Table 5: The visual assessment of PS2



Figure 7: Evidence of recent construction related activity and impact



Figure 8: Upstream view of PS2



Figure 9: Recent burning in the riparian area



Figure 10: Downstream view of PS2

The PS2 site (Figure 7 to Figure 10) was found to be locally impacted by construction activities within the study area. The riparian zone has been disrupted and exposed, due to construction. Burning was also observed as well as solid waste. The water was discoloured and moving slowly.

Table 6: The visual assessment of PS3



Figure 11: The upstream view of PS3



Figure 12: The downstream view of PS4



Figure 13 Organic matter and solid waste observed instream

The PS3 site (Figure 11 and Figure 13) was found in at low flows. The water was silty and smelly. There was evidence of recent burning in the riparian area and solid waste instream.

4.2 Water Quality Assessment

The *in situ* water quality water results are represented in *Table 7* below. The pH at all three sites was found to be within the Target Water Quality Requirements per (DWAF, 1996). Many fresh waters, including most in South Africa, are relatively well buffered and more or less neutral, with pH ranging around 6-8, (H. F. Dallas & Day, 2004). The TDS concentration is directly proportional to the electrical conductivity (EC) of water, they depend on the minerals in rocks, soils and decomposing plant material in the aquatic ecosystem. At this survey, the PS3 site had the highest levels. This may be attributed to inorganic inputs from construction upstream.

The overall temperature for the sites is good. The oxygen concentration and oxygen saturation are within the Target Water Quality Requirements of 80-100%; *in unpolluted surface waters, dissolved oxygen concentrations are usually close to saturation. Continuous exposure to concentrations of less than 80 % of saturation can be harmful, and could have acute effects; repeated exposure to reduced concentrations may lead to physiological and behavioural stress(DWAF, 1996).*

Table 7: The *in situ* water quality results for each site

	pH	Conductivity (µS)	TDS (ppm)	Temperature (ºC)	Dissolved oxygen (mg/l)	Dissolved oxygen saturation (%)	Turbidity (ntu)
PS1	7.39	297	297	19.1	8.5	85.1	61.0
PS2	7.42	258	173	12.2	9.9	92.3	6.99
PS3	7.64	752	532	11.3	9.8	92.6	4.48

4.1 Integrated Habitat Assessment System (IHAS) Assessment

Table *8* shows the results of the IHAS analyses undertaken at the PS1 and PS3 sites. The PS2 site was inaccessible at the time of the survey, therefore no IHAS study was undertaken. Both sites were found to have a poor habitat integrity therefore have insufficient habitat available to support a diverse community of macro-invertebrates. The study area is a within urbanised areas with bed and channel disturbance, WWTW and roads.

The PS1 site is in poor habitat class. This is mainly due to a lack of stones habitat at the site as well as the low flow. The analysis was undertaken on a pool, due to the low flow conditions, the water was still. The dominant biotopes were gravel, sand and mud with little marginal vegetation. There was a strong algal presence and sediment at the site, bringing the overall stream condition to be low.

The PS3 site is a site downstream of a bridge, the water was silty and smelly. The poor habitat class may be attributed to the lack of biotope availability at the site. There were no stones in or out of current. The site is dominated by soft sediment, mud and gravel. Good marginal vegetation was noted. Organic sediment and algae were noted. Surrounding impacts include the upstream bridge, solid waste, recent burning and construction in the study area.

Table 8: The IHAS scores and description for each site

Site	IHAS Score	Habitat Class
PS 1	36	Poor
PS 3	42	Poor

4.2 Macro-Invertebrate assessment

Table 9 shows the results from the macro-invertebrate assessment, for detailed results, abundances and taxa sampled refer to Appendix A. The following analyses are guided by (Dickens & Graham, 2002), (Thirion, 2007) and (H. Dallas, 2007).

At PS1, twelve taxa were sampled with sensitivity scores ranging between two (resilient to organic pollution and environmental change) and eight (relatively sensitive to organic

pollution and environmental change). The macro-invertebrate community shows diversity. The Lestidae family was sampled at this site, this family prefers vegetation and slow moving water, (Arimoro, 2009) and is also relatively sensitive to low quality water. This results in a SASS score of 49 and ASPT of 4.08, placing it in a seriously to critically modified ecological condition (**E/F state**). When compared to the reference conditions, the MIRAI resulted in is moderately to largely modified ecological condition (**C/D state**). This is due to slight changes in the natural habitat, biota however, the basic ecosystem functionality is unchanged.

At the PS3 site, eleven taxa were sampled with sensitivity scores ranging between one and five. This macro-invertebrate community is largely taxa that are resilient to environmental change and organic pollution. Most of the invertebrates are air-breathing taxa. The ability for aquatic macro-invertebrates to utilise atmospheric oxygen is a physiological advantage to be able to withstand organic pollution and changes in the environment. Therefore, the air-breathing taxa are more resilient. This results in a SASS score of 39 and ASPT of 3.5, placing it in a seriously to critically modified ecological condition **(E/F state**). When compared to the reference conditions, the MIRAI resulted in is largely modified ecological condition (**D state**). This is due to a loss of natural habitat, biota and basic ecosystem functionality.

Table 9: The macro-invertebrate assemblage results, MIRAI, SASS score, Number of Taxa and ASPT

Site	SASS Score	Number of Taxa	ASPT	SASS EC	MIRAI EC
PS1	49	12	4.08	**E/F**	**C/D**
PS3	39	11	3.55	**E/F**	**D**

4.3 Ichtyfauna assessments

4.3.1 Reference List

In the current study, the reference list for the expected species and abundances in the Palmietspruit, a tributary of Skoonspruit in the North West Province. This information was compiled using information collected from the RHP monitoring localities, and the FROC database (Kleynhans *et al.* 2007), DWS (2014). The only site where fish was found is PS1.

Table *10* shows the reference list for the study area, adapted from (Skelton, 2001).

Table 10: The fish reference list for Palmietspruit

Family	Scientific Name	Common Name	Description and Habitat Preference
Indigenous			
CICHLIDAE	*Pseudocrenilabrus philander*	Southern mouthbrooder	Hardy species. Prefers slow flowing shallow waters and has a high affinity for overhanging vegetation and undercut river banks.
CICHLIDAE	*Tilapia sparmanii*	Banded tilapia	Hardy species. Prefers slow flowing shallow waters and has a high affinity for overhanging vegetation and aquatic macrophytes.
CLARIIDAE	*Clarias gariepinus*	Sharptooth catfish	Occurs in numerous habitats but prefers slow flowing waters and thrive in dams.
CYPRINIDAE	*Barbus anoplus*	Chubbyhead barb	Occurs in a wide variety of habitats from small streams to large rivers and lakes.
CYPRINIDAE	*Barbus paludinosus*	Straightfin barb	Hardy species preferring well-vegetated waters and marginal areas of large rivers and slow flowing streams.
CYPRINIDAE	*Enteromius trimaculatus*	Three-spot barb	Shallow waters with lots of vegetation. Hardy species feeding on small invertebrates.
CYPRINIDAE	*Labeo umbratus*	Moggel	Slow and gentle flowing water, shallow dams and impoundments. Feeds on soft sediments and detritus.
CYPRINIDAE	*Labeo capensis*	Orange River Mudfish	Occurs in large, fast flowing waters and impoundments. Breeds in

Family	Scientific Name	Common Name	Description and Habitat Preference
			summer, over shallow rocky rapids.
CYPRINIDAE	*Labeobarbus aeneus*	Smallmouth Yellowfish	Prefers sandy to rocky substrates of clear and flowing water of large rivers.
Aliens			
POECILIIDAE	*Gambusia affinus*	Mosquitofish	Tolerant of wide temperature range preferring slow flowing water with plant cover.

4.3.2 Species sampled

No fish were found at PS3. Two species of fish were sampled at PS1, *Pseudocrenilabrus philander* (4) and *Gambusia affinus (1).* Table 11below shows the results.

Table 11: Fish species occurrence and abundance

Species	PS1
Pseudocrenilabrus philander	4
Gambusia affinus	1
Total individuals	**5**
Number of taxa	**2**
FRAI EC	**E**

The Southern mouthbrooder (*P.philander*) is described as an attractive species and has a history of introduction outide of its native range in South Africa. It indigenous to most of South Africa, excluding Western Cape province, (Muller, Strydom, & Weyl, 2015). It is a hardy species, resilient to environmental condition changes. It prefers shallow water and undercut river banks (Figure 14).



Figure 14: South mouth brooder (P. philander) at PS1

The alien fish species *G. affinis* (mosquitofish) was sampled, Figure 15 . Mosquitofish are tolerant of a wide range of water temperatures and salinities (salts), they have a high potential impact to the indigenous species and decrease the water quality of the aquatic eco-system.



Figure 15: *Gambusia affinis*
Mosquitofish

When compared to the reference condition, considering the type of fish species expected and their respective frequency of occurrence. The result is based on the changes to environmental conditions related to fish stress. The FRAI Ecological **Category is E: Seriously modified**. This can be attributed to low flow conditions and the loss of habitat and basic ecosystem functions.

5. CONCLUSION

The State of the Palmietspruit River in the North-West Province, South Africa is largely to critically modified. The PES of each site were determined by assessing the water quality, instream habitat, macro-invertebrates, fish community integrity. These poor results may be attributed to lack of habitat, low flows and surface runoff from surrounding catchment.

6. REFERENCES

Arimoro, F. O. (2009). Guides to the Freshwater Invertebrates of Southern Africa. Volume 7: Insecta I. Ephemeroptera, Odonata and Plecoptera: edited by IJ de Moor, JA Day and FC de Moor: Taylor & Francis.

Dallas, H. (2007). River health programme: South African Scoring System (SASS) data interpretation guidelines. *Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Institute of Natural Resources*.

Dallas, H. F., & Day, J. A. (2004). *The effect of water quality variables on aquatic ecosystems: a review*: Water Research Commission Pretoria.

Dickens, C. W. S., & Graham, P. M. (2002). The South African Scoring System (SASS) version 5 rapid bioassessment method for rivers. *African Journal of Aquatic Science, 27*(1), 1-10.

DWAF. (1996). South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems: Department of Water Affairs and Forestry Pretoria.

Hohls, D. R. (1996). *National Biomonitoring Programme for Riverine ecosystems: framework document for the programme*: Department of Water Affairs and Forestry.

Karr, J. R., & Chu, E. (2006). Seven foundations of biological monitoring and assessment. *Biologia Ambientale, 20*(2), 7-18.

Kleynhans, C. (2007a). *Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report.* Paper presented at the An Integrated Habitat Assessment System (IHAS v2), for the Rapid Biological Assessment of Rivers.

Kleynhans, C. (2007b). Module D: Fish response assessment index (FRAI). *River ecoclassification manual for ecostatus determination (Version 2): Report produced for the Department of Water and Sanitation and Forestry (Resource Quality Services) and the Water Research Commission*.

Meador, M. R., Cuffney, T. F., & Gurtz, M. E. (1993). *Methods for sampling fish communities as part of the National Water-Quality Assessment Program* (93-104). Retrieved from http://pubs.er.usgs.gov/publication/ofr93104

Muller, C., Strydom, N. A., & Weyl, O. L. F. (2015). Introduction, establishment and spread of the Southern mouthbrooder Pseudocrenilabrus philander in the Baakens River, Eastern Cape, South Africa : short communication. *African Zoology*(3), 259. doi:10.1080/15627020.2015.1058187

Skelton, P. H. (2001). *A complete guide to the freshwater fishes of southern Africa*: Struik.

Thirion, C. (2007). MODULE E: Macroinvertebrate Response Assessment Index (MIRAI). *River ecoclassification manual for ecostatus determination (Version 2): Joint Water Research Commission and Department of Water and Sanitation and Forestry report*.