# Aquatic Ecology Assessment for the Proposed Esperanza Weir Rehabilitation

# Umzinto, Kwa-Zulu Natal Province, South Africa

July 2018

**CLIENT**


**Prepared for:**

**Afzelia Environmental Consultants**

76 Valley View Rd, Morningside, Durban, 4001

Phone: +27 31 303 2835

**Prepared by:**

**The Biodiversity Company**

420 Vale Ave. Ferndale, 2194

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany

| | | |
|---|---|---|
| **Report Name** | **Aquatic Ecology Assessment for the Proposed Esperanza Weir Rehabilitation** | |
| **Submitted to** | **Afzelia Environmental Consultants** | |
| **Survey/Report** | **Russell Tate (Pr. Sci. Nat. 400089/15)** | |
| **Review** | **Dale Kindler (Pr. Sci. Nat. 114743)** | |

*The Esperanza Impoundment on the Mzinto River (May 2018)*

## EXECUTIVE SUMMARY

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener *et al.,* 2005). Proposed developments thus have the potential to negatively impact on local water resources and ecosystem services. In order to effectively supply water, a defunct impoundment is proposed to be rehabilitated. The proposed project has triggered several environmental conditions and therefore requires a Basic Assessment Report (BAR) and Water Use Licence Application (WULA) before the project can continue.

To complete the BAR and WULA, environmental specialist studies were required. Considering this, The Biodiversity Company was commissioned by Afzelia Environmental Consultants (Afzelia) to conduct aquatic ecology specialist studies to supplement the abovementioned application.

The proposed project is located approximately 3 km to the south west of Umzinto, KwaZulu-Natal Province. The proposed project is located in the Pongola - Mtamvuna Water Management Area (WMA), within the U80H quaternary catchment. The project is located on the U80H-5109 Sub Quaternary Reach (SQR). This river reach is a portion of the Mzinto River system. Standard methodologies were used to determine the Present Ecological Status (PES), Ecological Importance and Sensitivity for the aquatic ecology components of this study.

The results of the PES assessment derived moderately/largely modified (class C/D) conditions in the river reach considered in this assessment. Despite large modification to instream habitat through the presence of the various impoundments, aquatic ecology responses were determined to be moderately modified. This result provides an indication that there have been cumulative level impacts in the considered watercourse resulting in the moderately/largely modified nature of the river.

The results of the risk assessment derived low risks for the proposed project. The low risks of the proposed project can be attributed to the small scale rehabilitation activities. Furthermore, no riparian or bank alterations are anticipated to stem from the proposed project. Considering the nature of the proposed project, limited instream modification can be anticipated. In addition, the short nature of the rehabilitation activities further negates long terms impacts.

Considering the status of the aquatic ecosystems, and furthermore the nature and requirements of the project, the proposed project has limited potential to negatively affect local ecology. In light of the above mentioned, it is the opinion of the specialist that no significant fatal flaws could be identified through the completion of this aquatic ecology study.

# Table of Contents

# Tables

# Figures

**Declaration**

I, Russell Tate 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 71 and is punishable in terms of Section 24F of the Act.

Russell Tate

Aquatic Specialist

The Biodiversity Company

03/7/2018

# 1 Introduction

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener et al., 2005). Proposed developments thus have the potential to negatively impact on local water resources and ecosystem services. In order to effectively supply water, a defunct impoundment is proposed to be rehabilitated. The proposed project has triggered several environmental conditions and therefore requires a Basic Assessment Report (BAR) and Water Use Licence Application (WULA) before the project can continue.

To complete the BAR and WULA, environmental specialist studies were required. Considering this, The Biodiversity Company was commissioned by Afzelia Environmental Consultants (Afzelia) to conduct aquatic ecology specialist studies to supplement the abovementioned application.

This report presents the results of an aquatic ecological study on the riverine environments associated with the proposed infrastructure project. This report should be interpreted after taking into consideration the findings and recommendations provided by the specialist herein. Further, this report should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

The aim of the assessment was to provide information to guide the construction and operation of the proposed development with respect to the current ecological state of the aquatic ecosystems in the study area. As part of this assessment, the following objectives were established:

- **Aquatic Ecology Studies:**
  - The determination of the baseline Present Ecological Status (PES) of the local river systems;
  - The evaluation of the extent of site-related impacts;
  - A risk assessment for the proposed development; and
  - The prescription of mitigation measures and recommendations for identified risks.

# 2 Description of the Project Area

The proposed project is located approximately 3 km to the south west of Umzinto, KwaZulu-Natal Province. The proposed project is located in the Pongola - Mtamvuna Water Management Area (WMA), within the U80H quaternary catchment. The project is located on the U80H-5109 Sub Quaternary Reach (SQR). This river reach is a portion of the Mzinto River system. The location of the proposed project and the layout of the proposed infrastructure is presented below (Figure 2-1). The desktop information for the above-mentioned river is presented in Table 2-1. The quaternary catchment is not considered a National Freshwater Ecological Priority Area (NFEPA) (Nel *et al*., 2011).

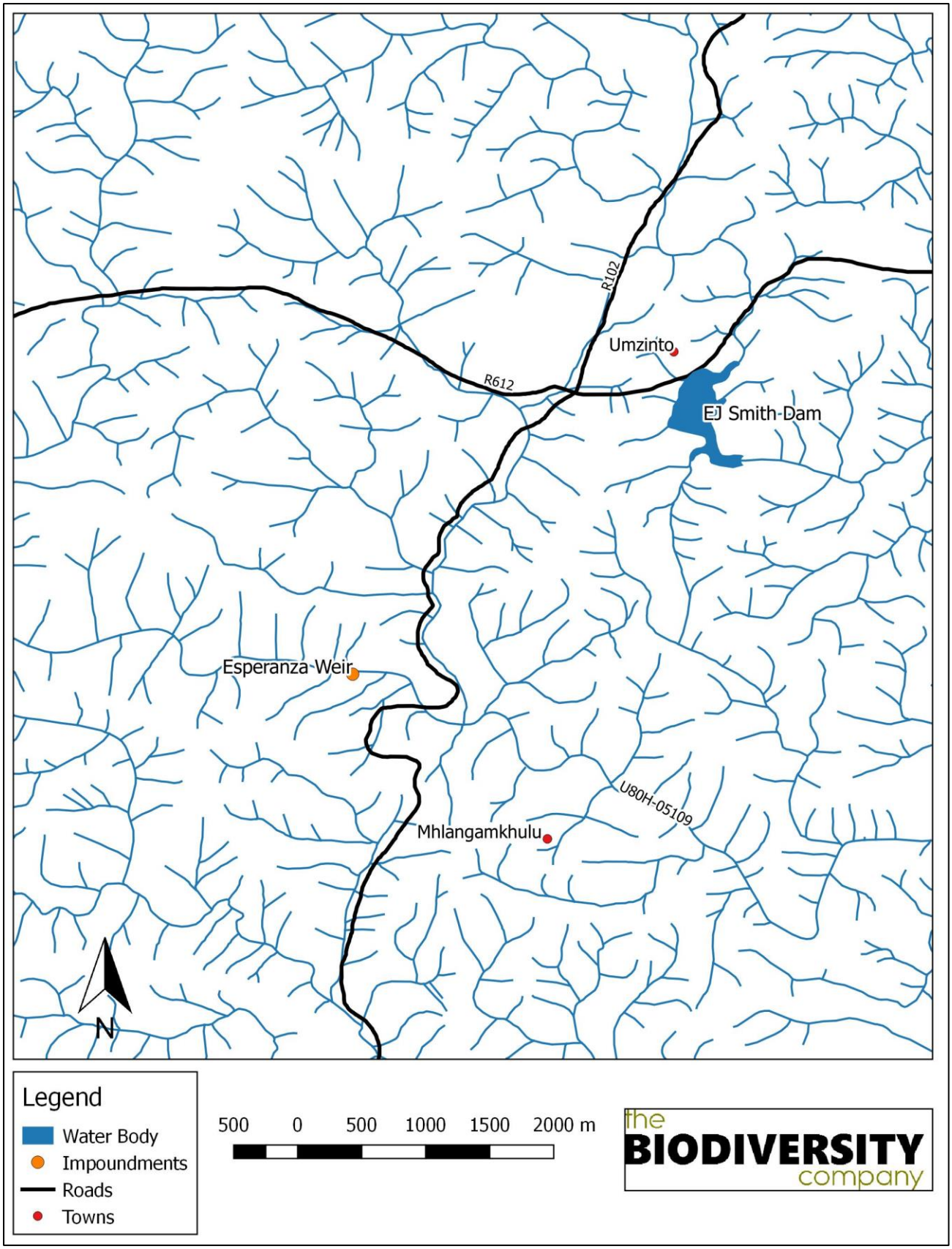


**Figure 2-1: Location of the Proposed Development**

**Table 2-1: The desktop information pertaining to the U80H-5109 Sub Quaternary Reach (DWS, 2018)**

| Component/Catchment | U80H-5109 |
|---|---|
| Present Ecological Status | Largely modified |
| Ecological Importance Class | High |
| Ecological Sensitivity | Very high |
| Default Ecological Category | Natural |

The results of the desktop assessment indicate that the considered SQR PES was in a class D or largely modified status. Ecological importance in the SQR was determined to be high. The ecological sensitivity of the SQR was determined to be very high. The Default Ecological Category for the considered river reach was class A or natural based on desktop information. The aquatic sampling point, survey methods and photographs details are provided in Table 2-2. The rationality for the selection of the location for the aquatic sampling point was based on the location of the proposed project immediately upstream of the sampling point.

**Table 2-2: Location of the Aquatic Sampling Point**

| Site Name | Assessment Conducted | May 2018 |
|---|---|---|
| A1 (Upstream) | Biology, Water and Habitat Quality |  |

| Site Name | Assessment Conducted | May 2018 |
|---|---|---|
| A1 (Downstream) | |  |

# 3 Methodology

## 3.1 Aquatic Assessment and Survey

A single aquatic sampling survey was conducted on the 19th of May 2018. The sampling during this period would constitute a low flow assessment.

### 3.1.1 Water Quality

Water quality was measured *in situ* using a handheld calibrated Extech ExStik II meter. The constituents considered that were measured included: pH, conductivity (µS/cm), temperature (°C) and Dissolved Oxygen (DO) in mg/l. A water sample was obtained during a February 2018 assessment at the Umzinto Dam and will be sued for this study.

### 3.1.2 Aquatic Habitat Integrity and Riparian Delineation

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), (1999) was used to define the ecological status of the river reach.

The area covered in this assessment included a reach the Mzinto River from the site A1 for 2 km upstream and 2 km downstream of the site. The IHIA makes use of data obtained at each site to compile a reach-based PES.

The IHIA model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 3-1 and Table 3-2 respectively.

**Table 3-1: Criteria used in the assessment of habitat integrity (Kleynhans, 1998)**

| Criterion | Relevance |
|---|---|
| **Water abstraction** | Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water. |
| **Flow modification** | Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season. |
| **Bed modification** | Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included. |
| **Channel modification** | May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included. |
| **Water quality modification** | Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions. |
| **Inundation** | Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments. |
| **Exotic macrophytes** | Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation. |
| **Exotic aquatic fauna** | The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance. |
| **Solid waste disposal** | A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river. |
| **Indigenous vegetation removal** | Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing. |
| **Exotic vegetation encroachment** | Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced. |
| **Bank erosion** | Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment. |

**Table 3-2: Descriptions used for the ratings of the various habitat criteria**

| Impact Category | Description | Score |
|---|---|---|
| **None** | No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability. | 0 |
| **Small** | The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small. | 1-5 |
| **Moderate** | The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited. | 6-10 |
| **Large** | The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced. | 11-15 |
| **Serious** | The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced. | 16-20 |
| **Critical** | The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. | 21-25 |

The riparian delineation was completed according to DWS (2005). Typical riparian cross sections and structures are provided in Figure 3-1. Indicators such as topography and vegetation were the primary indicators used to define the riparian zone. Contour data obtained from topography spatial data was also utilised to support the infield assessment.

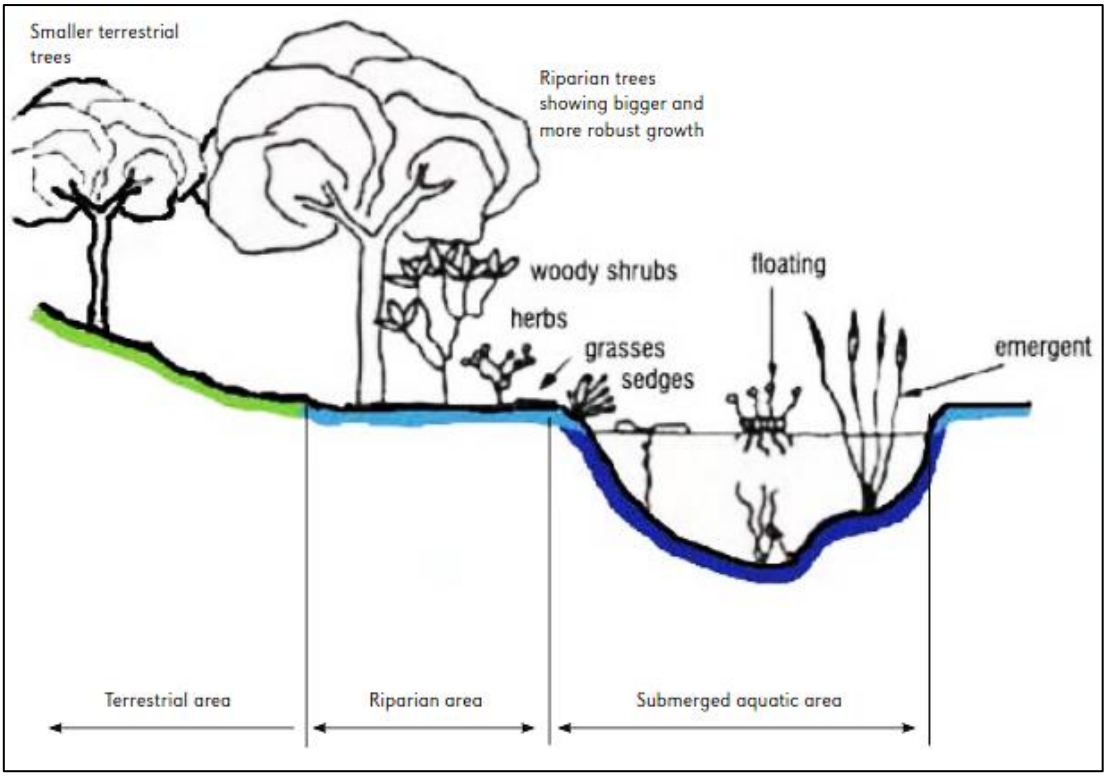


**Figure 3-1: Riparian Habitat Delineations (DWS, 2005)**

### 3.1.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour et al., 1999). Benthic macroinvertebrate assemblages are made up of

species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour et al., 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

### 3.1.3.1 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the “Aquatic Invertebrates of South African Rivers” Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion et al., 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Coastal Belt ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

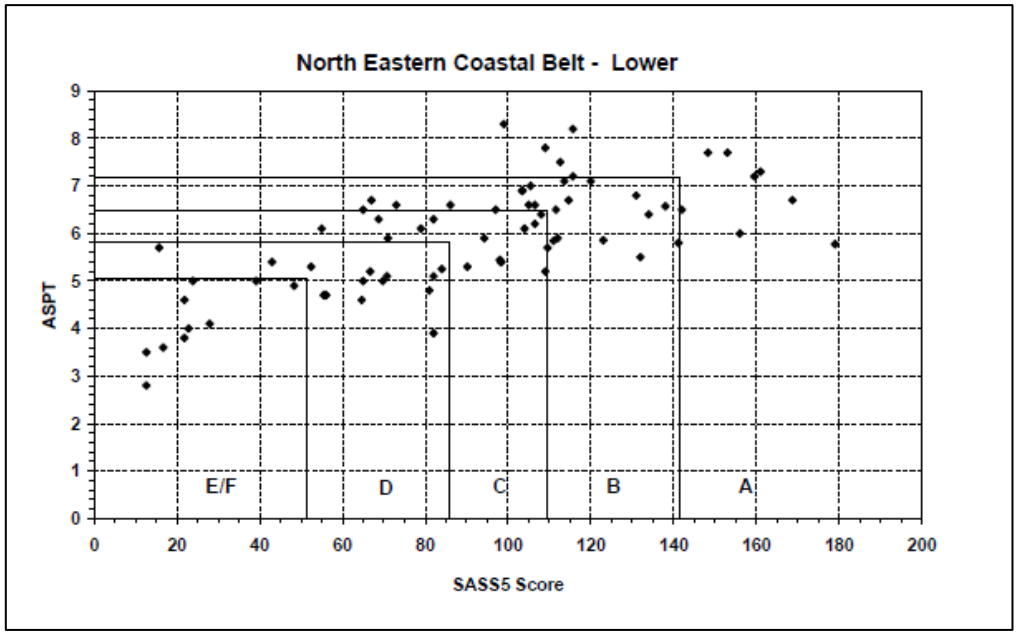


**Figure 3-2: Guidelines used for the interpretation and classification of the SASS5 scores (Dallas, 2007)**

### 3.1.3.2 Macroinvertebrate Response Assessment Index

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the SQR. This does not preclude the

calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;
- Water quality; and
- Energy inputs from the watershed Riparian vegetation assessment.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES.

### 3.1.4 Fish Community Assessment

The information gained using the Fish Response Assessment Index (FRAI) gives an indication of the PES of the river based on the fish assemblage structures observed. Fish were captured through electroshocking. All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). The identified fish species were compared to those expected to be present for the quaternary catchment. The expected fish species list was developed from a literature survey and included sources such as (Kleynhans et al., 2007) and Skelton (2001). It is noted that the FRAI Frequency of Occurrence (FROC) ratings were calculated based on the habitat present at the sites.

### 3.1.5 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this study, ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007).

## 3.2 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

**Consequence = Severity + Spatial Scale + Duration**

Whereas likelihood is calculated as:

**Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection.**

Significance is calculated as:

**Significance \Risk= Consequence X Likelihood.**

The significance of the impact is calculated according to Table 3-3.

**Table 3-3: Significance Ratings Matrix**

| Rating | Class | Management Description |
|---|---|---|
| 1 – 55 | (L) Low Risk | Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded. |
| 56 – 169 | M) Moderate Risk | Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded. |
| 170 – 300 | (H) High Risk | Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. |

# 4 Limitations and Assumptions

- A single aquatic ecology survey was completed for this assessment. Thus, temporal trends were not investigated.
- No wetlands were considered in this study.
- The extent of the riparian zone was delineated predominantly using desktop data and a low confidence site investigation.
- Due to the rapid nature of the assessment and the survey methods applied, fish diversity and abundance was likely to be under estimated.
- Invertebrates were only considered to the Family level and thus a defined species list for aquatic invertebrates was not completed.
- The specific activities and detailed infrastructure plans were not available at the time of writing this report.
- Only sites where there will be a proposed activity were selected for this assessment.
- No alternatives were considered for this assessment.
- The exact listed activities have not been provided for this report.
- The height and current inundation zone of the impoundment is assumed to remain as the baseline assessment.
- It is assumed that no major earthworks will be required for the proposed project.

# 5 Results and Discussion

## 5.1 Water Quality

*In situ* water quality analysis results from the May 2018 surveys are provided in Table 5-1.

**Table 5-1: Water Quality Results May 2018**

| Site | pH | Conductivity (µS/cm) | DO (mg/l) | Temperature (°C) |
|---|---|---|---|---|
| **TWQR*** | **6.5-9.0** | ** | **>5.00** | **5-30** |
| **A1** | 6.83 | 275 | 8.4 | 21 |
| ***TWQR – Target Water Quality Range (DWS, 1996)<br>**: Expert Opinion for Range** | | | | |

The results of the *in situ* assessment indicated no perturbations in terms of physical water quality. Considering the rural setting of the study site, limited non-point and point source water quality impacts are expected.

The chemical water quality results of the selected sampling point are provided below (Table 5-2).

**Table 5-2: Chemical Water Quality Results from below the Umzinto Dam Wall (February 2018)**

| Constituent | Result |
|---|---|
| pH | 7.1 |
| Electrical Conductivity (mS/cm) | 22.5 |
| Chloride (mg/l) | 34 |
| Nitrate (mg/l) | 0.1 |
| Phosphate (mg/l) | 0.2 |
| Free and Saline Ammonia as N (mg/l) | 0.3 |
| Sulphate (mg/l) | 2 |
| As (mg/l) | <0.01 |
| Ca (mg/l) | 7 |
| Cd (mg/l) | <0.01 |
| Co (mg/l) | <0.01 |
| Cr (mg/l) | <0.01 |
| Cu (mg/l) | <0.01 |
| Fe (mg/l) | 1.206 |
| Mg (mg/l) | 6 |
| Mn (mg/l) | <0.025 |
| Ni (mg/l) | 0.013 |
| Pb (mg/l) | <0.01 |

The results of the chemical water quality assessment indicated limited water quality deterioration in the considered river reach and confirm the *in situ* water quality.

## 5.2 Intermediate Habitat Integrity Assessment

The IHIA was completed for the assessed watercourses and is presented below (Table 5-3 and Table 5-4).

**Table 5-3: Instream Intermediate Habitat Integrity Assessment for the Mzinto River**

| Criterion | Average Score | Score |
|---|---|---|
| **Instream** | | |
| **Water abstraction** | 15 | 8.4 |
| **Flow modification** | 20 | 10.4 |
| **Bed modification** | 20 | 10.4 |
| **Channel modification** | 20 | 10.4 |
| **Water quality** | 5 | 2.8 |
| **Inundation** | 12 | 4.8 |
| **Exotic macrophytes** | 15 | 5.4 |
| **Exotic fauna** | 15 | 4.8 |
| **Solid waste disposal** | 10 | 2.4 |
| **Total Instream Score** | | **40.2** |
| **Instream Category** | | **class D** |

**Table 5-4: Riparian Instream Intermediate Habitat Integrity Assessment for the Mzinto River**

| Riparian | | |
|---|---|---|
| **Indigenous vegetation removal** | 20 | 10.4 |
| **Exotic vegetation encroachment** | 15 | 0 |
| **Bank erosion** | 5 | 2.8 |
| **Channel modification** | 20 | 9.6 |
| **Water abstraction** | 0 | 0 |
| **Inundation** | 20 | 8.8 |
| **Flow modification** | 20 | 9.6 |
| **Water quality** | 5 | 7.8 |
| **Total Riparian Score** | | **51** |
| **Riparian Category** | | **class D** |

The results of the instream and riparian integrity assessment derived a class D (largely modified) status for the considered river reach in this assessment. The predominant factor influencing the quality of the habitats are largely attributed to instream habitat modification relating to the direct impacts of the Esperanza impoundment (Figure 5-1). However, alien vegetation and riparian clearing was evident during the survey (Figure 5-2; Figure 5-3).

The riparian delineation indicated dominance of the marginal zone by *Arundo donax* upstream of the weir and *Phragmites australis* downstream of the weir. As demonstrated above, the riparian zone has a high abundance of alien vegetation and was determined to be largely modified. The delineated riparian zone is provided in Figure 5-4.

**Figure 5-1: Flow Regulation, abstraction, Channel and bed Modification (A1; May 2018)**

**Figure 5-2: Cleared marginal and upper riparian zone in the Mzinto River at A1 (May 2018)**

**Figure 5-3: Riparian habitat downstream of the Esperanza Weir. Note abundance of alien vegetation (*Melia azedarach, Tithonia diversifolia*; May 2018)**


**Figure 5-4: Riparian delineation for the Esperanza Weir Project**

## 5.3 Macroinvertebrates

Biological assessments were completed at representative sites in the considered river reaches. The invertebrate habitat at each site was assessed using the South African Scoring System version 5 (SASS5) biotope rating assessment as applied in Tate and Husted (2015). The results of the biotope assessment are provided below (Table 5-5).

**Table 5-5: Biotope scores at each site during the May 2018 Survey**

| Biotope | Weighting | A1 |
|---|---|---|
| Stones in current | 10 | 2 |
| Stones out of current | 10 | 1 |
| Bedrock | 3 | 3 |
| Aquatic Vegetation | 5 | 1 |
| Marginal Vegetation In Current | 5 | 2 |
| Marginal Vegetation Out Of Current | 5 | 3 |
| Gravel | 4 | 2 |
| Sand | 2 | 2 |
| Mud | 1 | 2 |
| **Biotope Score** | | **18** |
| **Weighted Biotope Score (%)** | | **37** |
| **Biotope Category (Tate and Husted, 2015)** | | **class D** |

Habitat availability within the assessed watercourse was rated as poor. The low biotope score can be attributed to low diversity/abundance of the stones in current. Invertebrate habitat typically consisted of gravel/sand substrates and marginal vegetation. The assessment of substrates observed high concentrations of filamentous algae, suggesting nutrient enrichment. The results of the SASS5 assessment are presented below (Table 5-6).

**Table 5-6: Macroinvertebrate Assessment Results Recorded During the May 2018 Survey**

| Site | SASS5 | Taxa | ASPT | *Class (Dallas, 2007) |
|---|---|---|---|---|
| **A1** | 221 | 33 | 6.7 | **class A** |
| ***North Eastern Coastal Belt** | | | | |

The results of the SASS5 assessment derived a SASS5 score of 221 with 33 macroinvertebrate families observed with an ASPT of 6.7. The ecological class was found to be class A (Natural) at the sampled point. The results of the MIRAI are presented below (Table 5-7).

**Table 5-7: Macroinvertebrate Response Assessment Index for the watercourse based on results obtained in May 2018**

| Invertebrate Metric Group | Score Calculated |
|---|---|
| **Flow Modification** | 60 |
| **Habitat** | 51 |
| **Water Quality** | 65 |
| **Ecological Score** | 60 |
| **Invertebrate Category** | **class C/D** |

The results of the MIRAI assessment indicate that a moderately/largely modified invertebrate community was present in the considered watercourse based on the survey results. Habitat availability was determined to be the primary driver of the macroinvertebrate community. The presence of several sensitive species in the SASS5 sample confirmed the good water quality as indicated in the water quality assessment of this study.

## 5.4 Fish Community

The results of the qualitative fish community assessment are provided in Table 5-8. Photographs of the species sampled in the May 2018 survey are presented in

Table 5-9.

**Table 5-8: Fish community assessment for May 2018**

| Species/Site | IUCN Status | A1 |
|---|---|---|
| *Anguilla mossambica* | LC | 1 |
| *Anguilla marmorata* | LC | 0 |
| *Amphilius natalensis* | LC | 0 |
| *Coptodon rendalli* | LC | 1 |
| *Clarias gariepinus* | LC | 1 |
| *Enteromius gurneyi* | VU | 0 |
| *Enteromius paludinosus* | LC | 1 |
| *Enteromius viviparus* | LC | 1 |
| *Labeobarbus natalensis* | LC | 1 |
| *Pseudocrenilabrus philander* | LC | 1 |
| *Oreochromis mossambicus* | NT | 1 |
| *Tilapia sparrmanii* | LC | 1 |
| *Micropterus salmoides (alien species)* | - | 1 |
| **Total Native Species** | | **9** |
| **Total Expected Native Species** | | **12** |
| **% Fish Community Sampled** | | **75** |

**Table 5-9: Fish species captured during the aquatic survey in May 2018**

| Species/Site | Photograph |
|---|---|
| *Clarias gariepinus* |  |
| *Coptodon rendalli* |  |
| *Enteromius viviparous* |  |
| *Labeobarbus natalensis* |  |
| *Oreochromis mossambicus* |  |
| *Pseudocrenilabrus philander* |  |

A total of 9 fish species were sampled during the May 2018 survey. The sampled species included a listed species, *Oreochromis mossambicus,* which is listed as Near Threatened (IUCN, 2017). The listed species is threatened by hybridisation and therefore the proposed project will not negatively affect the population of this species. Sampled native fish community structures were calculated according to the percentage of the expected fish species sampled at a site. The (FRAI) was completed on a reach level and is presented below (Table 5-10).

**Table 5-10: Fish Response Assessment Index for the May 2018 survey**

| | |
|---|---|
| ***FRAI% (Automated)*** | 65 |
| **EC FRAI** | **class C** |

The results of the FRAI derived a moderately modified (class C) fish community structure. This modified fish community was largely attributed to the absence of several fish species which is attributed to instream habitat modification. The presence of catadromous fish species provides an indication that connectivity within the Mzinto River is intact. Considering this, the proposed rehabilitation project should consider constructing a fishway.

## 5.5 Overall Aquatic Ecology Present Ecological Status

The results of the PES assessment are provided in the tables below Table 5-11.

**Table 5-11: Present Ecological Status of the river reach assessed in the May 2018 survey**

| Aspect Assessed | Ecological Category |
|---|---|
| Instream Ecological Category | 45 |
| Riparian Ecological Category | 51 |
| Aquatic Invertebrate Ecological Category | 60 |
| Fish Ecological Category | 65 |
| **Ecostatus** | **class C/D** |

The results of the PES assessment derived moderately/largely modified (class C/D) conditions in the river reach considered in this assessment. Despite large modification to instream habitat through the presence of the various impoundments, aquatic ecology responses were determined to be moderately modified. This result provides an indication that there have been cumulative level impacts in the considered watercourse resulting in the moderately/largely modified nature of the Mzinto River.

### 5.5.1 Aquatic Ecological Importance and Sensitivity

The overall Ecological Importance and Sensitivity (EIS) of the river reach in this study were guided by the desktop information. Several fish and invertebrate species observed during the assessment are considered to be sensitive to flow and water quality modification. The downstream SQR data for EIS therefore stands for this project and the Mzinto River is therefore considered to be of high importance and very high sensitivity.

# 6 Risk Assessment and Recommendations

Based on the requirements for the completion of the proposed project the following activities will take place.

- The rehabilitation and operation of the Esperanza Weir.

It is noted that the riparian area adjacent to the existing weir has been cleared of vegetation. Considering this, limited impacts to this area are anticipated (Figure 6-1).

**Figure 6-1: Cleared area on the left bank of the Mzinto River ( May 2018)**

## 6.1 Potential Impacts

The potential impacts arising from the abovementioned activities are summarised in Table 6-1.

**Table 6-1: Impacts Assessed for the Proposed Project**

| Phase | Activity | Aspect | Impact |
|---|---|---|---|
| **Construction** | Storage and use of construction materials and hydrocarbons | Contaminated runoff | • Deterioration of water quality |
| | Rehabilitation activities | Hydrological alteration | • Alteration of hydrology |
| **Operation** | Operation and maintenance of the rehabilitated weir | Physical presence of structure | • Modification of instream habitats |

**Table 6-2: DWS Risk Impact Matrix for the Proposed Project**

| This risk assessment was completed by Russell Tate (Pr. Sci. Nat: 400089/15) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Aspect** | **Flow Regime** | **Water Quality** | **Habitat** | **Biota** | **Severity** | **Spatial scale** | **Duration** | **Consequence** |
| **Construction Phase** | | | | | | | | |
| Storage and use of construction chemicals and hydrocarbons | 1 | 2 | 1 | 1 | 1.25 | 1 | 1 | 3.25 |
| Rehabilitation activities | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 5 |
| **Operational Phase** | | | | | | | | |
| Operation and maintenance of the rehabilitated weir | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

**Table 6-3: DWS Risk Impact Matrix for the Proposed Project Continued**

| Aspect | Frequency of activity | Frequency of impact | Legal Issues | Detection | Likelihood | Sig. | Without Mitigation | With Mitigation |
|---|---|---|---|---|---|---|---|---|
| **Construction Phase** | | | | | | | | |
| Storage and use of construction chemicals and hydrocarbons | 1 | 3 | 5 | 1 | 10 | 32.5 | **Low** | **Low** |
| Rehabilitation activities | 1 | 3 | 5 | 1 | 10 | 50 | **Low** | **Low** |
| **Operational Phase** | | | | | | | | |
| Operation and maintenance of the rehabilitated weir | 1 | 5 | 5 | 1 | 16 | 48 | **Low** | **Low** |
| ( * ) denotes-In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80). | | | | | | | | |

The results of the risk assessment derived low risks for the proposed project. The low risks of the proposed project can be attributed to the small scale rehabilitation activities. However, some impacts to hydrology can be anticipated through the construction phase. Furthermore, no riparian or bank alterations are anticipated to stem from the proposed project. Considering the nature of the proposed project, limited instream modification can be anticipated. In addition, the short nature of the rehabilitation activities further negates long terms impacts.

## 6.2 Cumulative Impact

The risk assessment indicated low risk to the downstream/upstream aquatic environment and therefore no cumulative impact can be anticipated to stem from the proposed project.

## 6.3 Recommendations and Environmental Management Plan

Based on the outcomes of the risk assessment, the following mitigation actions are recommended.

- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- All chemicals and toxicants during construction must be stored in bunded areas;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- Cofferdams are temporary structures used to displace water and provide dry access to usually submerged areas (such instream construction and maintenance of bridges etc). They can also be built to prevent water coming into contact with high impact zones (e.g. construction and mining sites) and reduce the amount of sedimentation and pollution;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- No dumping of construction material on-site may take place; and
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.
- Construction activities are proposed to be conducted in the dry season (April-August);
- Releases of water from the upstream Umzinto Dam should be limited during the construction period;
- Laydown yards for construction materials should be placed outside a 32m buffer zone from the rivers;
- Existing cleared roadways and riparian areas should be utilised for construction activities;

- An alien invasive plant management plan needs to be compiled and implemented prior to construction to control and prevent the spread of invasive aliens.
- No chemicals, building materials hydrocarbons or soils must be stockpiled within the 30m buffer zone.

The baseline study indicates that there has been a loss of connectivity between areas up- and downstream of the weir. In order to facilitate the movement of fish species, a fish ladder is recommended (if feasible, as one does currently not exist).

Detailed fish ladder designs should implement the established protocols found in the Water Research Commission (WRC) report No 1270/2/04 and WRC report No 1310/1/05. Essentially, four types of fishways should be considered namely: Pool and weir, vertical-slot, pool and slot, and natural by-pass channels.

Considering this literature, the following fishway concepts should be adhered to in the preferred option:

- The fishway should have water passing through it during both high flows and low flows to encourage fish to make use of the fishway no matter the flow levels;
- The fishway should cater for both rheophilic (fastmoving water) and anti-rheophilic (slow moving water) fish species. This can be achieved through having several different flow velocity areas across the fishway;
- It is recommended that a rough stone surface be cast into the fishway channel floor to cater for climbing and crawling species;
- Rocks used for the fishway should have flat sides with rounded edges (typical of quarried rock) rather than rounded rocks, as they provide a variety of water velocity and depths that are easy for fish to navigate;
- Pools or depressions of varying sizes and depths should be created at random throughout the length and width of the fishway and should be placed behind large rocks to create lower velocity resting areas (eddies) for fish. The more pools incorporated in the design, the more successful the fishway will be; and
- Additional guidelines for fishway design include:
    - **Channel slope (gradients)** – between 1/8 and 1/10 is recommended for South African fish;
    - **Fishway entrance** – furthest point upstream that the fish can penetrate, usually in a suitable pool (low turbulence with sufficient depth) located at the base of the weir;
    - **Fishway exit** – located in a quiet area, sheltered, with a low velocity to prevent fish from being swept downstream and to afford protection from predators;
        - The invert level of the exit (i.e. water inflow) should be lower than that of the weir overflow to ensure the low flows are directed down the fishway;
    - **Depth of pool** - small fish (20 to 200 mm in length: at least 300 mm deep to reduce predation and limit turbulence;
        - Larger fish (>200 mm): at least 500 mm, can be deeper to reduce turbulence, if necessary;
    - **Length of pool** – at least 2.5 times the length of the largest fish catered for;
    - **Drop height between pools/rock levels** – maximum of 100 mm to cater for small fish.

# 7 Conclusion

The results of the PES assessment derived moderately/largely modified (class C/D) conditions in the river reach considered in this assessment. Despite large modification to instream habitat through the presence of the Esperanza Weir, aquatic ecology responses were determined to be moderately modified. This result provides confirmation that although habitat quality is modified, water quality in the river reach is still unmodified.

## 7.1 Risk Assessment

The results of the risk assessment derived low risks for the proposed project. The low risks of the proposed project can be attributed to the small scale rehabilitation activities. Furthermore, no riparian or bank alterations are anticipated to stem from the proposed project. Considering the nature of the proposed project, limited instream modification can be anticipated. In addition, the short nature of the rehabilitation activities further negates long terms impacts.

## 7.2 Specialist Recommendation

Considering the status of the aquatic ecosystems, and furthermore the nature and requirements of the project, the proposed project has limited potential to negatively affect local aquatic ecology. In light of the above mentioned, it is the opinion of the specialist that no significant fatal flaws could be identified through the completion of this aquatic ecology study.

# 8 References

Barbour MT, Gerritsen J, White JS. 1999. Development of a stream condition index (SCI) for Florida. Prepared for Florida Department of Environmental Protection: Tallahassee, Florida.

Dallas HF. 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.

Department of Water and Sanitation (DWS). (2005). A practical field procedure for identification and delineation of wetlands and riparian areas. Pretoria: Department of Water Affairs and Forestry.

Department of Water and Sanitation (DWS). 1999. Resource Directed Measures for Protection of Water Resources. Volume 2: Integrated Manual (Version 1). Department of Water Affairs and Forestry, Pretoria.

Department of Water and Sanitation (DWS). 2018. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

Dickens CWS, Graham PM.2002. The South African Scoring System (SASS), Version 5, Rapid bioassessment method for rivers. *African Journal of Aquatic Science*. 27**:** 1–10.

Driver A, Nel JL, Snaddon K, Murray K, Roux DJ, Hill L, Swartz ER, Manuel J, Funke N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report Number 1801/1/11, ISBN 978-1-4312-0147-1.

Gerber A, Gabriel MJM. 2002. Aquatic Invertebrates of South African Rivers Field Guide. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 150pp.

IUCN. 2017. IUCN Red List of Threatened Species. Version 2017-3. <www.iucnredlist.org>. Downloaded on 05 July 2018.

Kleynhans CJ, Louw MD. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Resource Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 329/08.

Kleynhans CJ. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa) Journal of Aquatic Ecosystem Health 5:41-54.

Rowntree KM. 2013. Module B: Geomorphology Driver Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 551/13.

Skelton P. 2001. A complete guide to the freshwater fishes of southern Africa. Struik Publishers, South Africa.

Tate RB, Husted A. 2015. Aquatic macroinvertebrate responses to pollution of the Boesmanspruit river system above Carolina, South Africa. *African Journal of Aquatic Science*. 1-11.

Thirion C. 2007. Module E: Macroinvertebrate Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 332/08.

Thirion CA, Mocke A, Woest, R. 1995. Biological monitoring of streams and rivers using SASS4. A User's Manual. Internal Report No. N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 46.

Umgeni Water. 2016. Gauging weirs at Esperanza Pumpstation, Umzinto Dam, EJ Smith Dam and Imvutshane Dam.

Wepener V, Van Vuren JHJ, Chatiza FP, Mbizi Z, Slabbert L, Masola B. 2005. Active biomonitoring in freshwater environments: early warning signals from biomarkers in assessing biological effects of diffuse sources of pollutants. *Physics and Chemistry of the Earth* 30: 751–761.

**Appendix A: Curriculum Vitae**

# Russell Tate

## M.Sc Aquatic Health (*Pr Sci Nat*)

*Cell: +27824549019*

*Email: Russell@thebiodiversitycompany.com*

*Identity Number: 8809215227089*

*Date of birth: 21 September 1988*

### Profile Summary

I have completed aquatic ecology related assessments throughout Southern, Central and Western Africa (14 countries). My particular focus and skillset is focused on determining the impacts to water resources by industrial developments through aquatic ecology assessments.

Further, as I have worked on numerous large multidisciplinary projects. I am comfortable conducting a wide range of projects from impoundment and hydropower studies to industrial projects relating to iron, gold, copper and coal projects. In addition, I have worked on infrastructure developments such as roads and bridges and have completed High Conservation Value (HCV) projects for the oil palm industry.

### Areas of Interest

Mining, Oil & Gas, Renewable Energy & Bulk Services Infrastructure Development.

Publication of scientific articles.

High Conservation Value Assessments

### Key Experience

- Wide geographic experience in African ecosystems
- Specialised impact extent assessments for industrial related pollution events
- Specialist aquatic ecotoxicology investigations
- Water resource baseline, monitoring and impact assessments
- Aquatic ecology studies in accordance to local and international standards

### Countries worked in

Botswana

Cameroon

Democratic Republic of Congo

Ghana

Ivory Coast

Liberia

Mali

Mozambique

Namibia

Republic of Congo

South Africa

Sierra Leone

Senegal

Zambia

### Nationality

South African

### Languages

English – Proficient

Afrikaans – Conversational

### Qualifications

- MSc Aquatic Ecotoxicology
- BSc Honours Aquatic Health
- BSc Zoology and Botany
- Professional Natural Scientist: Aquatic Health 400089/15.
- SASS5– Department of Water Affairs and Forestry for the River Health Programme
- EcoStatus application for rivers and streams

## SELECTED PROJECT EXPERIENCE

**Project Name: An aquatic state assessment for the New Liberty Gold Mine 2016/2017.**

Client: Avesoro Resources

Personal position / role on project: Project Manager and Aquatic Specialist

Location: Liberia, Grand Cape Mount County.

Main project features: To conduct an aquatic ecological state assessment which informed a social impact and contamination extent assessment for a pollution event. The study utilised high level aquatic ecotoxicology methods to determine the effects and extent of the pollution event.

**Project Name: Matla Coal Mine Aquatic, Wetland, Satellite, Flora and Fauna Monitoring 2015/2016.**

Client: Exxarro Coal

Personal position / role on project: Project Manager and Aquatic Specialist.

Location: South Africa.

The detailed monitoring of large scale underground coal mining activities on the biophysical environment. The project covered several biophysical facets including the analysis of satellite imagery.

**Project Name: High Conservation Value Assessment for the Lokutu, Boteka and Yaligimba Oil Palm Concessions.**

Client: Feronia.

Personal position / role on project: Aquatic Ecology Specialist.

Location: Democratic Republic of Congo.

Main project features: The identification and assessment of various concessions for high conservation value aquatic ecology.

**Project Name: The Environmental and Social Impact Assessment (ESIA) for the Ntem Iron Ore Mine**

Client: International Mining and Infrastructure Corporation

Personal position / role on project: Aquatic Ecology Specialist.

Location: Cameroon

Main project features: The baseline and impact assessment for an Iron Ore Mine and associated road/rail infrastructure.

## PUBLICATIONS

- Tate, RB, Diarra H, Liefferink SL (2017). The assessment of river sediments and fish tissue from a west African River, Mali. *African Journal of Aquatic Science. As of 2017/01/30 the paper has been accepted with revision*.
- Thompson LA, Tate RB, Ikenaka Y, Van Vuren JHJ, Wepener V, Smit S, Vlok W, Yohannes YB, Nakayama SMM, Ishizuka M (2015). Vector-Control Pesticides Disseminating Via International Waterways to Accumulate in Free-Ranging Freshwater and Marine Fish Species. Conference Paper. Fifth International Wildlife Management Congress. Sapporo, Japan.
- Tate, RB, Husted A (2015) Aquatic macroinvertebrate responses to pollution of the Boesmanspruit above Carolina, South Africa. (2014). *African Journal of Aquatic Science*. 40: 153–163.
- Liefferink SL, Tate RB, Malherbe W, Ferreira M, Van Vuren JHJ (2015). A comparison of Incubation Methods of Zooplankton in Endorheic Pans from the Free State, South Africa. African Journal of Aquatic Science. 39:4, 417–423.
- Tate, RB, Husted A (2014). Bioaccumulation of metals in *Tilapia zillii* from the Badeni Dam, Cote d'Ivoire. African Journal of Aquatic Science. 39:2, 199–202.
- Tate RB, Van Vuren JHJ, Smit NJ (2013). The use of *Hydrocynus vittatus* as an indicator of pollution on the Nyamithi Pan and Phongolo River, Kwa-Zulu Natal, South Africa (MSc Dissertation, University of Johannesburg).

## OVERVIEW

An overview of the specialist technical expertise includes the following:

- Aquatic ecological state and functional assessments of rivers and dams.
- Instream Flow Requirement or Ecological Water Requirement studies for river systems.
- Ecological wetland assessment studies, including the integrity (health) and functioning of the wetland systems.
- Wetland offset strategy designs.
- Wetland rehabilitation plans.
- Monitoring plans for rivers and other wetland systems.
- Toxicity and metal analysis of water, sediment and biota.
- Bioaccumulation assessment of fish communities.

## EMPLOYMENT EXPERIENCE

**Name of Organization, City, Country:** The Biodiversity Company, Johannesburg, South Africa
**Month, Year:** July 2017 to Present
**Position:** Water Resource Specialist

- Management of multidisciplinary and standalone projects
- Managing, planning and implementing aquatic related studies
- Technical contributions for the monitoring, mitigation and identification of impacts to water resources associated with industrial and infrastructural developments
- Establishment and identification of baseline ecological and physical structures (surveys)

**Name of Organization, City, Country:** Digby Wells Environmental, Johannesburg, South Africa
**Month, Year:** January 2013 to June 2016
**Position: Aquatic Ecology:** Manger: Aquatic Ecology Unit.

- Managing, planning and implementing aquatic related studies
- Technical contributions for the monitoring, mitigation and identification of impacts to water resources associated with industrial and infrastructural developments
- Establishment and identification of baseline ecological and physical structures (surveys)

**Name of Organization, City, Country:** Digby Wells Environmental, Johannesburg, South Africa
**Month, Year:** March 2012 to December 2012
**Position: Aquatic Ecology:** Junior Aquatic Specialist

- Implementation and planning of aquatic related studies
- Technical contributions for the monitoring, mitigation and identification of impacts to water resources associated with industrial and infrastructural developments
- Establishment and identification of baseline ecological and physical structures (surveys)