Baseline Assessment of Aquatic Ecosystems Associated with proposed Bombay Road Extension

CLIENT

EnviroPro

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REFERENCE

BOMBAY

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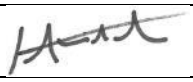
Report reviewer	**Andrew Husted**	

EXECUTIVE SUMMARY

The Biodiversity Company was appointed to conduct a baseline assessment of the aquatic ecosystems associated with proposed extension of the Bombay Road on the Bayne's Spruit, a tributary of the uMnsunduze River, Pietermaritzburg. The baseline aquatic assessment was carried out to meet the requirements for a Water Use Licence Application (WULA) according to NEMA (National Environmental Management Act) regulations.

This report presents the results of a single field survey conducted on the 19th of April 2016.

The objectives of the aquatic assessment were to characterise the biotic integrity of the aquatic ecosystem associated with the construction of the proposed road activities, evaluate the extent of site-related effects in terms of selected ecological indicators, identify potential impacts and recommend suitable mitigation / rehabilitation measures.

The project area is situated in quaternary catchment U20J and sub-quaternary reach U20J-4364 in the Mvoti to Umzimkulu Water Management Area (WMA 11). Sampling was conducted in the Bayne's Spruit. The site is situated in the South Eastern Uplands ecoregion.

The following conclusions were reached based on this assessment:

Desktop Data for Sub-Quaternary Catchment U20J-4364

NFEPA's	**4 NFEPAs listed**
Present Ecological Status	**Seriously modified (Class E)**
Ecological Importance	**Moderate**
Ecological Sensitivity	**Very High**

Based on the desktop assessment the Present Ecological Status (PES) category of the reach is classed as Seriously modified (Class E). Anthropogenic impacts in the catchment include the Campsdrift weir without fish ladder, industries, stormwater runoff, urban, road crossings, Dorpspruit, settlements, WWTW (Darvill) return flows, Bainspruit (pollution), oil industry, chicken farms, number of dams in the quaternary.

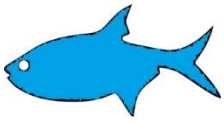
The EI of the reach was rated as moderate. This is attributed to the presence of species of conservation concern. It should be noted that the confidence that these species occur in the sub quaternary reach is very low:

- *Afrixalus spinifrons intermedius* (Natal Banana Frog) which is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;
- *Aonyx capensis* (African Clawless otter) which is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;

- *Balearica regulorum* (Grey Crowned Crane) that occurs in Eastern and southern Africa which is currently listed as Endangered (EN) on the IUCN Red List of Threatened Species;
- *Natalobatrachus bonebergi* (Natal Diving Frog) which is currently listed as Endangered (EN) on the IUCN Red List of Threatened Species.

The Ecological Sensitivity is categorised as very high due to the presence of fish and aquatic macroinvertebrate taxa that are considered to be highly sensitive to flow and physico-chemical water modifications. The stream size is rated as a very low sensitivity to modified flow.

Aquatic Assessment Results for the April 2016 survey

***In Situ* Water Quality**	**IHAS**	**Biotic Integrity (SASS5)**	**Fish**
			
Modified	**Poor**	**Poor (E/F)**	**Poor (E/F)**

- The *in situ* water quality measured fine with the exception of a slightly acidic below guideline value with a limiting effect on aquatic biota;
- Based on the IHAS results, habitat availability for aquatic macroinvertebrates was poor in the Bayne's Spruit. The available habitat at site was dominated by stones and mud with limited gravel and sand. There was adequate marginal vegetation present in the Bayne's Spruit;
- Based on the SASS results biotic integrity in the Bayne's Spruit was severely impaired (PES Class E/F). This can be attributed to limited habitat availability and modified water quality;
- The observed fish assemblage represented only 23% of the expected fish assemblage. This can be attributed to limited habitat availability and modified water quality in Bayne's Spruit; and
- Urban activities have resulted in the modification of instream and riparian habitats in this section of the Bayne's Spruit. Such modifications have resulted in an impaired biotic integrity with poor fish communities of low diversity.

Concluding Remarks

The current state of the project area associated with the proposed Bombay Road extension is in a seriously modified state. The proposed construction may provide opportunities to improve the current impacts on instream habitat, and dumping occurring at the site. According to the DWS Risk assessment, the risk rating for each of the aspects were determined to be low. It is therefore the opinion of the specialist that the project be favourably considered, and allow for the Bombay Road Extension to proceed.

It is recommended that an aquatic monitoring programme be implemented should the proposed road construction commence.

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1 INTRODUCTION

The Biodiversity Company was appointed by EnviroPro to conduct a baseline assessment of the aquatic ecosystems associated with proposed extension of the Bombay Road on the Bayne's Spruit, a tributary of the uMnsunduze River, Pietermaritzburg. The baseline aquatic assessment was carried out to meet the requirements for a Water Use Licence Application (WULA) according to NEMA (National Environmental Management Act) regulations.

This report presents the results of a single field survey conducted on the 19th of April 2016.

1.1 Project Background

The Bombay Road Extension project has been identified as a medium term roads improvement scheme in the Msunduzi Municipal Transportation plan. The project entails the extension of Bombay Road from Chota Motala Road to Bhambatha Road and linking into Ohrtmann Road to ease congestion within the surrounding vicinity.

1.2 Background

Freshwater biodiversity in Southern Africa is both highly diverse and of great local importance to livelihoods and economies. However, the conservation of these aquatic ecosystems is often poorly represented within the development planning process, and furthermore development is often not compatible with conservation of these resources. The value of the goods and services derived from freshwater ecosystems such as food and drinking water is considerable, however the lack of recognition of this value has led to a rapid decrease in the state of these resources through negative anthropogenic activities (Darwall *et al.,* 2009). Due to the rapid population growth rate in Africa and the increased demand for safe drinking water and sanitation there is a potential large scale impact to freshwater biodiversity. Initiative is required to assess the status of freshwater ecosystems and to integrate that information into the water development planning process. This information is critical to minimise or mitigate significant impacts to freshwater biodiversity and the resulting loss to livelihoods and economies which are dependent on these goods and services (Darwall *et al.,* 2009).

In 1994 the South African Department of Water Affairs and Forestry (DWAF) initiated the River Health Programme (RHP). The purpose of this programme was to establish a source of information on the ecological status of aquatic ecosystems in South Africa. Subsequently, in 1998, the South African National Water Act (NWA) came into effect. This act acknowledged the importance of protecting aquatic ecosystems and the maintenance of goods and services provided by these resources. This required the establishment of a national aquatic ecosystem health monitoring system (DWAF, 2006).

The RHP monitoring system primarily uses biological indicators such as fish communities, riparian vegetation and aquatic macroinvertebrates to assess the current state or health of river systems 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. This is conducted to measure, assess and report on the spatial and temporal trends of the aquatic ecosystem to identify and report emerging problems by providing scientifically and managerially relevant information for national aquatic ecosystem management (DWAF, 2006).

1.3 Objectives

The objectives of the aquatic assessment included the following:

- Characterise the biotic integrity of the aquatic ecosystem associated with the proposed road construction activities;
- Evaluate the extent of site-related effects in terms of selected ecological indicators;
- Identification of potential impacts associated with the activities; and
- Recommendation of potential mitigation or rehabilitation measures.

2 LIMITATIONS

This report is based on the results of a single survey conducted during the high flow season and should be interpreted accordingly. Aquatic ecosystems are dynamic by nature, in order to characterise the full variability seasonally representative surveys are required.

3 PROJECT AREA

3.1 Study area description

The project area is situated in quaternary catchment U20J and uMnsunduze Sub-Quaternary Reach (SQR) U20J-4364 in the Mvoti to Umzimkulu Water Management Area (WMA 11). Sampling was conducted in, a tributary of the uMnsunduze River. The site is situated in the South Eastern Uplands ecoregion.

The Mvoti to Umzimkulu WMA lies along the eastern coast of South Africa, predominantly within KwaZulu-Natal, and borders on Lesotho to the west. It is situated in a humid part of the country with a mean annual precipitation of 800 to 1 500 mm. The terrain is rolling, with the Drakensberg escarpment as the main topographic feature. Several parallel rivers drain the Mvoti to Umzimkulu WMA, two of which originate in the Drakensberg Mountains at the border with Lesotho. The area is characterised as rural, and activities include subsistence and commercial farming (StatsSA, 2010).

Sampling was conducted at sites upstream and downstream of the proposed Bombay road. Table 1 presents the GPS coordinates and photographs of the sampling sites. A map of the general project area is provided in Figure 1. A map of the sampling sites in the Bayne's Spruit is provided in Figure 2. The proposed Bombay road runs parallel to the Bayne's Spruit, surrounded by industrial area.

Table 1: GPS coordinates and description of sampling site

	Upstream	Downstream
BOMB1		
GPS coordinates	**Start of road**	**End of road**
	29°34'11.03"S 30°24'21.63"E	29°34'31.82"S 30°24'32.25"E
Site description	BOM1 is situated on the Bayne's Spruit, a tributary of the uMnsunduze River. The channel consisted of vegetated banks with areas of slow to medium flowing water over stones, sand, gravel and mud substrate. Large amounts of solid waste in the river channel was present at site. A weir and gabion structures were present.	

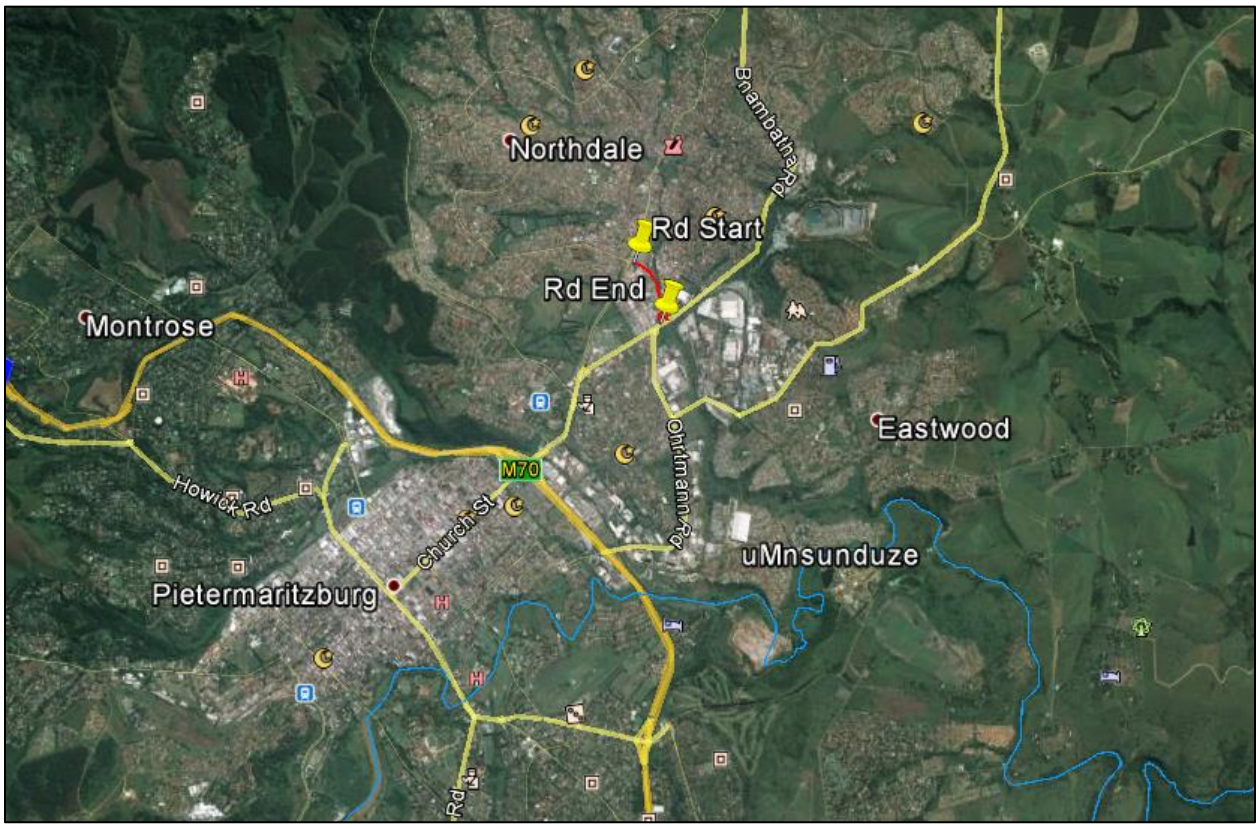


Figure 1: General area map showing the location of the proposed Bombay Road (red) in Rosedale, near Pietermaritzburg

Figure 2: Map showing the position of the proposed Bombay Road (red) to the Bayne's Spruit (blue)

3.2 National Freshwater Ecosystem Priority Area (NFEPA) Status

In an attempt to better conserve aquatic ecosystems, South Africa has recently categorised its river systems according to set ecological criteria (i.e. ecosystem representation, water yield, connectivity, unique features, and threatened taxa) to identify Freshwater Ecosystem Priority Areas (FEPAs) (Driver *et al*. 2011) The FEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act (NEM:BA) biodiversity goals (Nel *et al*. 2011).

3.2.1 FEPA's for sub-quaternary catchment U20J 4364

The Bombay Road construction project area fell within a single SQR, namely the uMnsunduze U20J-4364. There were 4 registered wetland, and no river NFEPA ecosystem types for the uMnsunduze SQR. These are listed in Table 2. It should be noted that this is data taken from the nearest SQR, the site sampled may not fall within these NFEPA's.

Table 2: Registered NFEPA's for the uMnsunduze SQR U20J-4364

Type of FEPA map category	Biodiversity features
Number of wetland clusters	2 WetCluster FEPAs
Wetland ecosystem type	Sub-Escarpment Savanna_Channelled valley-bottom wetland
Wetland ecosystem type	Sub-Escarpment Savanna_Flat
Wetland ecosystem type	Sub-Escarpment Savanna_Unchannelled valley-bottom wetland

Section 3.3 provides further desktop information regarding the uMnsunduze SQR U20J-4364 with regards to the Present Ecological Status (PES) including the Ecological Importance, Ecological Sensitivity and anthropogenic impacts within the SQR.

3.3 Status of Sub-Quaternary Reach U20J-4364

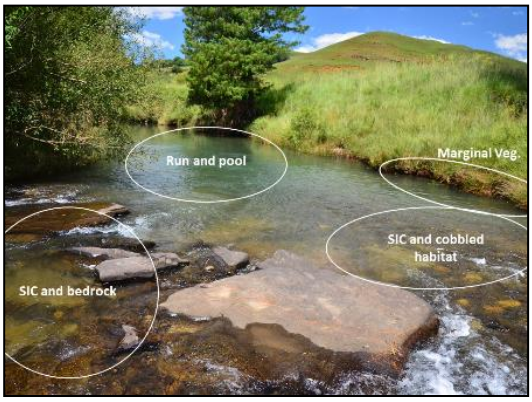
Table 3: Relevant PES/EIS/ES data

Present Ecological State		**Ecological Importance**		**Ecological Sensitivity**	
E (Seriously Modified)		**Moderate**		**Very High**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	Serious	Fish species per sub quaternary catchment	13	Fish Physico-Chemical sensitivity description	Very High
Modifications to Riparian/ Wetland Zone Continuity	Serious	Invertebrate taxa per sub quaternary catchment	89	Fish No-flow sensitivity description	Very High
Modifications to Riparian/ Wetland Zones	Serious	Habitat Diversity Class	Very Low	Invertebrate Physico-Chemical sensitivity	Very High
Potential Flow Modifications	Serious	Instream Migration Link Class	Low	Invertebrate velocity sensitivity	Very High
Potential Physico-Chemical Modifications	Large	Riparian-Wetland Zone Migration Link	Low	Stream size sensitivity to modified flow/water level changes description	Low
		Instream Habitat Integrity Class	High	Riparian-Wetland Vegetation intolerance to water level changes description	Very High
Anthropogenic Impacts					
Campsdrift weir without fish ladder, industries, stormwater runoff, urban, road crossings, Dorpspruit, settlements, WWTW (Darvill) return flows, Bayne's Spruit (pollution), oil industry, chicken farms, number of dams in the quaternary.					

4 METHODOLOGY

Various assessments conducted during the survey are illustrated in Figure 3. Full methodology can be requested from The Biodiversity Company.

***In situ* & *Ex situ* water quality analyses**



Habitat Assessments (IHAS)

Water clarity

Flow measurement

Kick and sweep sampling method, SASS5 (South African Scoring System Version 5)

Figure 3: Methodologies applied during the aquatic survey

4.1 Biotic Integrity Based on SASS5 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 South Eastern Uplands - Upper ecoregion were obtained from Dallas (2007) (Table 4 and Figure 4). Due to limited data available to generate biological bands for this ecoregion, classification results should be interpreted with caution.

Table 4: Biological Bands / Ecological categories for interpreting SASS data (adapted from Dallas, 2007)

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

** Average Score per Taxa*

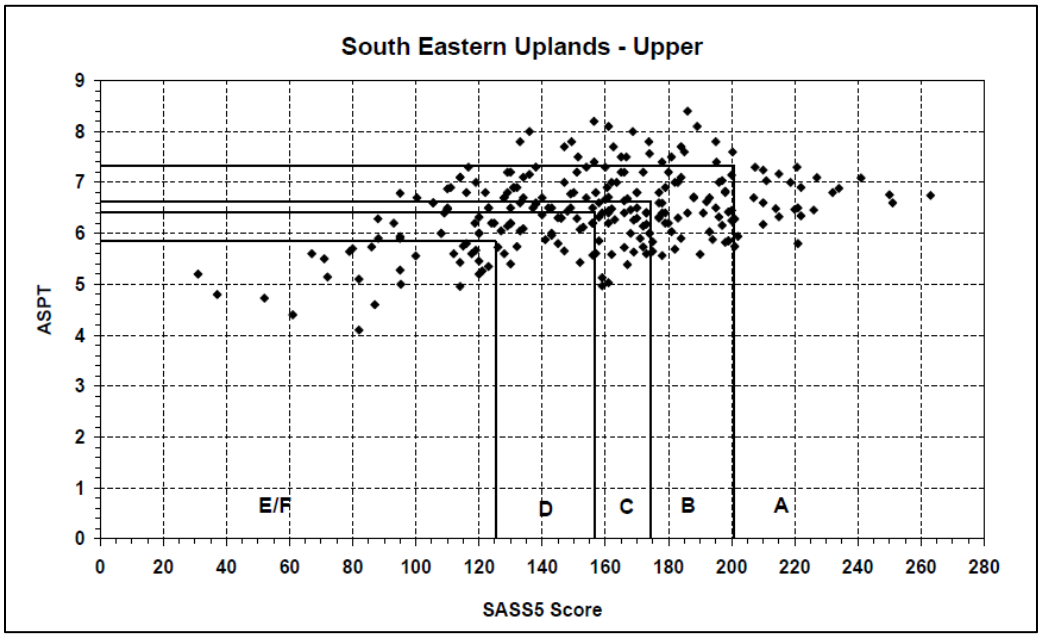


Figure 4: Biological Bands for the South Eastern Uplands – Upper zone, calculated using percentiles

4.2 Fish

Fish samples were collected by means of electrofishing. Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes placed in the water (USGS, 2004). The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance, electrotaxis (forced swimming), electrotetanus (muscle contraction), electronarcosis (muscle relaxation or stunning) and death (USGS, 2004). Electrofishing was conducted with a SAMUS 725MS portable electrofishing device (DC 12V pulsating). Electrofishing is regarded as the most effective single method for sampling fish communities in wadeable streams (Plafkin *et al*., 1989).

Fish were identified in the field, photographed and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001).

4.2.1 Expected Species List

An expected fish species list for the uMnsunduze SQR was obtained from DWS (2014). Based on this, 13 fish species are expected to occur in the SQR (Table 5). All of the expected fish species are indigenous with no introduced fish species expected in the reach.

It should be noted that these expected species lists are compiled on a SQR 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 SQR with habitat type and availability being the main driver of species present. Therefore Table 5 should be viewed as a list of potential species rather than an expected species list.

Table 5: Fish species expected to occur in the uMnsunduze SQR, their IUCN statuses (DWS, 2014; IUCN, 2016; Skelton, 2001; Fishbase, 2016)

Scientific name	Common name	IUCN Status
Awaous aeneofuscus	Freshwater Goby	LC
Anguilla bengalensis labiata	African Mottled Eel	NT
Anguilla mossambica	Longfin Eel	LC
Amphilius natalensis	Natal Mountain Catfish	LC
Barbus gurneyi	Redtail Barb	LC
Barbus pallidus	Goldie barb	LC
Barbus viviparus	Bowstripe Barb	LC
Clarias gariepinus	Sharptooth Catfish	LC
Labeobarbus natalensis	Natal Yellowfish	LC

Oreochromis mossambicus	Mozambique Tilapia	NT
Pseudocrenilabrus philander	Southern Mouth-brooder	DD
Tilapia rendalli	Redbreast Tilapia	LC
Tilapia sparrmanii	Banded Tilapia	LC
Total number of fish		**13**

LC - Least Concern DD - Data Deficient NT - Near Threatened

4.2.1 Presence of Species of Conservation Importance

The conservation statuses of the indigenous fish species were assessed in terms of the IUCN Red List of Threatened Species (IUCN, 2016). Based on this assessment the majority of the fish species (n = 11) are currently listed as Least Concern (LC) (Table 5). Species in this category are considered to be widespread and abundant with no immediate threat to their survival.

One (1) of the expected fish species, *Pseudocrenilabrus philander* (Southern Mouth-brooder) is currently listed as Data Deficient (DD) (Table 5). A taxon is categorized as DD when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status (IUCN, 2016). Due to the uncertainty over their status the precautionary principles should be applied and these species should be afforded a high degree of conservation importance.

Two (2) of the expected species are currently listed as Near Threatened (NT) on the IUCN Red List (Table 5). Species in this category do not qualify for Critically Endangered, Endangered or Vulnerable status but are near to qualifying or are likely to qualify for a threatened category in the near future. Descriptions of the 2 NT species are given below.

Oreochromis mossambicus (Mozambique tilapia), currently listed as NT, is a hardy species occuring in all but fast flowing waters and is tolerant of high salinities. It feeds on algae and invertebrates (IUCN, 2016). The primary threat to *O. mossambicus* is hybridization with the closely related and rapidly spreading introduced species *Oreochromis niloticus* (Nile tilapia) (IUCN, 2016). Hybridization has already been noted in the northern range of *O. mossambicus'* distribution (IUCN, 2016). Signs of hybridization include banding on the caudal fin.

Anguilla bengalensis labiata (African Mottled Eel) is currently listed as NT. *Anguilla bengalensis* is very widely distributed and common to east and southeast African water systems. While the species is a widespread species in Africa, its range and regional abundance has declined owing to a reduction in suitable freshwater habitat and exploitation for consumption purposes. Within Zimbabwe, numbers and range have been reduced by dam building, which block the migration of elvers, posing a threat to future escapement and spawning stock and suggesting that monitoring is required in many areas, to assess the impact of migration barriers to overall population stability. While there has been little or no quantitative time-series data relating to declines in the species, anecdotal evidence would indicate that both range and abundance of the species are shrinking.

The species has been assessed as NT, although there are no data available to determine actual rate of decline, it is suspected that a reduction of close to 30% is likely to have occurred over the last 3 generations (36 years), based on reports of declines across its range. However, it is essential further information is collected, as there is concern that a 'threatened' category would be more appropriate. Further, there are clearly serious concerns in certain regions of the species range which need immediate attention (IUCN, 2016).

5 RESULTS & DISCUSSIONS

5.1 *In situ* water quality

In situ water quality measurements were taken within the sampling reach. These results are important to assist in the interpretation of biological results because of the direct influence water quality has on aquatic life forms. The results of the survey are presented in Table 6.

Table 6: *In situ* water quality results for the Bayne's Spruit during the April 2016 survey (measurements exceeding the Target Water Quality Range are shown in **RED**)

Site	pH	EC (µS/cm)	DO (mg/l)	DO Saturation (%)	Temperature (°C)
TWQR*	**6.5 -9.0**	**< 700**	**> 5.00**	**80 - 120**	**5 - 30**
BOM1	5.91	230	8.61	94.4	19.6

5.1.1 pH

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 (Table 6).

The pH values in the Bayne's Spruit measured 5.91 (Table 6). This measured value was slightly acidic and below the guideline range and was expected to have a limiting effect on aquatic biota (Table 6).

5.1.2 Electrical Conductivity (EC)

Electrical conductivity (EC) 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.

During the April 2016 survey the EC concentration in the Bayne's Spruit measured 230 µS/cm at site BOM1 (Table 6). The EC value was within the Target Water Quality Range (TWQR) and was not a limiting effect to aquatic biota (Table 6).

5.1.3 Dissolved Oxygen (DO)

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 (DWAF, 1996). Therefore, DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO for the protection of freshwater fish, determined by a variety of fish faunas is > 4 - 5 mg/ℓ (Doudoroff & Shumway, 1970 and DWAF, 1996). Exposure to DO concentrations below 2 mg/l will lead to death of most fishes (UNESCO, 1996). Percentage saturation (% sat) is the amount of oxygen (O2) in a litre of water relative to the total amount of oxygen that the water can hold at that temperature. DO levels fluctuate seasonally and diurnally over a 24-hour period and vary with water temperature and altitude (DWAF, 1996). The South African Water Quality Guidelines (1996), state that the target water quality range (TWQR) for DO to protect aquatic biota through most life stages is 80% - 120% of saturation, and that saturation levels below 40% would be lethal.

During the survey, DO concentrations and percentage saturation levels in the Bayne's Spruit were adequate and were not expected to have had a limiting effect on aquatic ecosystems or biota (Table 6).

5.1.4 Water Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (DWAF, 1996). Temperature affects the rate of development, reproductive periods and emergence time of organisms (DWAF, 2005b). Temperature varies with season and the life cycles of many aquatic macroinvertebrates are cued to temperature (DWAF, 2005b).

At the time of the survey water temperature was within the guideline range and was not expected to have had a limiting effect on aquatic ecosystems or aquatic biota (Table 6). The water temperatures measured during the survey are considered normal seasonal temperatures.

5.2 Habitat Assessment

Whilst on site, anthropogenic impacts were noted and these were primarily associated with the disturbance of riparian and instream habitats due to industrial activities in the urban setting and solid waste dumping within the river channel.

5.2.1 Integrated Habitat Assessment System

The IHAS index was developed by McMillan (1998) for use in conjunction with the SASS5 protocol. The IHAS results for the April 2016 survey are presented in Table 7.

Table 7: IHAS score for the Bayne's Spruit

Site	Score	Description
BOM1	54	**Poor**

Based on the IHAS results, habitat availability for aquatic macroinvertebrates was poor at site BOM1 (Table 7). The available habitat at site was dominated by stones and mud with limited gravel and sand. There was poor variety in both depth and flow classes, although flows varied from slow to medium with some deeper pools. There was adequate marginal vegetation present in the Bayne's Spruit.

5.3 Aquatic Macroinvertebrates

The results of the SASS5 assessment are presented in Table 8. Based on the ASPT scores the aquatic macroinvertebrate communities for the sampling reach comprised primarily of tolerant taxa (Intolerance Rating < 5) in low abundances. The macroinvertebrate communities comprised taxa which included some semi-intolerant taxa (Intolerance Rating 5 - 10) in low abundances.

Table 8: Aquatic macroinvertebrate assessment results recorded during the April 2016 survey

Site	SASS Score	No of taxa	ASPT*
BOM1	78	17	4.6

* Average Score per Taxon

5.3.1 Biotic Integrity based on SASS5 Results

Based on the SASS results biotic integrity in the Bayne's Spruit was severely impaired (PES Class E/F) at site BOM1 (Table 9). This indicates that the macroinvertebrate assemblage is in an impacted state. The ASPT score indicates a high percentage of tolerant taxa were recorded at site. The low diversity of Ephemeroptera, Plecoptera and Trichoptera taxa indicates poor instream habitat diversity and availability, such as stones in riffles, runs and pools. This agreed with the IHAS results that showed the habitat available for aquatic biota was limited and considered poor. An absence of highly sensitive taxa during sampling indicates modified or poor water quality conditions. Low pH was recorded in the Bayne's Spruit at the time of the survey. The macroinvertebrate assemblage indicates that the biotic integrity of the Bayne's Spruit system is largely modified.

The results of the field survey agreed with the desktop assessment results which predicted a PES Class E/F for the uMnsunduze SQR (see section 3.3).

Table 9: Present Ecological State of the Bayne's Spruit based on the results of the April 2016 survey

Site	Present Ecological State (PES) Class	Description
BOM1	E/F	Severely impaired. Only tolerant taxa present.

5.4 Fish

5.4.1 Observed fish assemblage

Three species of fish were collected during the survey namely *Clarias gariepinus*, *Labeobarbus natalensis* and *Oreochromis mossambicus* (Table 10). Photographs are presented in Table 12.

Table 10: Fish species recorded during the April 2016 survey

Scientific name	Common name	IUCN status	Site	Sensitivity	
			BOM1	No-flow	Phys-chem
Clarias gariepinus	Sharptooth Catfish	LC	1	1.7	1.0
Labeobarbus natalensis	Natal Yellowfish	LC	43	3.5	3.0
Oreochromis mossambicus	Mozambique Tilapia	NT	31	0.9	1.3

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 11. These tolerance levels are scored to show each fish species sensitivity to flow and physico-chemical modifications.

Table 11: Intolerance rating and sensitivity of fish species

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

The fish species present at site during the April 2016 survey range from tolerant (*Clarias gariepinus* and *Oreochromis mossambicus*) to moderately tolerant (*Labeobarbus natalensis*) of flow and physico-chemical modifications.

Table 12: Photographs of fish collected during the April 2016 survey

Scientific name	Photo
Clarias gariepinus	
Labeobarbus natalensis	
Oreochromis mossambicus	

Fish were collected in the slow moving runs (slow-shallow, slow-deep and fast-shallow) between the overhanging vegetation.

Based on the results of the fish survey, 23% or 3 of the 13 expected species were found at site BOM1 in the Bayne's Spruit during the survey. Two species, namely *L. natalensis* and *O. mossambicus* comprised juveniles to adults in high abundances, while a single *C. gariepinus* juvenile was found at site. The results from the fish assessment indicate the fish community structure at the Bombay Road site is in poor condition with a very low diversity of fish. The 3 species found range from tolerant to moderately intolerant (high sensitivity) to flow and physico-chemical modifications and should be considered during the proposed Bombay Road construction. Although only 23% of the expected fish species were recorded during the April 2016 survey it should be noted that the results are based on a single survey of relatively short duration. It is likely that some more but not all of the expected fish species may be recorded with additional sampling effort. Many of the expected fish species may not be found within the Bayne's Spruit due to the presence of solid waste within the channel as well as the proximity of site to an industrial area. These factors together with a pH reading below guideline values, place pressure on

sensitive fish species leading to either the fish moving out of the Bayne's Spruit to larger rivers downstream or death due to adverse living conditions.

5.4.2 Species of Conservation Concern

Only one species of conservation concern was recorded in the Bayne's Spruit during the April 2016 survey. Schools of *Oreochromis mossambicus* (Near Threatened) were found at site. The primary threat to O. mossambicus is hybridization with the closely related introduced species *O. niloticus* (Nile Tilapia). This species is capable of poor living conditions and is fairly widespread throughout South Africa.

6 RISK ASSESSMENT

Risks on the river systems that may be a result of the road construction are as follows:

- During construction, the clearing of areas for infrastructure (e.g. camps, laydown yards etc.) will expose topsoil that could be transported to the river system by wind or storm water, resulting in sedimentation of these systems;
- Construction activities and vehicles could cause spillages of lubricants, fuels and construction material that could then be transported to the systems, impacting on the water quality and potentially the functioning of the systems;
- The construction of the road will most likely result in increased traffic, this would increase the likelihood of spillages (i.e. fuels, oils etc.) onto the road surface which is then transported during storm events into the river systems;
- Loss of habitat on riverbanks due to clearing of riparian vegetation;
- Disturbing the sediments in the river during the construction process can have a negative impact on downstream aquatic ecosystems. Instream silt and sediment churned up during the construction process can smother downstream aquatic habitats. Focus should be placed on monitoring species with specific habitat preferences, this includes macroinvertebrate taxa from the Ephemeroptera, Plecoptera and Trichoptera family groups as well as sensitive fish species.

Findings from the DWS aspect and impact register / risk assessment are provided below:

Activity	Aspect	Impact
Construction of new roads	Drainage patterns change due to road levels.	Impeding the flow of water. Damage to banks Loss of aquatic habitat. Siltation of watercourse. Erosion of watercourse. Flow sediment equilibrium change Increased traffic
	Cutting/reshaping of river banks	
	Denuding the area	
	Borrow Pits	
	Stormwater management	
	Temporary Infrastructure (construction camps, etc.)	

Severity								
Aspect	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**
Drainage patterns change due to road levels.	2	2	3	2	**2.25**	2	3	**7.25**
Cutting/reshaping of river banks	3	3	3	3	**3**	2	3	**8.75**
Denuding the area	2	2	3	2	**2.25**	1	2	**5.25**
Borrow Pits	1	1	1	1	**1**	1	2	**4**
Stormwater management	3	2	2	2	**2.25**	2	4	**8.25**
Temporary Infrastructure (construction camps, etc.)	1	1	2	1	**1.25**	1	2	**4.25**

Aspect	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Sig.**	**Risk Rating**
Drainage patterns change due to road levels.	2	3	1	2	**8**	**58**	**Low**
Cutting/reshaping of river banks	1	3	5	1	**10**	**80**	**Low***
Denuding the area	1	3	5	2	**11**	**57.75**	**Low***
Borrow Pits	2	1	1	1	**5**	**20**	**Low**
Stormwater management	2	2	1	1	**6**	**49.5**	**Low**
Temporary Infrastructure (construction camps, etc.)	2	3	1	2	**8**	**34**	**Low**

(*) denotes - In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below.”

According to the current state of the Bayne’s Spruit and taking the proposed activities associated with the Bombay Road extension into consideration, the risk rating for each of the aspects were determined to be low. The moderate risk ratings were re-allocated a low status due to implementation of additional mitigation methodologies.

The mitigation measures that should be considered for the road extension are as follows:

6.1 Road extension mitigation measures

The following road extension specific mitigation measures are provided:

- To minimise the impact on both surface water flow and interflow, portions of the road must include a coarse rock layer that has been specifically incorporated to increase the porosity and permeability of the sub-layers of the road;
- Concrete pipes must be strategically positioned under the road to drain surface water, this will ensure the road prism does not act as a barrier to water flow;
- The footprint area of the road should be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;
- All construction activities and access must make use of the existing Bombay Road;
- The construction vehicles and machinery must make use of existing road. Construction must be conducted from the road itself and not the adjacent areas;
- Exposed road surfaces awaiting bitumen must be stabilised to prevent the erosion of these surfaces. Signs of erosion must be addressed immediately to prevent further erosion of the road;
- Silt traps and fences must be placed in the preferential flow paths along the road to prevent sedimentation of the watercourse;
- Temporary storm water channels should be filled with aggregate and logs (branches included) to dissipate flows;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly; and
- A suitable storm water plan must be compiled for the road. This plan must attempt to displace and divert storm water from the road, and discharge the water into adjacent areas without eroding the receiving areas. It is preferable that run-off velocities be reduced with energy dissipaters and flows discharged into the uMnsunduze tributary.

6.2 General mitigation measures

The following general mitigation measures are provided:

- The delineated aquatic and riparian areas outside of the specific project site area must be avoided where possible;
- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the aquatic areas. Where possible, the extension of the road and crossings must take place from the existing road and not from within the aquatic systems;

- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Contamination of the river system with unset cement or cement powder should be negated as it is detrimental to aquatic biota;
- Prevent uncontrolled access of vehicles through the river system that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All chemicals and toxicants to be used for the road extension must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- 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”;
- 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 contractors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- Large trees and other debris often collect upstream against the bridge pylons, damming up the channel with risk of flooding and damaging the river crossing and its banks. This debris should be cleared routinely with appropriate disposal of the debris. Timber can be sold or donated to local communities;
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- Due to the potential increase of pedestrians using the extended river crossing, it is suggested that waste bins are installed and maintained at the end of the new crossing to

reduce solid waste disposal into the stream. Signage discouraging littering of the system can also be erected;

- Quarterly vegetation rehabilitation surveys need to be conducted of the vegetation within the project footprint for a period of at least a year after construction has been completed to assess vegetation regrowth and recovery;
- An alien invasive plant management plan needs to be compiled and implemented post construction to control current invaded areas and prevent the growth of invasives on cleared areas; and
- An **aquatic monitoring survey** needs to be conducted after the construction activities so that impacts can be assessed and adaptive management practices implemented if necessary. A number of sensitive aquatic biota should be specifically monitored to identify fluctuation in abundances and diversity, including fish and macroinvertebrates. The frequency of the monitoring programme should be as follows:
    - Shortly after construction of the road extension.
    - Bi-annually for at least one year after the first monitoring survey.

7 CONCLUSIONS

The following conclusions were reached based on this assessment:

- Based on the desktop assessment the Present Ecological Status (PES) category of the reach is classed as Seriously modified (Class E). Anthropogenic impacts in the catchment include the Campsdrift weir without fish ladder, industries, stormwater runoff, urban, road crossings, Dorpspruit, settlements, WWTW (Darvill) return flows, Bainspruit (pollution), oil industry, chicken farms, number of dams in the quaternary;
- The EI of the reach was rated as moderate. This is attributed to the presence of species of conservation concern. It should be noted that the confidence that these species occur in the sub quaternary reach is very low:
    - *Afrixalus spinifrons intermedius* (Natal Banana Frog) which is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;
    - *Aonyx capensis* (African Clawless otter) which is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;
    - *Balearica regulorum* (Grey Crowned Crane) that occurs in Eastern and southern Africa which is currently listed as Endangered (EN) on the IUCN Red List of Threatened Species;
    - *Natalobatrachus bonebergi* (Natal Diving Frog) which is currently listed as Endangered (EN) on the IUCN Red List of Threatened Species.
- The Ecological Sensitivity is categorised as very high due to the presence of fish and aquatic macroinvertebrate taxa that are considered to be highly sensitive to flow and physico-chemical water modifications. The stream size is rated as a very low sensitivity to modified flow.

The following conclusions were reached based on the results of this assessment:

- The *in situ* water quality measured fine with the exception of a slightly acidic below guideline value with a limiting effect on aquatic biota;
- Based on the IHAS results, habitat availability for aquatic macroinvertebrates was poor in the Bayne's Spruit. The available habitat at site was dominated by stones and mud with limited gravel and sand. There was adequate marginal vegetation present in the Bayne's Spruit;
- Based on the SASS results biotic integrity in the Bayne's Spruit was severely impaired (PES Class E/F). This can be attributed to limited habitat availability and modified water quality;
- The observed fish assemblage represented only 23% of the expected fish assemblage. This can be attributed to limited habitat availability and modified water quality in Bayne's Spruit; and
- Urban activities have resulted in the modification of instream and riparian habitats in this section of the Bayne's Spruit. Such modifications have resulted in an impaired biotic integrity with poor fish communities of low diversity.

The current state of the project area associated with the proposed Bombay Road extension is in a seriously modified state. The proposed construction may provide opportunities to improve the current impacts on instream habitat, and dumping occurring at the site. According to the DWS Risk assessment, the risk rating for each of the aspects were determined to be low. It is therefore the opinion of the specialist that the project be favourably considered, and allow for the Bombay Road Extension to proceed.

It is recommended that an aquatic monitoring programme be implemented should the proposed road construction commence.

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