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WATER USE AUTHORISATION APPLICATION

FOR THE

Proposed Eradication of Alien Fish Species, Using a Piscicide containing Rotenone, in the Krom River, Cederberg

In terms of:

Section 21(i): Altering the bed, banks, course or characteristics of a watercourse, of the National Water Act, Act 36 of 1998

PREPARED FOR: CapeNature
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Programme Manager: Mr. Ben Van Staden

DATE: 1 February 2017

SES REPORT REF: 46/WUA/KRO/01/17

EXECUTIVE SUMMARY

The Krom River is a tributary of the Doring River which in forms part of the Olifants- Doorn River catchment in the Cederberg, Western Cape. It is approximately 45km from Clanwilliam on the secondary road between CapeNature's Algeria Resort and Matjiesrivier. The Krom River is a perennial river that contains about 15 km of ideal habitat for indigenous fishes but is currently invaded by several alien species. The majority of headwater streams in the region contain threatened, some critically, indigenous species. Without the impact of alien fish none of the species would have been assessed as Critically Endangered. It is therefore recognised that these rivers, such as the Krom River, are conservation management priority areas. Eradication of invasive alien fish is a critical component of conservation plans for endangered fish species. Therefore, Cape Nature is proposing to eradicate alien fish species from a 6.3 km reach of the lower Krom River as a conservation intervention. The objective of the project is to eradicate alien fish in the river to rehabilitate the reach resulting in significant benefits for endangered fish species and other biota.

An alien fish barrier has already been constructed on the Krom River farm to prevent the further upstream migration of alien invasive fish in the river. Cape Nature is planning to eradicate alien fish downstream of this barrier with a piscicide (CFT Legumine) containing rotenone as the active ingredient. The downstream limit of the treatment area is a natural fish barrier. The use of rotenone appears to be the only effective and appropriate method that could be used to eradicate alien fish in the river section proposed for treatment. Rotenone is a phosphorylation inhibitor that interferes with a fish's ability to absorb oxygen, thus causing the fish to suffocate. Rotenone is non-specific and will affect other non-target aquatic fauna such as native fish, aquatic insects, and juvenile amphibians (tadpoles). Rotenone will alter the characteristics (water quality and biota) of the watercourse.

In terms of the Section 40 of the National Water Act, 1998 (Act No 36 of 1998) (NWA), every party proposing water usage, as defined in Section 21 of the Act, must also apply to the responsible authority for authorisation before such water use can commence. In terms of Section 21 of the NWA, the following water use is proposed to take place as part of this application:

Activity No.	**Relevant Water Use License Activity as per section 21 of the NWA**
21 (i)	Altering the bed, banks, course or characteristics of a watercourse
Justification ((Impacts on Flow (surface and ground water), Water quality, Biota and/or Habitat))	
The treatment of rotenone will not affect the flow regime or geomorphology of the river. It is also unlikely to impact significantly upon physical habitat. However, It will temporarily affect water quality. The main risk associated with the piscicde use is the high impact it will have on indigenous fishes and biota. The impact will be severe, but infrequent, of very short duration and controlled. Therefore, there is a medium –high risk associated with this proposal. The implementation of the mitigation measures detailed in the EIA and the details of the method statements are highly likely to lower this risk rating. The activity will have a positive impact if successful.	

The impacts associated with the proposed water use were identified, described, and assessed to determine their overall significance. The table below indicates a summary of these findings:

	Impact	Mitigation	Significance
Preparation Phase	**Clearance of alien vegetation** POSITIVE	With Mitigation	**+ High**
Operational Phase	**Impact on indigenous fishes**	Without Mitigation	**Low**
		With Mitigation	**Very Low**
	Impact on aquatic invertebrates	Without Mitigation	**High**
		With Mitigation	**Moderate**
	Impacts on vertebrates	Without Mitigation	**Low**
		With Mitigation	**Very Low**
	Impact on recreational angling	Without Mitigation	**Low**
		With Mitigation	**Very Low**
Post Operational Phase	**Impact on indigenous fishes**	Without Mitigation	**+ Moderate**
	POSITIVE	With Mitigation	**+ High**
	Impact on aquatic invertebrates	Without Mitigation	**+ High**
	POSITIVE	With Mitigation	**+ Very High**
	Impacts on vertebrates	Without Mitigation	**+ Low**
	POSITIVE	With Mitigation	**+ Low**
	Eco-tourism and research POSITIVE	With Mitigation	**+ Moderate**

It is concluded that the negative impacts are outweighed by the likely long-term successful re-colonisation of the reach by native fishes and other biota. Therefore, the use of rotenone is at present the most practical and best option for the eradication of the alien invasive fishes in the Krom River and should be authorised.

PROJECT DETAILS

TITLE: Proposed Eradication of Alien Fish Species, Using a Piscicide containing Rotenone, in the Krom River, Cederberg

ENVIRONMENTAL CONSULTANCY: Sharples Environmental Services cc.

PRIMARY EAP & AUTHOR: Debbie Bekker

EXPERTISE: Debbie studied at Rhodes University completing a BA degree, majoring in Environmental Science and Geography. She then completed her Honours degree in Environmental Science in 2009. Debbie has submitted her Master of Science degree thesis on the origin, development and collapse of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She has specialised in aquatic habitat assessment and has conducted numerous aquatic habitat impact assessment reports.

SECONDARY EAP & AUTHOR: John Sharples – Managing Director

EXPERTISE: John started Sharples Environmental Services in 1998 and has overseen the company's growth and development since then. John also started the Cape Town office in 2010. John holds a Masters in Environmental Management from the University of the Free State as well as a Bachelors degree in Conservation. He has consulted for 18 years running a team of highly trained and qualified consultants and prior to this gained 12 years of experience working for environmental organizations. John is registered with EAPASA as a certified Environmental Practitioner.

APPLICANT: Cape Nature

REPORT CLASSIFICATION: Water Use Authorisation Application Report.

DECISION MAKING AUTHORITY: Department of Water and Sanitation

APPENDIX A - **DW 756** – Details of the individual farm owner
DW 768 - Section 21(i): Altering the bed, banks, course or characteristics of a watercourse
DW 781 - Supplementary water use information: Section 21 (c) & (i) uses
DW 901 - Property where the water use, 21(c) and 21(i),occurs
DW 902 - Details of property owner where the water use, 21(c) and 21(i) occurs

APPENDIX B - Certified copy of Identity Document
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APPENDIX E - Method Statement and Monitoring Programme

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1 INTRODUCTION

1.1 TERMS OF REFERENCE

Sharples Environmental Services cc (*SES*) was appointed as an independent Environmental Assessment Practitioner (EAP) by Cape Nature (applicant) to undertake a Water Use Authorisation Application (WUAA) in terms of the National Water Act, 1998 (Act No 36 of 1998) (NWA) for water use associated with the use of a piscicide, with the active ingredient Rotenone, for alien fish species eradication, in the Krom River, Cederberg.

1.2 DEVELOPMENT OVERVIEW

Cape Nature is proposing to eradicate alien fish species from a 6.3 km reach of the lower Krom River (in the Cederberg) as a conservation intervention. An alien fish barrier has already been constructed on the Krom River farm to prevent the further upstream migration of alien invasive fish in the river. Cape Nature is planning to eradicate alien fish downstream of this barrier with a piscicide (CFT Legumine) containing rotenone as the active ingredient. The downstream limit of the treatment area is a natural alien fish barrier.

Rotenone is a phosphorylation inhibitor that interferes with a fish's ability to absorb oxygen, thus causing the fish to suffocate. Rotenone is non-specific and will affect other non-target aquatic fauna such as native fish, aquatic insects, and juvenile amphibians (tadpoles). Rotenone will alter the characteristics (water quality and biota) of the watercourse.

1.3 LEGISLATIVE REQUIREMENT

The eradication of alien species by whatever means is not a listed activity in terms of South Africa's environmental legislation. However, under the National Environmental Management Act 107 of 1998, Section 28, duty of care should be exercised when engaging in activities that may have a detrimental effect on the environment, and the National Water Act contains legislation pertaining to the use of water that needs to be addressed. To address any concerns an EIA was however conducted for the use of rotenone in four CAPE rivers, including the Krom River.

1.4 PURPOSE OF THIS DOCUMENT

In terms of the Section 40 of the National Water Act, 1998 (Act No 36 of 1998) (NWA), every party proposing water usage, as defined in Section 21 of the Act, must also apply to the responsible authority for authorisation before such water use can commence. In terms of section 21 of the NWA, the following water use is proposed to take place as part of this application:

Table 1: Water use triggered by proposed project

Activity No.	Relevant Water Use License Activity as per section 21 of the NWA
21 (i)	Altering the bed, banks, course or characteristics of a watercourse

This document aims to provide the Department of Water Affairs (DWA) with the necessary information on all water uses associated with the proposed project.

2 PROJECT AND ENVIRONMENTAL DESCRIPTION

2.1 PROJECT LOCATION

The water use (piscicide treatment using rotenone to kill fish) is to take place in the Krom River in the Cederberg. The Krom River is a tributary of the Doring River which in forms part of the Olifants- Doorn River (ODR) catchment. The Krom River is about 45km from Clanwilliam on the secondary road between CapeNature's Algeria Resort and Matjiesrivier. Figure 1 below indicates the location of the Krom River and the proposed treatment area between the two fish barriers. The downstream limit of the treatment area is the natural fish barrier.

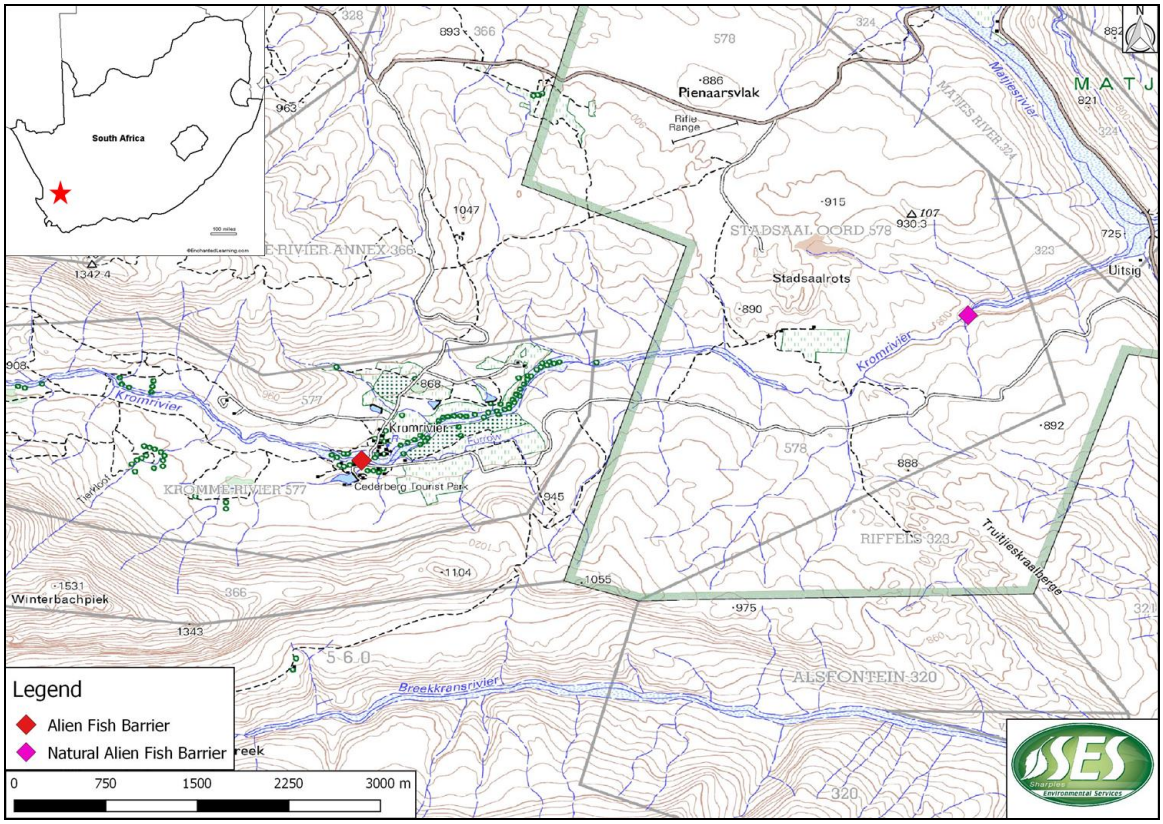

Figure 1: The location of the study area relative to the rest of the Krom River, Matjiesrivier and South Africa

2.2 BACKGROUND TO PROPOSED WATER USE

2.2.1 Alien invasive fish eradication

The invasion of alien fish species is internationally recognised as a threat to indigenous fish populations and other aquatic fauna. In South Africa, 44 species of alien invasive fish have established and 37 % of which are considered fully invasive (Weyl *et al.* 2016). The impact of these species is considered the primary threat to indigenous South African fish species. Tweddle *et al.* (2009) describe the impacts of alien fish species on indigenous species to include: increased competition, direct predation, habitat alterations, hybridisation and the transfer of parasites and diseases.

In the rivers of the Cape Floristic Region (CFR), South Africa, a decline in the number and extent of distribution of indigenous fishes has occurred. The impact of alien invasive fish species has been identified as the main reason for this devastation of indigenous populations (Impson *et al*. 2013). These environmentally damaging species were introduced for recreational angling. The majority of headwater streams in the CFR contain threatened, some critically, indigenous species. Without the impact of alien fish none of the species would have been assessed as Critically Endangered. Cederberg tributaries of the

Olifants River system in the north-western parts of the CFR provide some of the most extreme examples (Woodford *et al.* 2013). The fish of this area are especially vulnerable to threats as they have high endemism and restricted ranges (Tweddle *et al.* 2009). It is therefore recognised that these rivers are conservation management priority areas.

Eradication of invasive alien fish is a critical component of conservation plans for endangered fish species in the CFR (EFA 2009). Additionally, the management and control of alien invasive species is a legislated priority in South Africa. According to Weyl *et al.* (2016), "*eradicating alien fish allows for the rehabilitation of several kilometres of river, with very significant benefits for the endangered fish species present and for the associated aquatic biota*".

Therefore, Cape Nature initiated research and discussion between experts and management bodies to develop an invasive alien eradication strategy. As part of this proposal, Cape Nature appointed Enviro-Fish Africa (Pty) Ltd to carry out an Environmental Impact Assessment (EIA) on its behalf (EFA 2009). An eradication strategy was proposed and investigated for four river systems, one of which being the Krom River in the Cederberg.

2.2.2 Methods of eradication investigated for the Krom River

The Krom River was selected as it fit the following prerequesites:

- the presence of barriers to prevent re-invasion,
- indigenous species are critically endangered with alien fishes a major component of the threats to survival,
- alien eradication is feasible,
- ecological integrity is such that the river would provide healthy habitat for the indigenous fish if the aliens are removed,
- the river is not identified as being of major importance for angling.

Various methods and alternatives of eradication were investigated in the EIA (EFA 2009). The methods assessed in the EIA for the Krom River alien fish eradication included:

Physical eradication

Physical methods include intensive, repeated fishing using gear such as gillnets, seine nets, fyke nets, hook and line, electric fishing and, in clear water pools, spearfishing while snorkeling. However it was found that only the upper section of the Krom River presents no obstacles to the use of physical eradication methods.

Dewatering

This would involve the temporary channelisation of braided rivers to confine flow to a single channel that is more easily fished, either by physical or chemical methods. However, it is believed that this is not feasible or appropriate in the lower Krom site.

Chemical eradication

When physical methods of eradication are unlikely to remove all alien fish, the use of piscicides such as rotenone is the only means of ensuring the complete removal of alien fish from the section of river to be cleared. The disadvantage of using piscicides is that they are indiscriminate and would also eradicate any indigenous fish, while macroinvertebrates, tadpoles and zooplankton would also be adversely affected.

2.2.3 Rotenone

The piscicide rotenone is a natural toxic chemical found in the roots of many tropical plants of the Leguminosae family (Woodford *et al.* 2013). It is a poison that kills all organisms that utilize gills during part of their life cycle and is especially toxic to fish (Dalu *et al.* 2015). Rotenone is highly sensitive to light and

air, and quickly breaks down when exposed to sunlight. It has a half-life in water of 1 to 3 days and does not leach easily into the soil, thus limiting the threat to ground water. Its toxicity can be quickly neutralised by exposure to potassium permanganate (Woodford *et al*. 2013).

In South Africa, rotenone is one of the preferred methods for achieving eradication (Weyl *et al*. 2009). It has been widely used for fish sampling, alien fish eradication and museum/research collection for many years (although rarely reported in literature). However, while alien fish removal by rotenone has been demonstrated to be an effective management tool, it has been surrounded by controversy due to its known and unknown collateral effects on non-target aquatic organisms (Weyl *et al*. 2009). The piscicide is indiscriminate and will also eradicate any indigenous fish, while macroinvertebrates, tadpoles and zooplankton will also be adversely affected (EFA 2009). In documented examples of rotenone use, the severity of impacts on aquatic invertebrates varies greatly. Its use remains contentious as its effects on non-target biota are still largely unknown. For example, a 5 year study on a river in Utah (Mangum and Madrigal 1999) found that: "*up to 100% of Ephemeroptera, Plecoptera, and Trichoptera [mayflies, stoneflies and caddis flies] were missing after the second rotenone application. Forty-six percent of the taxa recovered within one year, but 21% of the taxa were still missing after five years.*" Therefore, it is a challenge to conservation practitioners as the impacts of the proposed rotenone use are difficult to predict (Dalu *et al.* 2015).

However, after taking into consideration the impacts of rotenone use, the EIA concluded that it is the most practical and best option for the eradication of the alien invasive fishes in the Krom River (See text box below). The impacts are outweighed by the likely long-term successful recolonisation of the reach by native fishes and other biota.

Appropriateness of using rotenone for alien eradication in the lower Krom River

Excerpt from the EIA (EFA 2009)

The use of a piscicide such as rotenone, is the only practical method of eradicating fish from the numerous deep pools below Kromrivier Farm, but it will be very difficult. There is extensive braiding and almost impenetrable alien vegetation between the farm and downstream weir site. The dense alien vegetation cover makes it extremely difficult to access the whole river to ensure that the rotenone is thoroughly distributed. With the braiding and dense vegetation it is possible that side pools could be overlooked. It is also possible that there are seeps into the river and side pools from wetlands that will allow fish to avoid the rotenone in the main stream. There are deep pools throughout this stretch and the flow rate in some of these pools was virtually nil at the time of the site visit in November 2007. Later in summer, the river is even slower flowing. Rotenone would be adsorbed quickly by the vegetation and in the river sediments in such habitats, thus rotenone application would have to be widespread and require a lot of manpower. The clearing of alien vegetation from the seriously infested stretch (~2 km) beforehand would greatly facilitate the rotenone application. If the rotenone application is conducted at the period of lowest river level, when the river is reduced to a series of isolated pools, application of the rotenone to the individual pools would be effective and the rotenone could be allowed to degrade naturally before the stream flow resumes.

The use of rotenone appears therefore to be the only effective and appropriate method that could be used to eradicate alien fish in the lower Krom River section proposed for treatment.

2.2.4 A case study of the Rondegat River project

The alien fish eradication proposal, initiated by Cape Nature, identified four river sections appropriate for the proposed use of rotenone for river rehabilitation (EFA 2009). A 4 km stretch of the Rondegat River was selected, along with a section of the Krom River and two others, as a pilot project. The Rondegat River is a small, perennial tributary of the Olifants River, located approximately 45km away from the Krom River, in the Cederberg.

The short section of river selected for treatment was severely impacted by alien fish and vegetation infestation. Research on the system suggested that the alien eradication project could significantly improve the natural habitat. Therefore, in February 2012 and March 2013 a section of river, between the barriers in the form of a waterfall and weir, was treated using rotenone (Weyl *et al.* 2016; Dalu *et al.* 2015; Impson *et al.* 2013; Woodford *et al.* 2013). This project was the first example of direct intervention by conservation authorities to eradicate alien invasive fishes and rehabilitate the threatened indigenous fish species.

The project involved extensive scientific research, discussion with experts, and monitoring at every stage so that the long-term effect of the rotenone on the river could be better understood. After the two treatments of rotenone the project was declared a success as the complete absence of alien fishes was confirmed. Comprehensive follow-up surveys and research indicated that indigenous fishes has successfully colonised the formerly invaded site (Weyl *et al.* 2016). It was also found that the aquatic invertebrate community (biomass and diversity) also recovered rapidly after treatment (Impson *et al.* 2013). Additionally, according to Weyl *et al.* (2016) "*ecosystem health as estimated by the SASS5 scoring system was not significantly altered by the rotenone treatment and densities of EPT taxa recovered to pre-treatment levels within one year following treatment*".

Therefore, this pilot project has been deemed by many as a success story, attributed to comprehensive planning, good execution, and long-term monitoring. Apart from the seemly successful results of active management, the knowledge generated and research outputs from this project are significant in themselves. The Krom River has many similarities to the Rondegat River, and although the EIA states that there will be a higher level of difficulty associated with the Krom River project, the research from the Rondegat River has provided the best available platform for successful implementation.

2.3 ACTIVITY DESCRIPTION

The project aims to create additional habitat for threatened indigenous fish species by eradicating alien invasive fish species from a stretch of the Krom River that formerly supported populations of the indigenous species. The river is not an important angling river. Extensive discussions with experts, together with current and existing research, showed that intervention is urgently needed to protect threatened indigenous fishes in the river (EFA 2009). The use of rotenone appears to be the only effective and appropriate method that could be used to eradicate alien fish in the river section proposed for treatment.

Therefore, Cape Nature is proposing to use rotenone to eradicate alien fish species from a 6.3 km reach of the Krom River (in the Cederberg) as a conservation intervention. An alien fish barrier has already been constructed on the Krom River farm to prevent the further upstream migration of alien invasive fish in the river. Cape Nature is planning to eradicate alien fish downstream of this barrier with a piscicide (CFT Legumine) containing rotenone as the active ingredient. The downstream limit of the treatment area is a natural alien fish barrier.

2.4 WATER USE DESCRIPTION

This section of the document is to be read in conjunction with Appendix A to this report.

2.4.1 Section 21 (i): Altering the bed, bank, course or characteristics of a watercourse

Cape Nature is applying in terms of Chapter 4 of the National Water Act, (Act No 36 of 1998), for a Section 21 (i) water use authorisation for the use of rotenone treatment to eradicate alien invasive fishes in a section of the Krom River as this activity will alter the characteristics of the watercourse (Table 2).

Table 2: Risk of water use impacting habitat, biota, water quality, and flow regime

Water Resource	Water Resource Type	Characteristic Potentially Impacted *(Yes/No =Y/N)*				Risk Rating (Before mitigation)
		Habitat	Biota	Water Quality	Flow Regime	
Krom River	Perennial River	**N**	**Y**	**Y**	**N**	**Medium- High**
Justification ((Impacts on Flow (surface and ground water), Water quality, Biota and/or Habitat))						
The treatment of Rotenone will not affect the flow regime or geomorphology of the river. It is also unlikely to impact significantly upon physical habitat. However, It will temporarily affect water quality. The main risk associated with the piscicde use is the high impact it will have on indigenous fishes and biota. The impact will be severe, but infrequent, of very short duration and controlled. The implementation of the mitigation measures detailed in the EIA and the details of the method statements are highly likely to lower this risk rating. The activity will have a positive impact if successful.						

2.5 BIO-PHYSICAL AND SOCIAL ENVIRONMENT

2.5.1 Bio-physical

The water use will take place in the Krom River, Cederberg. The Krom River begins in the Cederberg mountains at an maximum altitude of 1723 m and has a catchment size of 49.6 km^2. The DWS quaternary catchment E21K catchment has a mean annual precipitation of 348 mm with an annual potential evaporation rate more than double that amount (2108.7 mm). The most rain falls during winter between May and September (Mucina and Rutherford, 2006).

The Krom River stretches all the way to the Driehoeks River which it joins at an altitude of 725 m from where it becomes known as the Matjies River. A large pool, known as Disa Pool is a prominent landmark in the upper river and below this pool the river flows through a narrow valley dominated by bedrock steps, pools and chutes. Lower down, the valley opens with the river becoming braided with a low gradient and sandy bottomed pools and runs. The lower reaches are located in the Matjies River Provincial Nature Reserve while most of the upper reaches are located in the Krom River Contract Nature Reserve.

2.5.2 Geology

The geology of the Cederberg comprises of the Cape Supergroup (Table Mountain Group, Bokkeveld Group and Witteberg Group) and the Karoo Supergroup (Dwyka Group, Ecca Group and Beaufort Group). The Cape Supergroup was formed about 700 – 600 Ma ago by a succession of sedimentation of sandstone (silt, mud and sand). The distinct reddish colour of rock is a result of minerals like iron and manganese that formed part of the sediments.

2.5.3 Vegetation and conservation context

Mucina and Rutherford (2006) delineated vegetation units throughout Southern Africa. According to this data, the majority of the study site is located in Cederberg Sandstone Fynbos and linear strips of Northern Inland Shale Band Vegetation (Mucina & Rutherford 2006).

The 2006 South African Vegetation Map has been updated and now provides floristically based vegetation units at a greater level of detail than was previously available. Thus, in an effort to utilize best available science and to generate figures which more accurately reflect the current degree of habitat loss, provincial ecosystem status statistics have been produced. The Western Cape Biodiversity Framework (WCBF) is a spatial biodiversity plan recognized by both the Department of Environmental Affairs and South African National Biodiversity Institute. It identifies areas crucial for conserving a representative sample of biodiversity and maintaining ecosystem functioning.

According to the WCBF (Pence 2014), the vegetation of the project study area is classified as vulnerable. A small part of the catchment is a terrestrial Critical Biodiversity Areas (CBAs) for Red Data List Species and an upper portion of the Krom is considered an Ecological Support Area (ESA) buffer. Critical Biodiversity Areas are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan. Ecological Support Areas are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. The majority of the treatment area is located in within a formal provincial reserve.

The National Aquatic Ecosystem Priority Areas (NFEPA) map provides strategic spatial priorities for conserving South Africa's aquatic ecosystems and supporting sustainable use of water resources. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al.* 2011). The proposed treatment site is listed as being in AB condition and is classified as a FEPA river for fish rehabilitation and sanctuary.

2.5.4 Existing Catchment Impacts

The upper reaches in the narrow valley are part of a conservancy, but where the valley widens out it enters Kromrivier farm which, in addition to supporting livestock farming, provides holiday chalets and a camp site, with a small shop catering for tourism. The water storage dams on the farm, which draw water directly from the Krom River, are stocked with bass and provide angling for tourists. The Krom is visited by a small number of trout fly fishermen. Downstream of the farm the river flows for 4 km through the CapeNature Matjiesrivier Nature Reserve to the Matjies River. The main existing impacts to the Krom River are water abstraction, changes in water quality, alien invasive fish, and alien invasive vegetation encroachment (Figure 2).

The section of river at Kromrivier farm

Invasive alien vegetation below the farm.

Figure 2: Photographs illustrating the existing study area (photographs sourced from the EIA (EFA 2009).

2.5.5 Biota

The Krom River is a perennial river that contains about 15 km of ideal habitat for indigenous fishes but is currently invaded by several alien species. At present the only indigenous fish species in the river is the rock catlet, *A. gilli*, the distribution of which extends for a few hundred metres above the Kromrivier farm (Figure 3). It is almost certain that the Krom River was formerly populated by redfins, specifically the undescribed Doring River species related to *Pseudobarbus phlegethon (*EFA 2009). The fast-flowing stretch of the Krom in the valley is invaded by rainbow trout, *Oncorhynchus mykiss,* and from the farm downstream the river is also invaded by bluegill sunfish and largemouth black bass (EFA 2009). The aquatic invertebrate community diversity and abundance in this section of the river is low due to existing impacts.

The only indigenous fish species in the river is the rock catlet, A. gilli.

The Pseudobarbus phlegethon, similar to the indigenous species of redfin thought to historically populate the Krom River.

Figure 3: Photographs of the Kat River at the proposed crossing

2.5.6 Socio-economic

The landowners of the area are increasingly concentrating on eco-tourism and support the proposed project. The Kromrivier Farm, at the upper limit of the proposed treatment zone, will likely benefit from the project as it will enhance the ecotourism potential and conservation value of the farm and catchment. However, the majority of this section of river is located within formally protected conservation area and will not significantly affect any inhabitants of the area. Riparian land-owners on the Krom are interested to see indigenous yellowfishes re-established in their rivers and dams. In addition, the National Yellowfish Working Group supports projects that better conserve indigenous yellowfishes.

The river is occasionally used by anglers but this has been found to be of very minor significance in the area. One of the criteria used in the selection of the river for the project was that it is of limited interest to anglers. Additionally, the Cape Piscatorial Society is collaborating with CapeNature in the zoning of trout waters and the Krom River is not included in the zone where trout will be permitted. Some angling bodies have however opposed the project as they believe that it will lead to further eradication programmes that will negatively affect their fishing activities. In response, CapeNature has assured the public that the eradication of trout in the river is not the first step in the elimination of trout throughout South Africa. The proposed eradication will therefore have an insignificant impact on water users of the Krom River and negligible negative socio-economic impacts are anticipated.

3 METHOD STATEMENT

The method of using rotenone for alien fish eradication in the Krom River will be based on the methods used in the Rondegat River. The Rondegat River was the pilot river for the first river application of a piscicide containing rotenone in the CFR. The extensive research and monitoring of the treatment on the Rondegat River, and the apparent success of this project, has resulted in a suitable approach for eradication in the Krom River. Therefore, please refer to Appendix E for the Rondegat River method statements. Within these documents it is stated that an excellent recovery of threatened fish species and associated biota can be expected.

As per the Rondegat Method Statements in Appendix E, a piscicide, CFT Legumine, manufactured by Prentiss, which contains 5% rotenone and is approved for use in the USA, has been selected for treatment. Approval for the experimental use of this piscicide by CapeNature in The Rondegat River was granted by the Registrar of the Department of Agriculture, Forestry and Fisheries in 2011. Rotenone will likely be used at a concentration of 75 to 150 µg/L (1.5 to 3.0 ppm rotenone formulation).

Initially, an attempt will be made to capture and adult and sub-adult yellowfish from any pools via setting fyke nets overnight and the use of seine nets. The river channel will be trimmed during the week before the treatment. Over-hanging vegetation will be cut so that areas with water are easily visible. All backwaters, nearby springs, side channels, furrows and barriers should be identified and mapped to effect a successful treatment to prevent re-invasion. These areas will be identified with red flags. All permanent waters at the time of the treatment will be sprayed using backpack sprayers, and when these difficult areas have been treated, the red flags will be replaced with blue flags.

The flow rate will need to be determined to obtain the recommended rotenone concentration to be used (the minimum desired concentration of 2ppm rotenone product). The exact spacing of the drip stations will then be verified using a non-toxic Rhodamine dye prior to treatment. This would allow for a minimum of four complete volume turnovers in the 8 hour treatment. Several treatment stations will likely be required. At the end of the treatment reach, a deactivation station will dispense Potassium Permanganate to neutralise the rotenone. Dead fish will be given to scientists that are part of the monitoring team. About 1m above each treatment station, sentinel fish (bass) will be placed in cages (plastic keepnets) to determine whether dosages have been sufficient to achieve a complete kill. Fish will be inspected after each treatment.

February to March is the recommended period for treatment, as the river then is low and warm and the weather is usually settled with little or no rain. Two treatments are likely to be necessary to maximise the likelihood of a successful treatment. A third treatment may be undertaken a year later if alien bass are still found in the treatment area. Biological monitoring will take place during and after treatment.

The equipment is required is detailed within the Rondegat method statements in Appendix E. It includes drip cans, sprayers, associated tools, safety gear and live cage monitoring equipment.

4 RISK ASSESSMENT

IMPACTS (refer to Table 2 and 3 below)
PREPARATION PHASE IMPACTS
Clearance of alien vegetation In preparation of the treatment it will be necessary to clear alien vegetation. This is due to the rehabilitation objective to restore natural aquatic habitat, not only for the fishes but also for all other components of the flora and fauna. Also, it will allow access to the river to ensure that the piscicide reaches all parts of the stream to ensure that pockets of alien fishes do not survive in isolated pools or backwaters. This is likely to be a high, positive impact.
OPERATIONAL PHASE IMPACTS
Impact on indigenous fishes The only indigenous fish in the Krom River is the rock catfish, *Austroglanis gilli*, that are known to be in the stretch above Kromrivier Farm. The treatment zone for this project is largely below the farm where there may be some indigenous species remaining (likely the Clanwilliam rock catfish) but they will be targeted in the native fish rescue in the weeks before the treatment. The project will therefore have a low impact on indigenous fishes in this phase.
Impact on aquatic invertebrates The level of impact on invertebrates of the piscicide application is dependent on the concentration of piscicide reached in the system. Invertebrates are typically an order of magnitude less susceptible than fish to rotenone. Without mitigation, the impact on invertebrates will be high, with mitigation this becomes moderate.
Impacts on vertebrates The project will not have any measurable impact upon birds, terrestrial vertebrates or flora. However, amphibian tadpoles are susceptible to rotenone and will be slightly impacted by the treatment. The impact of treatment on these without mitigation is only regarded as low. The area is fairly remote and human will be advised not to drink the treated water. Therefore, it is highly unlikely and a very low significance that they will be impacted in any way.
Impact on recreational angling The trout in the Krom River are occasionally targeted by light tackle flyfishing specialists, while holiday makers occasionally fish the farm dams for bass. Discussions between CapeNature and the Cape Piscatorial Society have resulted in the Krom being omitted from the list of recognised trout waters. The loss of the Krom trout is rated as low. Replacement of the trout and bass by indigenous fishes for anglers will mitigate for the loss of the resource, reducing the impact rating to very low.
POST OPERATIONAL PHASE
Impact on indigenous fishes The treatment will result in expanded habitat and decreased threats for the indigenous fish populations. A restocking programme using the offspring of redfins should be considered to raise the significance level to high.
Impact on aquatic invertebrates It is likely that, if mitigation measures are implemented, invertebrate populations in the stream will recover fully. Therefore, in the long-term, there will be a high positive significance. Combined with removal of alien vegetation the invertebrate fauna will benefit through the restoration of the natural habitat and fish species balance.
Impacts on vertebrates The long-term impact of river rehabilitation on many species will be positive and indirect through proposed improvements in catchment management and integrity.

Eco-tourism and research

There is a strong environmental focus in the Krom River catchment. The upper reaches of the Krom River catchment, there is the Cederberg Wilderness Area, a contract nature reserve, and the Kromrivier farm (that has tourism activities). Kromrivier farm was previously used for tourism (camping sites and chalets) and low intensity farming (deciduous fruit, livestock –goats), but the focus now is on ecotourism using the spectacular natural resources. The middle and lower reaches of the Krom catchment are in the Matjiesriver Nature Reserve. Therefore, the implementation of direct conservation actions and potential ecological improvement will benefit the eco-tourism of the area.

The implementation and monitoring of the proposed treatment, as in the Rondegat River case study, will likely supplement future scientific research and learning, as well as informing conservation management strategies. The research generated will have the potential to improve current understanding on the subject and better guide future conservation decisions.

Table 3: The significance of the impacts of the proposed project

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility
Preparation Phase	**Clearance of alien vegetation** POSITIVE	Without Mitigation	-	-	-	-	NIL	-
		With Mitigation	Local (2)	Permanent (5)	Moderate (6)	Definite (5)	**+ High (65)**	Partly
Operational Phase	**Impact on indigenous fishes**	Without Mitigation	Local (2)	Short (2)	Minor (2)	Probable (3)	**Low (18)**	Irreversible
		With Mitigation	Site Specific (1)	Very Short (1)	Small (0)	Improbable (2)	**Very Low (4)**	Partly
	Impact on aquatic invertebrates	Without Mitigation	Local (2)	Permanent (5)	Moderate (6)	Definite (5)	**High (65)**	Irreversible
		With Mitigation	Site Specific (1)	Medium (3)	Moderate (6)	Highly Probable (4)	**Moderate (40)**	Barely
	Impacts on vertebrates	Without Mitigation	Local (2)	Short (2)	Minor (2)	Probable (3)	**Low (18)**	Irreversible
		With Mitigation	Site Specific (1)	Very Short (1)	Small (0)	Improbable (2)	**Very Low (4)**	Partly
	Impact on recreational angling	Without Mitigation	Local (2)	Medium (3)	Minor (2)	Highly Probable(4)	**Low (28)**	Reversible
		With Mitigation	Site Specific (1)	Very short (1)	Minor (2)	Improbable (2)	**Very Low (8)**	Partly
Post Operational Phase	**Impact on indigenous fishes** POSITIVE	Without Mitigation	Site Specific (1)	Permanent (5)	Moderate (6)	Probable (3)	**+ Moderate (36)**	Partly
		With Mitigation	Local (2)	Permanent (5)	Very High (10)	Highly Probable (4)	**+ High (68)**	Barely
	Impact on aquatic invertebrates POSITIVE	Without Mitigation	Local (2)	Permanent (5)	High (8)	Highly Probable (4)	**+ High (60)**	Partly

	Impact	Mitigation	Extent	Duration	Magnitude	Probability	Significance	Reversibility
		With Mitigation	Regional (3)	Permanent (5)	Very High (10)	Highly Probable (4)	**+ Very High (72)**	Barely
	Impacts on vertebrates POSITIVE	Without Mitigation	Site Specific (1)	Permanent (5)	Small (0)	Probable (3)	**+ Low (18)**	Partly
		With Mitigation	Local (2)	Permanent (5)	Minor (2)	Probable (3)	**+ Low (27)**	Barely
	Eco-tourism and research POSITIVE	Without Mitigation	--	-	-	-	**-**	-
		With Mitigation	International (5)	Permanent (5)	Moderate (6)	Probable (3)	**+ Moderate (48)**	Barely

The negative impacts are outweighed by the likely long-term successful recolonisation of the reach by native fishes and other biota. Therefore, the use of rotenone is at present the most practical and best option for the eradication of the alien invasive fishes in the Krom River.

Table 4: Risk Assessment methodology

METHODS FOR IMPACT SIGNIFICANCE WEIGHTINGS

Direct, indirect and cumulative impacts should be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it will be indicated whether:
    - The lifetime of the impact will be of a very short duration (0-1 years) – assigned a score of 1.
    - The lifetime of the impact will be of short duration (2-5 years) – assigned a score of 2;
    - Medium term (5-15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.
- The **magnitude**, quantified on a scale of 0-10, where:
    - 0 is small and will have no effect on the environment,
    - 2 is minor and will not result in an impact on processes,
    - 4 is low and will cause a slight impact on processes,
    - 6 is moderate and will result in processes continuing but in a modified way,
    - 8 is high (processes are altered to the extent that they temporarily cease), and
    - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5, where:
    - 1 is very improbable (probably will not happen),
    - 2 is improbable (some possibility, but low likelihood),
    - 3 is probable (distinct possibility),
    - 4 is highly likely (most likely) and;
    - 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high;
- The degree to which the impact can be reversed.
- The significance is calculated by combining the criteria in the following formula, **S = (E+D+M) P**, where:
    - S = significance weighting
    - E = extent
    - D = duration
    - M = magnitude
    - P = probability
- The significance weightings for each potential impact are as follows:
    - <30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop the area),
    - 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
    - >60 points: High (i.e. where the impact must have an influence on the decision).

5 CONSIDERATION ITO SECTION 27 OF THE NWA (1998)

The consideration of factors in Section 27 of the National Water Act, 1998 is necessary to assess all license applications for water use. These involve factors such as the National Water Resource Strategy, Catchment Management Strategies, the Reserve, existing lawful water use, the need to redress the results of past racial and gender discrimination, the socio-economic impact, the strategic importance of the use and others. The most important factor, the public interest, is essentially a synthesis of the other considerations (Perkins 1998). The sub sections below discuss these considerations in terms of water use for the proposed project:

5.1 SECTION 27 (1) (A): EXISTING LAWFUL WATER USES

Existing lawful water use is dealt with in this sub paragraph of section 27(1) and in sub paragraph (f), which refers to "the likely effect the water use to be authorised on the resource and on the other water users". The reasoning for this consideration is that it is necessary to know the amount of water currently being used in the catchment and by water users and the applicant. The result is the ability to determine the amount of remaining available water and therefore the amount available for allocation.

The land-owner has informed CapeNature that water use on the property has been registered and the customer number for water billing is 22013198. The farm dam is very small and is used for recreation.

The proposed project, in the context of this sub section, will not have an effect on water users or the amount of available water in the catchment. There will be short term changes to the characteristics of the watercourse, but, there will not be any stream flow reduction activities.

5.2 SECTION 27 (1) (B): THE NEED TO REDRESS THE RESULT OF PAST RACIAL AND GENDER DISCRIMINATION

The allocation of water in the past, under the old act, discriminated against people from former homelands. In order to rectify past imbalances it is necessary to consider the needs of all stakeholders in the catchment to ensure equity of allocation policy. According to Perkins (1998) "*the human reserve must be met first, followed by the ecological reserve. Thereafter, other demands should be addressed in an equitable manner, with a view to addressing past imbalances*". Therefore, it is necessary to accommodate previously disadvantaged users and promote projects which actively reverse race and gender discrimination and empower and uplift historically disadvantaged individuals.

The allocation of this water use does not discriminate against any stakeholders. Therefore, the proposed project is in alignment with such objectives.

5.3 SECTION 27 (1) (C): EFFICIENT AND BENEFICIAL USE OF WATER IN THE PUBLIC INTEREST

Water needs to be allocated equitably and used beneficially for the public interest, while protecting the environment. As public trustee of the nation's water resources, the National Government, acting through the Minister, is ultimately responsible for this. Section 152 and 153 of the constitution of the Republic of South Africa and The National Spatial Development Perspective (2003) puts forward the objective that local government has an obligation to provide sustainable basic services to all citizens wherever they reside and to give priority to such basic needs of communities. The proposed project is predicted to significantly improve the integrity of the ecosystem and our current knowledge of the subject. It is not infringing on any other water uses and therefore is in the public interest.

5.4 SECTION 27 (1) (D): THE SOCIO ECONOMIC IMPACT OF THE WATER USE

This sub section of the water use application considers the socio-economic impact of water use to be authorised or failure to authorise the water use. It is important to compare the two impacts in order to balance the benefits of allocating the licence with the advantages.

<u>The positive aspects of the proposed project are:</u>

- The successful eradication of alien invasive fish species in the treated section of river.
- The re-colonisation of the reach by indigenous fish and other biota.
- A long-term improvement in river health and increased habitat due river rehabilitation
- Knowledge generation for future research and conservation management.
- Increased/sustained eco-tourism in the area.

No-Go Alternative:
Intervention is urgently needed and the No-Go option would result in almost certain extinction for some species and continued vulnerability of others. The impact would be significant and negative in nature. It is therefore not an option.

Negative Impacts associated with refusing the license:

- By NOT authorizing this water use the some indigenous fish species will become extinct due to alien invasive fish species.
- No knowledge for future interventions will be generated
- The current land users will struggle to advertise their farms as "eco-tourism" areas.
- The encroachment of other alien species will add to the decline in ecosystem integrity

"It is unfortunately true that virtually no allocations can be made without impact on someone, somewhere in the catchment downstream. The philosophy of dealing with this dilemma should therefore be to maximise the advantages to the greatest number of people and to minimise the negative impacts" (Perkins 1998).

5.5 SECTION 27 (1) (F): THE LIKELY EFFECT OF THE WATER USE TO BE AUTHORISED ON THE WATER RESOURCE AND ON OTHER WATER USERS

It is necessary to consider the impact of the water use on the quantity and quality of the water resource being assessed. Again, this must be understood in the context of the equitable treatment of existing and potential water users in the catchment.

The proposed project will not be abstracting water or discharging effluent into the river. The Krom River in the Western Cape is occasionally visited by a small number of trout anglers but the fish are very small and effort is minimal. The Cape Piscatorial Society is collaborating with CapeNature in the zoning of trout waters and the Krom River is not included in the zone where trout will be permitted. The Kromrivier dams are fished by holiday makers. In all cases on farm dams, the farmers are agreeable to the replacement of bass by indigenous species. The proposed removals will therefore have an insignificant impact on users of the fish resources.

5.6 SECTION 27 (1) (H): INVESTMENTS ALREADY MADE AND TO BE MADE BY THE WATER USER IN RESPECT OF THE WATER USE

CapeNature initiated the research into the proposed project over a decade ago. An environmental impact assessment (EIA) was carried out in 2009 to address public concerns and satisfy the requirements of national legislation. The EIA concluded that the project is justified and that the choice of rotenone is appropriate. Thereafter, various bodies and researchers came aboard with funding and expertise. Over the years, time and substantial amounts of money have gone into the proposed project, thus, an enormous investments have already been made.

Additionally, the land-owners, at significant expense, have supported and financially contributed towards the rehabilitation project. They have also erected fish screens in the inflow canal to prevent fish from the river entering the "chalet dam" once the alien fish have been eradicated. The land-owner is also establishing awareness and communication opportunities for fish conservation (public aquarium, awareness boards) at the tourist facilities there.

5.7 SECTION 27 (1) (I): THE STRATEGIC IMPORTANCE OF THE WATER USE TO BE AUTHORISED

The strategic importance envisaged under section 27(1)(i), is more the regional significance of the application under consideration and should be used to prioritise the application and rank its importance when compared with other applications being considered.

The strategic importance associated with this water use is the conservation of an extremely ecologically vulnerable river, an ecosystem of national importance, for the future. In the rivers of the Cape Floristic Region (CFR) a decline in the number and extent of distribution of indigenous fishes has occurred. The impact of alien invasive fish species has been identified as the main reason for this devastation of indigenous populations. The majority of headwater streams in the CFR contain threatened, some critically, indigenous species. Without the impact of alien fishes none of the species would have been assessed as Critically Endangered. It is therefore recognised that these rivers are conservation management priority areas.

Eradication of invasive alien fishes is a critical component of conservation plans for endangered fish species in the CFR. The management and control of alien invasive species is a legislated priority in South Africa. Eradicating alien fish allows for the rehabilitation of several kilometres of river, with very significant benefits for the endangered fish species present and for the associated aquatic biota.

CapeNature and other relevant bodies have invested heavily in this project and done detailed investigations into its potential success. The project will undoubtedly have regional significance and is strategically important.

5.8 SECTION 27 (1) (J): THE QUALITY OF THE WATER IN THE WATER RESOURCE WHICH MAY BE REQUIRED FOR THE RESERVE AND FOR MEETING INTERNATIONAL OBLIGATIONS

It is assumed that this section is to be addressed by the Breede Gouritz Catchment Management Agency (CMA) during the review of the Water Use Authorisation Application.

5.9 SECTION 27 (1) (K): THE PROBABLE DURATION OF ANY UNDERTAKING FOR WHICH A WATER USE IS TO BE AUTHORISED

The treatment within the watercourse will be temporary and should be completed with 1-4 days. There may be need for another treatment in the future though, as in the Rondegat River case study.

6 CONCLUSION

It is submitted that the information contained in this report meets all of the requirements as necessitated by the Competent Authority to review the application and is sufficient to enable informed decision-making. It is the opinion of the author that the negative impacts are outweighed by the likely long-term successful re-colonisation of the reach by native fishes and other biota. Therefore, the use of rotenone is at present the most practical and best option for the eradication of the alien invasive fishes in the Krom River.

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