BASELINE AQUATIC ASSESSMENT ASSOCIATED WITH 5 CSP FACILITIES

Northern Cape

April 2016

REFERENCE

Karoshoek AQ

VERSION

Final

Prepared for:

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Report name	**Baseline Assessment Associated With 5 CSP Facilities**	
Reference code	**Ilanga CSP**	
Submitted to	**Savannah Environmental**	
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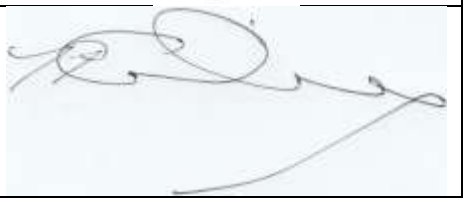
Report reviewer	**Peter Kimberg**	

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EXECUTIVE SUMMARY

The Biodiversity Company was appointed by Savannah Environmental (Pty) Ltd. to conduct an aquatic assessment as part of the Environmental Impact Assessment process for 5 proposed Concentrated Solar Plants (CSP) in the Northern Cape Province.

The proposed solar development is situated to the south of the Orange River with a proposed abstraction point that is situated on the Orange River approximately 25 km upstream of Upington. The banks of the Orange River adjacent to the proposed abstraction point are utilised for irrigated agricultural activities with fruits such as grapes being the main crop grown due to the fertile floodplain soils. The activities in the area and local land uses have had impacts on the aquatic system and visible disturbances were moderate. Due to these activities the system is regarded as largely modified at a desktop level.

The following conclusions were reached based on this assessment:

- The Orange Sub-Quaternary Reach (SQR) is listed as a Fish Support Area Freshwater Ecosystem Priority Area (FEPA) for *Barbus anoplus* (Chubbyhead barb);
- Due to its ephemeral nature the Matjies River which drains the project area was not assessed during the field survey;
- Ten (10) indigenous fish species are expected to occur in the Orange River in the vicinity of the proposed abstraction point. Of these, 4 are expected to be sensitive to the impacts associated with water abstraction due to their preference for fast flowing habitats and their moderate intolerance of no flow conditions;
- One of these fish species, *L. kimberleyensis* is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;
- Nine (9) of the 10 expected fish species were recorded during the February 2016 survey;
- Four species of conservation concern were captured during this survey. This included 2 indigenous with high sensitivity and 2 alien invasive species that threaten biotic integrity in the Orange River and need to be removed;
- Potential impacts on aquatic ecosystems are primarily associated with the abstraction of water for the Ilanga CSP facility from the Orange River. Abstraction of water may result in modification of instream habitats which may in turn result in changes to the aquatic fauna and flora communities which includes species and ecosystems of conservation importance;
- The significance of potential impacts were rated as low prior to implementation of mitigation measures;

A professional opinion is required as per the NEMA regulations with regards to the proposed development. The final summary opinion of the study area is as follows:

- Based on the fish community, biotic integrity in this section of the Orange River is in a good state with 9 of the 10 potential fish species recorded during the February 2016 survey; and
- The project has the potential to address issues regarding current power shortages in South Africa;
- Risks associated with the abstraction of water from the Orange River were rated as low prior to implementation of mitigation measures.

In light of the above mentioned, it is the professional opinion of the specialist that the project be favourably considered

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List of Abbreviations

ASPT	Average Score Per Taxon
BA	Basic Assessment
BAR	Basic Assessment Report
CBA	Critical Biodiversity Area
DD	Data Deficient
DO	Dissolved Oxygen
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Electrical conductivity
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EPT	Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies)
ES	Ecological Sensitivity
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GSM	Gravel, Sand, and Mud
HGM	Hydro-geomorphic
IHAS	Integrated Habitat Assessment System
IHIA	Intermediate Habitat Integrity Assessment
IT	Invertebrate Tolerance
LC	Least Concern
NEM:BA	National Environment Management Biodiversity Act's
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NT	Near Threatened
NWA	National Water Act
NWCS	National Wetland Classification System
PES	Present Ecological Status
RHP	River Health Project
RQI	Riparian Quality Index
SANBI	South African National Biodiversity Institute
SASS	South African Scoring System
SIC	Stones In Current
SOOC	Stones Out OF Current
SoW	Scope of Work
SQR	sub-quaternary reach
TWQR	Target Water Quality Range
VU	Vulnerable
WMA	Water Management Area
WULA	Water Use Licence

DECLARATION

I, **Dale Kindler** declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Dale Kindler

The Biodiversity Company

15 April 2016

1 INTRODUCTION

The Biodiversity Company was appointed by Savannah Environmental (Pty) Ltd. to conduct an aquatic assessment as part of the Environmental Impact Assessment (EIA) for 5 Ilanga Concentrated Solar Plant (CSP) facilities in the Northern Cape Province.

2 PURPOSE OF THE REPORT

This report, after taking into consideration the findings and recommendation provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project from an aquatic perspective.

2.1 Objectives

2.1.1 Aquatic Assessment

The aim of the assessment is to describe within the context of the immediate catchment and segment, the historic as well as the current state (Present Ecological State or PES) of the affected reach/es of the watercourses or wetlands with regards to the following characteristics (attributes):

- Instream Habitat (structure and composition); and
- Biota (fish).

2.1.2 Hydrology and Hydraulic Assessment

The objective of the assessment is to undertake a hydraulic cross-section downstream of the solar facility, to establish the hydrological linkages to the present day flow in the river and to integrate/ extrapolate the ecological water requirements (EWR) using an existing EWR site on the Orange River. This will enable the assessment of the impact of abstraction of water from the river.

3 KEY LEGISLATIVE REQUIREMENTS

3.1 National Water Act (NWA, 1998)

The DWS is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (Act No. 36 of 1998) (NWA) allows for the protection of water resources, which includes:

The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way.

- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS. Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) and (i).

3.2 National Environmental Management Act (NEMA, 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations (No R. 544 and No R. 545) as amended in December 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

4 PROJECT AREA

4.1 Study area description

The project footprint crosses 2 quaternary catchments namely D73E (majority) and D73D in the Lower Orange Water Management Area (WMA 14). The project area is situated in the Nama Karroo Ecoregion. The study area is located east of the town Upington in the Northern Cape Province, South Africa. The proposed CSP facilities are situated to the south of the Orange River with a proposed abstraction point that is situated on the Orange River approximately 25 km upstream of Upington (Figure 1). The area surrounding the abstraction point consists of residential and irrigated agricultural activities with fruits such as grapes being the main crop grown due to the fertile floodplain soils. The activities in the area and local land uses have had impacts to the aquatic system and visible disturbances were moderate. Due to these activities the system is regarded as largely modified at a desktop level.). An additional abstraction point nearer to Upington is also being considered. A site description, photographs and GPS coordinates for the sampled reaches are provided in Table 1.

The Lower Orange WMA is situated in the western extremity of South Africa, bordering on Botswana, Namibia and the Atlantic Ocean. The region has a harsh semi-desert to desert climate. Rainfall is minimal, ranging from 20 to 400 mm per annum with prolonged droughts. The Lower Orange WMA is entirely dependent on flow in the Orange River from upstream WMAs, with the exception of intermittent runoff from local tributaries and occasional inflows from the Fish River in Namibia. Important conservation areas in the WMA include the

Kgalagadi Transfrontier National Park, the Augrabies National Park, the Richtersveld National Park and a transboundary Ramsar wetland site at the Orange River mouth. The economy is driven by mining (alluvial diamonds & other mineral resources) and irrigated agriculture. Extensive irrigation occurs along the Orange River. Sheep and other livestock farming is practised where the climate is favourable. Water resources in this WMA are fully developed due to the fact that water has to travel 1,400 km from its release at Vanderkloof Dam to the most downstream point of use (StatsSA, 2010).

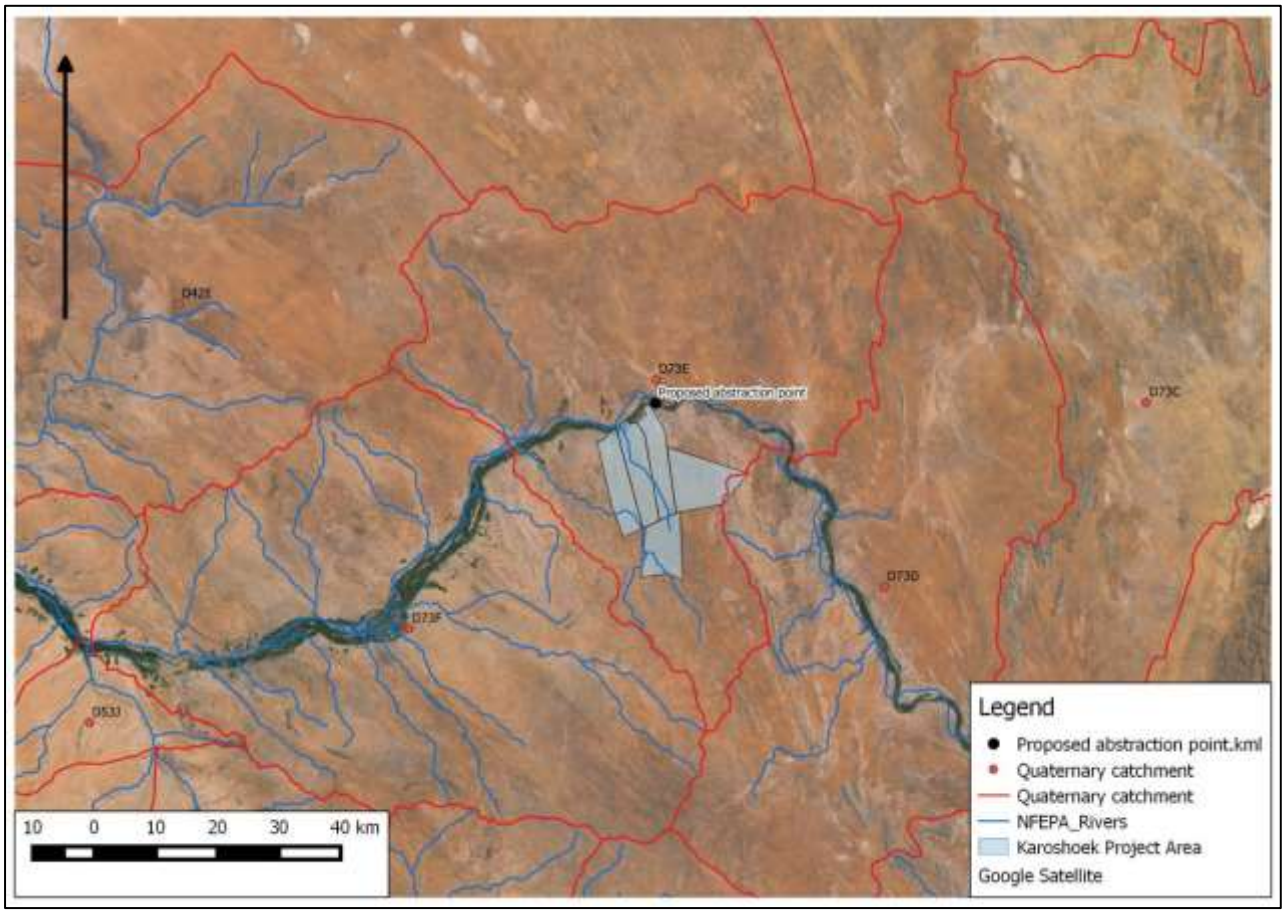

Figure 1: Locality map of the proposed project area near Upington showing the location of the proposed abstraction point on the Orange River

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

KAR1	**Upstream**	**Downstream**
		
GPS coordinates	28°27'10.13"S 21°15'36.65"E	
Site description	The KAR1 site located on the Orange River was characterised by a variety of flow and depth classes over boulders, stones, cobbles and gravel with some areas of sand and mud. Limited marginal vegetation was present. The site is the furthest most downstream point from the Solar project boundary.	
KAR2	**Upstream**	**Downstream**
		
GPS coordinates	28°25'36.99"S 21°26'5.95"E	
Site description	The KAR2 site located upstream of site KAR1 in close proximity to the Solar project boundary on the Orange River. The site was characterised by a variety of flow and depth classes over boulders, stones with areas of mud. Marginal vegetation was present at most of the site. This site was generally deeper that site KAR1.	

The main drainage line associated with the Karoshoek CSP facility is the Orange River which is situated to the north of the project area (Figure 2). A proposed water abstraction point is situated in the Orange River (Figure 2). The Matjies River, a 1st order tributary of the Orange River flows in a northerly direction down the centre of the proposed site whilst an unnamed tributary of the Orange River flows through the south western portion of the site

(Figure 2). The Donkerhoekspruit, another 1st order tributary of the Orange River, is situated to the west of the project area and is unlikely to be impacted upon by the project.

Of all these rivers only the Orange River is perennial and the smaller tributaries are likely only to flow for brief periods after rainfall events.

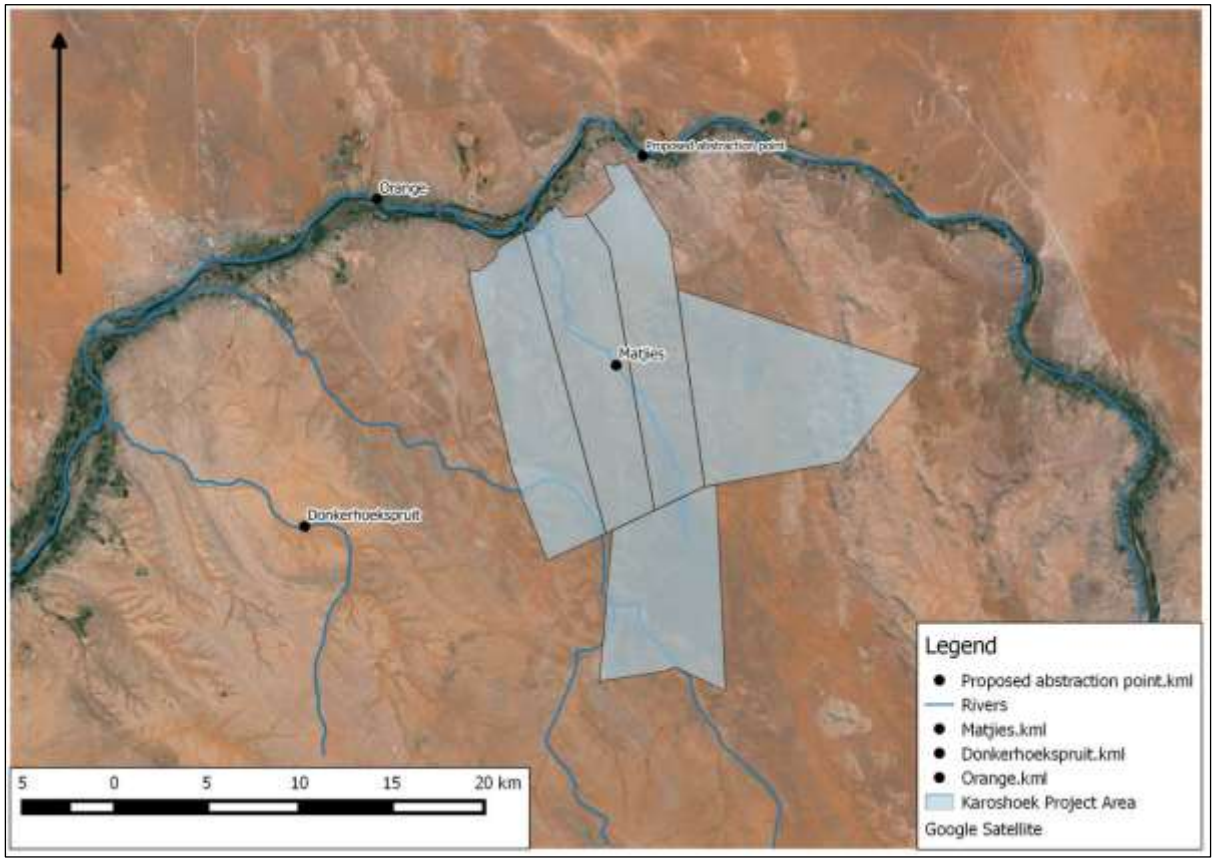

Figure 2: Map of the drainage line and rivers associated with the Karoshoek CSP project

5 LIMITATIONS

The aquatic baseline assessment was based on the results of a single wet season survey only, and information provided should be interpreted accordingly.

6 DESKTOP ASSESSMENT

6.1 National Freshwater Ecosystem Priority Area (NFEPA) Status

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies,

water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

6.1.1 NFEPA's for the two sub-quaternary catchments

The project area overlaps with 2 Sub Quaternary Reaches (SQR) namely:

- Orange SQR (D73E-2740); and
- Matjies SQR (D73E- 3043).

The Orange SQR is listed as a Fish Support Area FEPA for *Barbus anoplus* (Chubbyhead barb) (Table 2).

The Matjies SQR has 2 FEPA river ecosystem types namely Ephemeral - Nama Karoo - Lower foothill and Ephemeral - Nama Karoo - Upper foothill (Table 2).

Table 2: River NFEPA's within the Orange (D73E-2740) and Matjies (D73E- 3043) SQRs

SQR	FEPA Category	Biodiversity Feature
D73E-2740	Fish Support Area	*Barbus anoplus*
D73E-3043	River ecosystem type	Ephemeral - Nama Karoo - Lower foothill
	River ecosystem type	Ephemeral - Nama Karoo - Upper foothill

Section 6.2 and 6.3 provides further information regarding the Present Ecological Status (PES) including the Ecological Importance, Ecological Sensitivity and anthropogenic impacts within the 2 SQRs.

6.2 Present Ecological Status for the Orange Sub-quaternary reach (D73E-2740)

Present Ecological State		Ecological Importance		Ecological Sensitivity	
D (Largely Modified)		Moderate		High	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	Moderate	Fish species per sub quaternary catchment	10	Fish Physico-Chemical sensitivity description	High
Modifications to Riparian/ Wetland Zone Continuity	Serious	Invertebrate taxa per sub quaternary catchment	49	Fish No-flow sensitivity description	High
Modifications to Riparian/ Wetland Zones	Moderate	Habitat Diversity Class	Low	Invertebrate Physico-Chemical sensitivity	Very High
Potential Flow Modifications	Serious	Instream Migration Link Class	High	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	High
Anthropogenic Impacts					
Anthropogenic impacts identified within the sub-quaternary catchment included extensive irrigation from river and associated canal (agriculture), instream weirs and dams, riparian tree removal, eutrophication and extensive farming and irrigation of floodplain.					

6.3 Present Ecological Status for the Matjies Sub-quaternary reach (D73E- 3043)

Present Ecological State		Ecological Importance		Ecological Sensitivity	
Not Assessed		**Low**		**Not Assessed**	
Variable	**Status**	**Variable**	**Status**	**Variable**	**Status**
Modifications to Instream Habitat Continuity	None	Fish species per sub quaternary catchment	0	Fish Physico-Chemical sensitivity description	-
Modifications to Riparian/ Wetland Zone Continuity	None	Invertebrate taxa per sub quaternary catchment	0	Fish No-flow sensitivity description	-
Modifications to Riparian/ Wetland Zones	None	Habitat Diversity Class	Low	Invertebrate Physico-Chemical sensitivity	-
Potential Flow Modifications	None	Instream Migration Link Class	-	Invertebrate velocity sensitivity	-
Potential Physico-Chemical Modifications	None	Riparian-Wetland Zone Migration Link	-	Stream size sensitivity to modified flow/water level changes description	-
		Instream Habitat Integrity Class	-	Riparian-Wetland Vegetation intolerance to water level changes description	Very Low
Anthropogenic Impacts					
Not assessed – Ephemeral (Lack of surface water)					

7 METHODOLOGY

7.1 Fish

Fish samples were collected by a variety of techniques including electrofishing, cast netting, gill netting, fyke nets, barb nets, angling and visual observations. These techniques were deployed in a variety of depth and flow classes to sample each habitat to show fish species preferences for each.

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).

7.1.1 Expected Fish Species

An expected fish species list for the Orange SQR D73E-2740 was obtained from the following sources: Skelton (2001) and DWS (2013). Based on this, 10 indigenous fish species are expected to occur in the vicinity of the proposed extraction point (Table 3).

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 drivers of species diversity. Therefore, Table 3 should be viewed as a list of potential species rather than an expected species list.

Table 3: Expected species list for the Orange SQR

Scientific name	Common name	IUCN Status (IUCN, 2015)	Habitat preference (Skelton, 2001)
Austroglanis sclateri	Rock catfish	LC	Prefers rocky habitat in mainstream areas of major rivers. Omnivorous, feeding on invertebrates especially from rock surfaces with larger specimens also feeding on small fish (Skelton 2001)

Barbus anoplus	Chubbyhead barb	LC	Prefers cooler waters, occurring in a wide variety of habitats from small streams to large rivers and lakes. Omnivorous, feeding on insects, zooplankton, seeds, green algae and diatoms. Preyed on by larger fish and birds
Barbus paludinosus	Straightfin Barb	LC	It occupies a wide range of habitats, including large rivers, both vegetated and rocky, lagoons both connected to and isolated from main river channels, and small and large streams
Barbus trimaculatus	Three spotted barb	LC	Commonly occurs in a wide variety of habitats, especially where there is vegetation. It occurs in main channels of large rivers, it penetrates high into some tributary systems and may also be present in isolated floodplain pools. It feeds on insects and other small organisms, and seeds of plants
Clarias gariepinus	Sharptooth Catfish	LC	Widespread and abundant and occurs in a wide variety of habitats. Omnivorous
Labeo capensis	Orange River mudfish	LC	Prefers running water of large rivers, but also occurs in large impoundments.
Labeobarbus aeneus	Smallmouth yellowfish	LC	It prefers sandy and rocky substrates of clear and flowing water of large rivers, but also tolerates turbid rivers. Omnivorous with benthic invertebrates, bivalve molluscs.
Labeobarbus kimberleyensis	Largemouth yellowfish	NT	Favours deeper pools (deeper than 2 m) with an abundance of cover in the form of reefs, weed beds and over hanging vegetation. Primarily a predator with fishes above 30 cm being almost exclusively piscivorous.
Pseudocrenilabrus philander	Southern Mouth-brooder	Unlisted	Occurs in a widely diverse habitat; it favours areas where plant cover exists along the edges of rivers, lakes or swamps and prefers shallow sheltered waters
Tilapia sparrmanii	Banded Tilapia	LC	Occurs in a widely diverse habitat; it favours areas where plant cover exists along the edges of rivers, lakes or swamps and prefers shallow sheltered waters

LC - Least Concern
EN - Endangered
NT - Near Threatened

7.1.2 Attributes of expected fish community

A breakdown of the velocity-depth preferences, flow intolerance and tolerance for modified water quality of the potential fish species is provided in Table 4.

Fifty percent (50%) of the expected fish species have a high preference for slow deep or slow shallow habitats (Table 4). Three (3) of the 10 expected fish species showed a high preference for fast flowing habitats namely *Austroglanis sclateri* (Rock catfish), *Labeobarbus aeneus* (Smallmouth yellowfish) and *Labeobarbus kimberleyensis* (Largemouth yellowfish) (Table 4). The same 3 species along with *Labeo capensis* (Orange River mudfish) are considered to be moderately intolerant of no flow (Table 4). These 4 fish species are therefore considered to be the most sensitive to impacts associated with increased abstraction.

Nine (9) of the 10 expected fish species are considered to be either moderately tolerant or tolerant of modified physico-chemical water quality parameters (Table 4). The only exception is *L. kimberleyensis* which is considered to be moderately intolerant of modified water quality (Table 4).

Table 4: Velocity Depth Preferences, Flow Intolerance and Tolerance of Modified Water Quality of the expected fish community

Scientific Names	Velocity-Depth Preferences				Flow Intolerance				Tolerance Modified Water Quality			
	Fast deep	Fast shallow	Slow deep	Slow shallow	INTOLERANT: NO-FLOW (>4)	MODERATELY INTOLERANT: NO FLOW(>3-4)	MODERATELY TOLERANT: NO FLOW (>2-3)	TOLERANT: NO FLOW (1-2)	INTOLERANT: MODIFIED WQ (>4)	MODERATELY INTOLERANT: MODIFIED WQ (>3-4)	MODERATELY TOLERANT (>2-3): MODIFIED WQ	TOLERANT: MODIFIED WQ (1-2)
Austroglanis sclateri		3.80	3.40			3.20					2.60	
Labeobarbus aeneus	3.50	4.00	3.50			3.30					2.50	
Barbus anoplus			4.10	4.30			2.30				2.60	
Labeobarbus kimberleyensis	4.30	3.80	3.70			3.80				3.60		
Barbus paludinosus			3.90	3.90			2.30					1.80
Barbus trimaculatus			3.90	3.20			2.70					1.80
Clarias gariepinus			4.30	3.40				1.70				1.00
Labeo capensis	3.30		4.20			3.50					2.80	
Pseudocrenilabrus philander				4.30				1.00				1.40
Tilapia sparrmanii				4.30				0.90				1.40

7.1.3 Presence of Species of Conservation Concern

The conservation statuses of the indigenous fish species were assessed in terms of the IUCN Red List of Threatened Species (IUCN, 2015). Based on this assessment 8 of the expected fish species are currently listed as Least Concern (LC), 1 species as Unlisted and a single species as Near Threatened (NT) (Table 3). Species that are listed as LC are

considered to be widespread and abundant with no immediate threat of extinction. A species is listed as NT when it does not currently qualify for a Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) status but is close to qualifying or is expected to qualify in the near future.

Labeobarbus kimberleyensis (Largemouth yellowfish) is currently listed as Near Threatened (NT). The major threat to *L. kimberleyensis* is decreased water quality in the Vaal River below Vaal Dam and from tributaries which receive treated effluent water. Instream dams and weirs are not a problem if suitable spawning habitat is present above the dam. River regulation and destruction of different habitat types may be contributing further to the decline of this species (IUCN, 2015).

7.2 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The details of the scoring of the various aspects is provided in Table 5 below.

Table 5: Scoring of various aspects of DWS risk-based water used authorisation approach

Severity	Rating
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Spatial scale	
Area specific	1
Whole site	2
Regional / neighbouring areas	3
National	4
Global	5
Duration	
One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
Frequency of activity	

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5
Frequency of impact	
Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5
Legal issues	
No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Detection	
Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Once the various aspects have been scored as per Table 5, the significance is calculated as follows:

- **Consequence** = Severity + Spatial Scale + Duration;
- **Likelihood** = Frequency of Activity + Frequency of Incident + Legal Issues + Detection;
- **Significance \ Risk** = Consequence x Likelihood.

Once the significance \ risk score has been calculated it is rated according to Table 6.

Table 6: Risk rating and associated management descriptions

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

8 RESULTS & DISCUSSIONS

8.1 Fish

Twelve species of fish totalling 415 individuals were collected during the survey (Table 7).

The 12 recorded species consisted of 9 of the 10 expected and 3 exotic species, of which one is indigenous to South Africa but exotic to the Orange River system. Photographs of the fish collected during the survey are presented in Table 8.

Table 7: Fish species recorded during the February 2016 survey

Scientific name	Common name	IUCN status	Site		Intolerance	
			KAR1	KAR2	No-flow	Phys-chem
Austroglanis sclateri	Rock catfish	LC	2	0	3.2	2.6
Barbus paludinosus	Straightfin Barb	LC	20	0	2.3	1.8
Barbus trimaculatus	Three spotted barb	LC	23	1	2.7	1.8
Clarias gariepinus	Sharptooth Catfish	LC	2	1	1.7	1.0
Ctenopharyngodon idella (ex)	Grass Carp	Unlisted	7	3	3.3	1.5
Cyprinus carpio (ex)	Carp	VU	6	OBS	2.1	1.1
Labeo capensis	Orange River mudfish	LC	23	74	3.5	2.8
Labeobarbus aeneus	Smallmouth yellowfish	LC	48	5	3.3	2.5
Labeobarbus kimberleyensis	Largemouth yellowfish	NT	2	0	3.8	3.6
Oreochromis mossambicus	Mozambique Tilapia	NT	110	0	0.9	1.3
Pseudocrenilabrus philander	Southern Mouth-brooder	Unlisted	30	0	1.0	1.4
Tilapia sparrmanii	Banded Tilapia	LC	31	35	0.9	1.4
Total number of individuals			**274**	**121**		
Total number of species			**12**	**7**		

LC - Least Concern
NT – Near Threatened
VU - Vulnerable
ex – Exotic
OBS - Observed

Table 8: Photographs of fish species collected during the February 2016 survey

Scientific name	Photo
Austroglanis sclateri	
Barbus paludinosus	
Barbus trimaculatus	
Clarias gariepinus	
Ctenopharyngodon idella (ex)	

Cyprinus carpio (ex)	
Labeo capensis	
Labeobarbus aeneus	
Labeobarbus kimberleyensis	
Oreochromis mossambicus (Alien to Orange River)	

Pseudocrenilabrus philander	
Tilapia sparrmanii	

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

Table 9: 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 collected during the February 2016 survey ranged from tolerant to moderately tolerant of flow and physico-chemical modifications (Table 7).

Fish were collected from a variety of flow and depth classes which included: slow to fast runs, riffles and rapids and pools with variations of boulders, stones, gravel, sand and mud as substrate. Marginal vegetation was also sampled for fish.

Oreochromis mossambicus was not on the expected fish species list but is a common indigenous cichlid species found in Southern Africa. The presence of this fish species is of concern to the other cichlid fish species present in the SQR due to competition for food and habitat. Several exotic fish species that are alien and invasive in South African waters were found in the project area during the aquatic survey. These included *Ctenopharyngodon idella*

and *Cyprinus carpio*. Both of the Cyprinid carp species are known habitat modifiers and should be removed if caught.

Based on the results of the fish survey, 1 of the 10 expected species was not found during the survey. The results from the fish assessment indicate the fish community structure in the project area is in good condition with fish of high sensitivity present. Four species of special concern were captured during this survey, 2 indigenous with high sensitivity and 2 alien invasive species that need to be removed. Although 90% of the expected fish species were recorded during the February 2016 survey it should be noted that the results are based on a single survey of relatively short duration. The Orange SQR is listed as a Fish Support Area Freshwater Ecosystem Priority Area (FEPA) for *Barbus anoplus* (Chubbyhead barb), therefore it is likely that the remaining expected fish species, *B. anoplus*, will be recorded with additional sampling effort provided suitable habitat is present.

A more in-depth assessment of the fish species habitat preferences will be provided to the client. This report serves as a basic overview of the fish survey results for the proposed CSP facilities.

8.1.1 Presence of Species of Conservation Concern

The conservation statuses of the fish species collected during the survey were assessed based on the IUCN Red List of Threatened Species (IUCN, 2015). Based on this assessment 7 of the collected fish species are currently listed as Least Concern (LC), 2 species as unlisted, 1 as Vulnerable (VU) and 2 species as Near Threatened (NT) (Table 7).

Ctenopharyngodon idella is currently unlisted and has not been assessed (IUCN, 2015). This is an exotic species in South African waters and is a known habitat modifier. *Ctenopharyngodon idella* was originally stocked as a form of weed control in farm dams due to its exclusive and ravenous vegetarian diet. This species has escaped from the stocked farm dams and is now found throughout the Orange-Vaal River system posing risk to aquatic and marginal vegetation habitats that are used as cover and breeding grounds by many indigenous fish species. This species should be eradicated if caught.

Cyprinus carpio (Carp) is currently listed as Vulnerable (VU) in its native range but is considered to be a problem species in South African waters. *Cyprinus carpio* is known to be a habitat modifier through its feeding methods that involve stirring up the sediment in search of plant roots and other sources of protein, often increasing the turbidity of the water body (IUCN, 2015).

Oreochromis mossambicus (Mozambique tilapia) is currently listed as Near Threatened (NT). The most serious threat facing *O. mossambicus* is hybridization with the rapidly spreading introduced species *Oreochromis niloticus* (Nile tilapia) (IUCN, 2015). Hybridization has already been documented throughout the northern part of the species' range, with most of the evidence coming from the Limpopo River catchment (IUCN, 2015). Given the rapid spread of *O. niloticus* it is anticipated that *O. mossambicus* will qualify as threatened under Criterion A due to rapid population decline through hybridization (IUCN, 2015). *Oreochromis*

mossambicus occurs in all but fast flowing waters and is tolerant of high salinities. It feeds on algae and invertebrates. The clearest morphological indicator of hybridization between *O. mossambicus* and *O. niloticus* is barring on the caudal fin. No traces of hybridization were recorded amongst the *O. mossambicus* recorded in the project area although DNA analysis would be needed in order to confirm this.

8.2 Risk Assessment

Based on desktop information, the project area for the 5 proposed CSP facilities is currently in a largely modified state. This is largely due to modified riparian habitats. Impacts observed in the project area included residential areas and irrigated agricultural activities such as vineyard and livestock farming taking place within the riparian area. Much of the riparian area on both banks of the Orange River has been modified for housing and agriculture purposes, removing much of the green belt corridor, both providing habitat for animals and serving as a buffer between the river and the terrestrial environment. Instream habitat impacts were few with the only visible impacts in the form of inundation of shallow habitats (riffles areas, etc.) stemming from weirs and the addition of a canal used for abstraction for agriculture. Furthermore, some exotic vegetation encroachment into the marginal and riparian zones was observed.

8.2.1 Potential impacts on river ecosystems associated with the proposed CSP facilities

The proposed water abstractions may alter flow quantities and inundation levels in the Orange River thereby impacting on habitat availability and migration corridors for fish.

Potential impacts on river ecosystems due to abstraction include the following:

- Changes in biotic communities due to changed habitat structure;
- Changes in aquatic habitats; and
- Loss of sensitive aquatic biota.

The potential impacts associated with the proposed development are listed in Table 10.

Table 10: Potential impacts on aquatic ecosystems associated with the development

Activity	Aspect	Impact
Water abstraction	Drainage and flow patterns change due to reduced water levels.	Changes in biotic communities
		Loss of aquatic habitat
		Loss of sensitive species

8.2.2 Risk Assessment Matrix

During operation average abstraction rate will be 0.012m^3/s. The base-flow of the Orange would be approx. 60m^3/s during low flows. The impact of the abstraction is therefore regarded as negligible. The abstraction rate during construction will be 0.0078 m^3/s with a similarly negligible impact expected on aquatic ecosystems.

The severity, consequences and likelihoods of the potential impacts were rated in Table 11. The assessment of significance and significance ratings is provided in Table 12.

Based on this assessment the significance ratings of all the potential impacts were rated as low prior to mitigation (Table 12).

Table 11: Assessment of Severity, Consequence and Likelihood of Potential Impacts prior to implementation of mitigation

Impact	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
Changes in biotic communities due to changed habitat structure		2	**2.0**	1	1	**4.0**	5	2	1	3	**11**	44	**L**
Changes in aquatic habitats	2		**2.0**	1	1	**4.0**	5	2	1	2	**10**	40	**L**
Loss of sensitive aquatic biota including fish species of conservation concern		2	**2.0**	1	1	**4.0**	5	2	1	3	**11**	44	**L**

Table 12: Assessment of Significance and Significance Ratings Associated with the Potential Impacts

Impact	Prior to mitigation	
	Significance	Risk Rating
Changes in biotic communities due to changed habitat structure	44	**L**
Changes in aquatic habitats	40	**L**
Loss of sensitive aquatic biota including fish species of conservation concern	44	**L**

8.2.3 Potential mitigation measures

The mitigation measures that should be considered for the proposed facilities and water abstractions are as follows:

- Structures should be put in place to reuse process water thereby reducing the requirement for continual water abstraction.

9 IMPACT STATEMENT

An impact statement is required as per the NEMA regulations with regards to the proposed development. The final summary opinion of the study area is as follows:

- Based on the fish community, biotic integrity in this section of the Orange River is in a good state with 9 of the 10 potential fish species recorded during the February 2016 survey; and
- The project has the potential to contribute positively to South Africa's growing power demands;
- Risks associated with the abstraction of water from the Orange River were rated as low prior to implementation of mitigation measures.

It is the professional opinion of the specialist that the project be favourably considered.

10 CONCLUSIONS

The following conclusions were reached based on this assessment:

- The Orange Sub-Quaternary Reach (SQR) is listed as a Fish Support Area Freshwater Ecosystem Priority Area (FEPA) for *Barbus anoplus* (Chubbyhead barb);
- Due to its ephemeral nature the Matjies River which drains the project area was not assessed during the field survey;
- Ten (10) indigenous fish species are expected to occur in the Orange River in the vicinity of the proposed abstraction point. Of these, 4 are expected to be sensitive to the impacts associated with water abstraction due to their preference for fast flowing habitats and their moderate intolerance of no flow conditions;
- One of these fish species, *L. kimberleyensis* is currently listed as Near Threatened (NT) on the IUCN Red List of Threatened Species;
- Nine (9) of the 10 expected fish species were recorded during the February 2016 survey;
- Four species of special concern were captured during this survey. This included 2 indigenous with high sensitivity and 2 alien invasive species that threaten biotic integrity in the Orange River and need to be removed;
- Potential impacts on aquatic ecosystems are primarily associated with the abstraction of water for the Ilanga CSP facility from the Orange River. Abstraction of water may result in modification of instream habitats which may in turn result in changes to the aquatic fauna and flora communities which includes species and ecosystems of conservation importance;
- The significance of potential impacts were rated as low prior to implementation of mitigation measures.

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