SCHAMBOUA TRUST

WATER USE LICENSE APPLICATION
FOR AN AGRICULTURAL DEVELOPMENT ON THE REMAINDER OF FARM 81 STYR-KRAAL UPINGTON RD

FRESH WATER REPORT

A REQUIREMENT IN TERMS OF SECTION 21 OF THE NATIONAL WATER ACT
OCTOBER 2020

Index

List of Figures

List of Tables

Abbreviations

Critical Biodiversity Area	CBA
Department of Environment, Forestry & Fisheries	DEFF
Department of Environment and Nature Conservation	DENC
Department of Water and Sanitation	DWA
Ecological Importance	EI
Ecological Sensitivity	ES
Ecological Support Area	ESA
Environmental Impact Assessment	EIA
Electronic Water Use License Application (on-line)	eWULAA
Government Notice	GN
Hectares	ha
Legal water Use	LWU
Metres Above Sea Level	masl
National Environmental Management Act (107 of 1998)	NEMA
National Freshwater Environment Priority Area	NFEPA
National Water Act (36 of 1998)	NWA
Present Ecological State	PES
South Africa National Biodiversity Institute	SANBI
Section of an Act of Parliament	S
Water Use License Application	WULA

1 Introduction

The Styerkraal Agricultural Development is located on the banks of the Lower Orange River in the Northern Cape. Across the river to the north is Namibia. This is an arid region, with agriculture entirely dependent on irrigation out of the Orange River.

The Schamboua Trust, the agency that is tasked with the development of the Farm Styerkraal, is now confronted with the legal requirement that prior to any agricultural activity, an EIA must be executed. Hence, Enviro Africa of Somerset West was appointed.

Apart from the Orange River, Styerkraal Farm borders onto a mostly dry drainage line. This "triggers" Section 21(c) and (i) if the NWA, in terms of which a WULA is necessary. For this reason, Dr Dirk van Driel of WATSAN Africa in Cape Town was appointed.

A WULA of this nature requires a Fresh Water Report, a document that has to be produced along premeditated guidelines. These specifications have been developed over many applications and a number of years. The aim is to provide adequate information for official decision-making.

The Fresh Water Report includes a Risk Matrix, a particular assessment that is specified in government regulations in terms of the NWA.

The Fresh Water Report serves a dual purpose, because it has to provide information to the EIA. Hence, an Impact Assessment is included, according to a specified methodology.

This report does not deal with water rights (S21a of the NWA) and it does not deal with the storage of water (S21b of the NWA). For these aspects a separate report is required, prepared by a specialist in this field.

2 Legal Framework

The proposed development “triggers” sections of the National Water Act. These are the following:

S21 (c) *Impeding or diverting the flow of a water course*

The proposed development is spanning the banks of a drainage line. The drainage line would be altered, should the development go ahead.

S21 (i) *Altering the bed, bank, course of characteristics of a water course.*

Some part of the proposed development will alter the characteristics of the banks of the drainage line.

Government Notice 267 of 24 March 2017

Government Notice 1180 of 2002. *Risk Matrix.*

The Risk Matrix as published on the DWS official webpage must be completed and submitted along with the Water Use Licence Application (WULA). The outcome of this risk assessment determines if a letter of consent, a General Authorization or a License is required.

Government Notice 509 of 26 August 2016

An extensive set of regulations that apply to any development in a water course is listed in this government notice in terms of Section 24 of the NWA. No development take place within the 1:100 year-flood line without the consent of the DWS. If the 1:100-year flood line flood line is not known, no development may take place within a 100m from a water course without the consent of the DWS. The development is adjacent to drainage lines, which are defined as legitimate water resources.

Likewise, the development triggers a part of the National Environmental Management Act, NEMA, 107 of 1998).

The EIA Regulations of 2014 No.1 Activity 12 states that no development may take place within 32m of a water course without the consent of the Department of Environmental Affairs and its provincial representatives. A part of the development is adjacent to drainage lines. Consequently, this regulation is relevant to this application.

3 Quaternary Catchment

Styerkraal is in the D81F quaternary catchment.

4 Conservation Status

The Orange River is listed as a NFEPA on the SANBI BGIS webpage (Figure 1). The large drainage line has been assigned a NFEPA as well. The banks have been listed as a wetland NFEPA and is quite broad on the outside of the bend (Figure 1).

There are no critical biodiversity areas in and around the area of interest, according to the Cape Farm Mapper. Neither are there any ecological support areas.

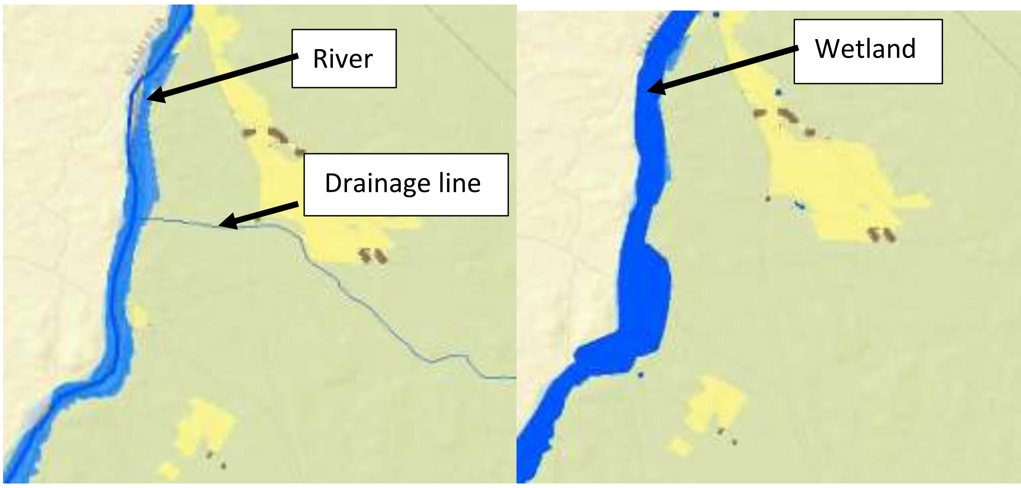


Figure 1 NFEPA

5 Farm Styerkraal Locality

Figure 2 Styerkraal Locality

Farm Styerkraal is located on the southern bank of the Orange River on the boundary between South Africa and Namibia, 5.8km to the east of the border crossing at Onseepkans (Figure 2). It is some 50km to the north of Pofadder on the N14 trunk road that connects Upington and Springbok in the Northern Cape.

The centre of Farm Styerkraal is approximately at the coordinates:

28°43'45.92"S
19°21'42.27"E

6 The Project

The project (Figure 3) amounts to 494ha of agricultural land that is to be developed into mainly vineyards. This land is in 5 portions (Figure 3). The rocky areas (Figure 3) in between these portions cannot be developed and will be left in its current state.

The proposed development will be right next to one of the larger dry drainage lines (north eastern corner of Figure 3). The other portions will be in the field of smaller drainage lines. This necessitates a S21 (c) and (i) WULA.

All of the proposed development has been previously ploughed over, even though this was more than 10 years ago. The network of small drainage lines has naturally been rejuvenated since the last ploughing over as they are visible on Google Earth images, despite the very low rainfall and the lack of moving storm water.

Figure 3 Project

7 Climate

The following was taken from Erasmus, 2017:

This Namakwa District of the Northern Cape Province is known for its semi-desert climate with extreme temperatures ranging from up to 45˚C in summer to - 2˚C in winter. The climate is variable due to its position in the transitional area between winter and summer rainfall. The winters are short and the area is well known for its high summer temperatures. Rainfall (Figure 4) is erratic with average annual precipitation of 90 mm which occurs mainly in the late summer in the form of thunder showers. Days with frost per year average at only 2 and crops can only be grown under irrigation.

All regions with a rainfall of less than 400 mm per year are regarded as arid. The Onseepkans area falls within the desert biome or hyper-arid region fringing the western South African shoreline, Southern Angola and Namibia. The desert biome is characterised by ecological extremes and of all the biomes in South Africa it has the lowest amount and variability in rainfall. Onseepkans normally receives about 90 mm of rain per year, with most rainfall occurring mainly during autumn.

According to www.saexplorer.co.za, Onseepkans receives the lowest rainfall (0 mm) in May and the highest (9 mm) in March. The monthly average daily maximum temperatures for Onseepkans range from 20.7°C in July, to 33.4°C in January. The region is the coldest during July with temperatures of 4.7°C, on average, during the night.

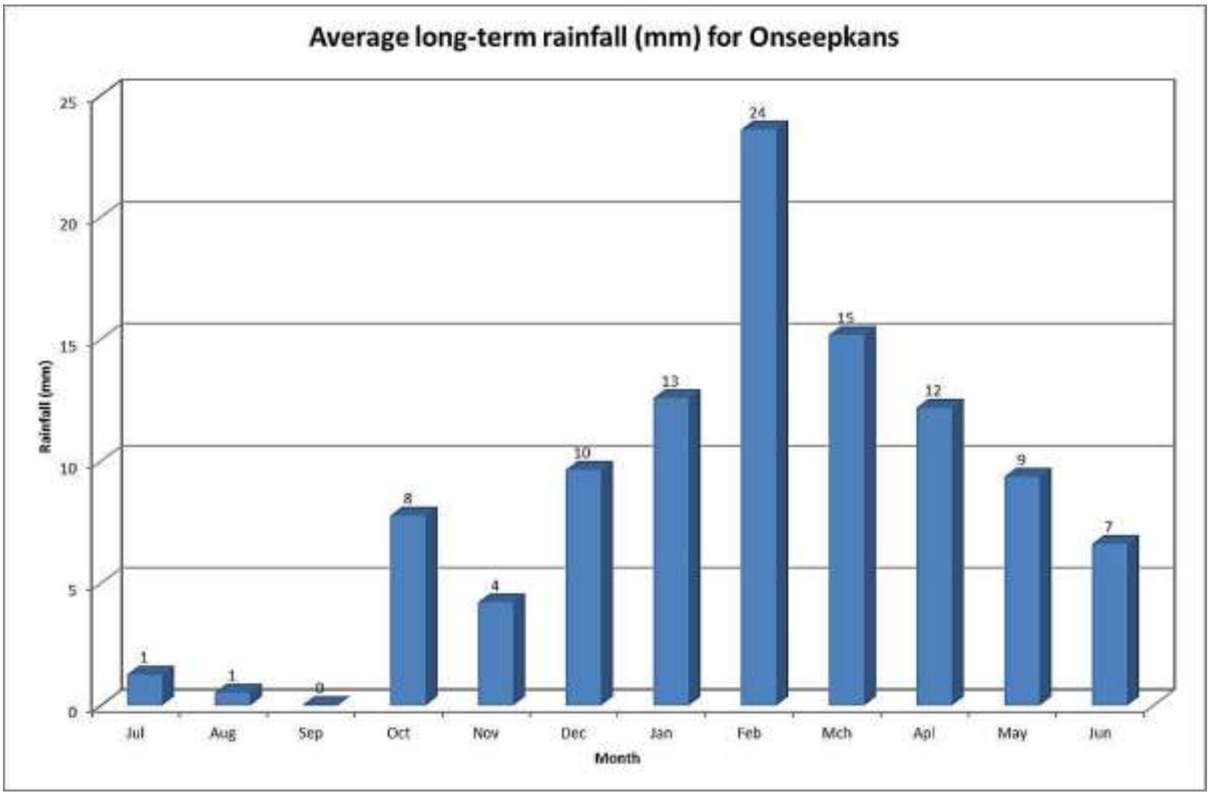


Figure 4 Rainfall Onseepkans

8 Vegetation

Mucina and Rutherford (2006) list 2 vegetation types in and adjacent to Styerkraal farm:

Eastern Gariep Rocky Desert (Figure 5).

This is the bulk of the farm. This vegetation type is not endangered in any way. The development of the farm would not change this conservation status.

Lower Gariep Alluvial Vegetation (Figure 6).

This type of vegetation borders onto the proposed development along the western boundary along the Orange River. This vegetation is listed as “Endangered”, which

Figure 5 Eastern Gariep Rocky Desert

Figure 6 Lower Gariep Alluvial Vegetation

raises a red flag. It is therefore advised that the proposed agricultural development stays out of the 32m buffer sone along the river.

9 Drainage Lines

The landscape around much of the Lower Orange River and the Sak River is dominated by a dense succession of drainage lines, each with their own sub-catchment. The drainage lines spread along the river with many smaller tributaries to cover the entire area. The iron oxides in the sands renders a red hue that is visible from space on the Google Earth images. These reds are concentrated in the drainage lines, making them even more visible (Figure 7).

The drainage lines are mostly dry, with water only during rains and perhaps shortly thereafter. During the odd thunder storm, drainage lines can come down in flood. These floods maintain the drainage line's morphological integrity, as sediments are moved and these water ways are scoured out.

Because rainfall events are far apart, the drainage lines must have been formed over millennia, even since geological times.

The vegetation in these arid parts is sparse, with a low diversity op plant species and a limited habitat variability. Drainage lines are often overgrown with a mature stand of sweet thorn *Vachellia karoo*, together with some other scrub and low trees such as *Searsia* species. In other parts the dominant tree is swarthaak *Senegalia mellifera.* This considerably adds to the habitat variability of the region. These tree lines stretch over the otherwise barren landscape and provide a linear connected habitat that would have been entirely absent if it was not for the shallow ground water in the unconfined aquifer in the drainage line's alluvium. Likewise, these tree lines provide habitat and nourishment to a variety of fauna that would have been entirely absent, was it not for the gradual migration of shallow ground water along the drainage lines.

All over the arid and semi-arid landscape of the western half of South Africa, these tree lines are considered to have a special and high conservation value.

Towards the west, as rainfall becomes lower, the tree lines are sparse. In the desert-like conditions of the far west, tree lines are no longer apparent, with the vegetation resembling that of the surrounding area.

Around the Orange River and even the Sak and Hartbees River, large-scale agriculture has changed the drainage lines into drainage channels among the vineyards and orchards. The upper reaches away from the rivers are less impacted, even near-pristine, as intense agriculture is not possible, apart from those areas where water is piped over long distances from the Orange River.

The conservation of drainage lines along the Lower Orange River deserves and demands attention by decision-making authorities, environmental practitioners, the conservation and farming community alike. As more of these drainage lines are impacted upon, and because impacts are radical by nature, because sections of drainage lines are replaced by vineyards or other forms of agriculture, or transformed into return flow infrastructure, the necessity for a widely accepted conservation policy becomes urgent as development escalates.

Figure 7 Drainage Lines

10 Sub-Catchments

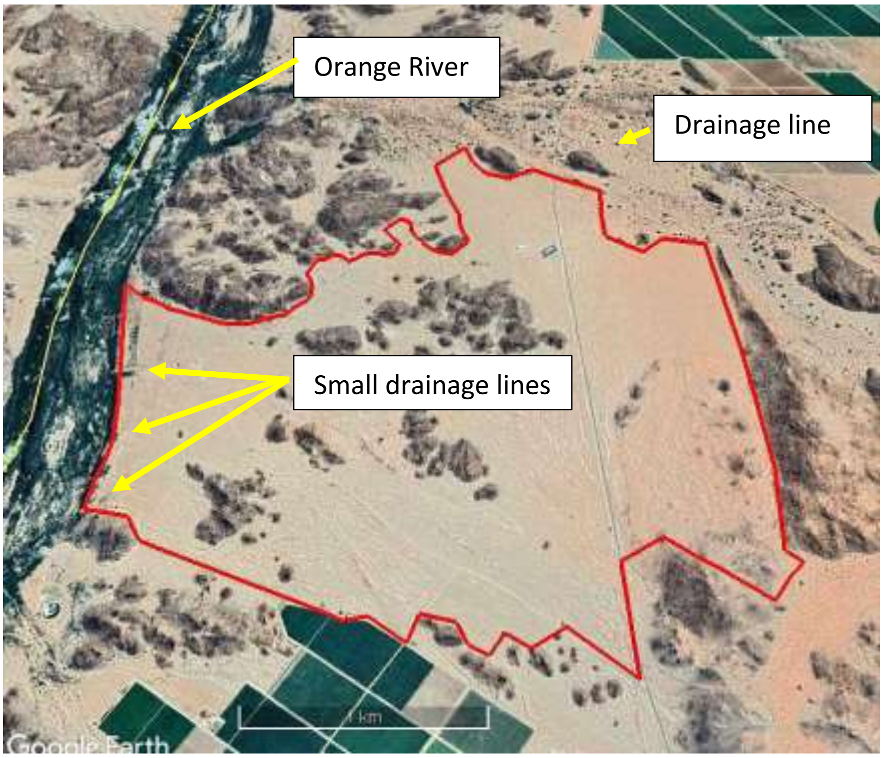


Figure 8 Styerkraal Development outline

The proposed development is roughly outlined in Figure 8 to indicate its position in relation to the mostly dry drainage lines. The development is adjacent to a large drainage line along its northern boundary. It spans three small drainage lines. Styerkraal's proximity to the larger drainage line and its crossing of the smaller drainage lines, apart from its boundary with the Orange River, necessitated the need for a S21 (c) and (i) WULA.

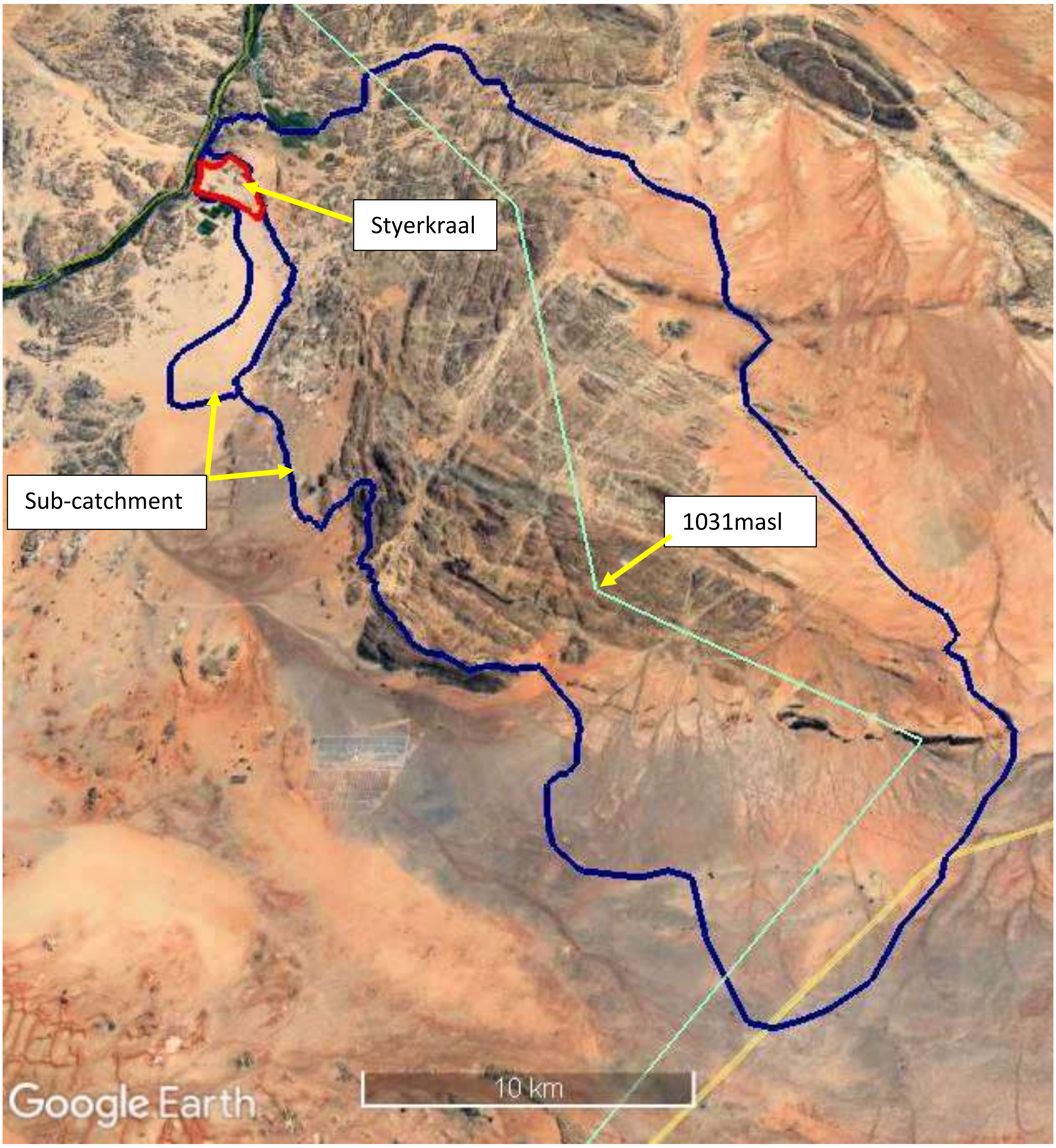


Figure 9 Sub-Catchment Areas

The larger drainage line rises on a sandy Bushmanland plain some 40km to the south, from where it cuts through a rocky area, which covers most of the sub-catchment. Only at the very north, close to the confluence with the Orange River, sand has been re-deposited to establish an area suitable for agriculture.

The two sub-catchments of concern were outlined using the Google Earth's polygon function (Figure 9). The highest points around the drainage lines were connected. This is made easy with the drainage lines visible on Google Earth.

The two sub-catchments vary greatly in size, as is indicated in Table 1

Table 1 Sub-Catchments

Sub-catchment	Area ha	Circumference km	Lengh km	Width km
Larger Smaller	50 000 1870	117 29.5	40 10.8	13.8 2.8

This larger drainage line is by no means the biggest one in the area. Up and down the Orange River, there are much bigger ones with much larger surface areas.

The entire proposed development is within the smaller sub-catchment area (Figure 10). This sub-catchment area consists of 3 smaller drainage lines, each with its own small confluence with the Orange River. The catchments of these three has been lumped, for the purpose of this description.

All over this smaller sub-catchment, these drainage lines are mostly on very flat ground in sandy soils, leaving their configuration unstable, or dynamic, with their interconnections changing with consecutive rainfall events. These have been named sheet-wash plains (Mucina & Rutherford, 2006). Figure 10 shows a sheet-wash plain in the foreground and sparsely vegetated drainage line further back against a rocky desert outcrop.

Even in the upper sub-catchments, where the drainage lines rise, the watershed line is not fixed, but may move in time over the flat and sandy substrate.

The highest point is a rocky outcrop in the south of 1031masl. The Orange River where the series of drainage lines join is at 396masl. This amounts to a mean slope of 2.5 vertical meters in every 100 horizontal meters, which is adequate for flow of storm water during high rainfall events and a moderate potential erosion potential of these sandy soils. Erosion is not evident because of the very low rainfall and the even slope on the wide sheet-wash plains, where mobilised sand because of moving water during rainfall is re-deposited.

Apart from the vineyards next to the Orange River and access roads, there are no other developments in the sub-catchments.

Figure10 Sheet-wash plain

Figure 11 Causeway

The paved access road passes through the large drainage line with a simple causeway (Figure 11).

The riparian vegetation upstream as well as downstream from the causeway is well developed, with shrub and mature trees, which stretches right to the Orange River, probably with the help and as a result of the agricultural return flow from the adjacent vineyards. This is probably not enough to give rise to the prolific growth of *Phagmitis* reeds, as elsewhere along the lower Orange River.

11 Biomonitoring the Lower Orange River

The biomonitoring was carried out according to the description of Dickens & Graham (2002).

Biomonitoring was carried out on the Lowers Orange River during site visits for successive WULAs. So far 10 samples have been analyzed at 9 localities (Table 1). The site furthest east was at Hopetown and furthest west at Augrabies, with Upington in the middle. All of these are located upstream of the Augrabies Falls.

Another sample was analyzed at Styerkraal just east of the border post of Onseepkans downstream of the Augrabies Falls.

The river is mostly braided, with many smaller streams and with islands in the middle. The river sports many rapids and riffles, but also pool-like features where the river is broad and slower flowing.

The bottom is mainly muddy, with some large rocky outcrops in the middle of the river.

12 Impacts on the Lower Orange River

The river is heavily utilized for agriculture, with the banks entirely modified into cultured vineyards. A multitude of large electric water pumps have been placed in the river for abstracting large volumes of water for irrigation. Abstraction significantly lowers the flow in the river.

Berms for the purpose of flood protection have been constructed on the banks of the river for most of its length. These berms have been constructed by the Department of Water Affairs and now have been a feature of the landscape for many decades. The berms keep flood water out of adjacent agricultural land and has denaturalised the riparian zone.

The single most impact on the Orange River are the two very large dams, The Gariep Dam and the Vanderkloof Dam. The river flow has been modified to a much even regime, different from the varied flown with high peak flows and low drought flows.

The Lower Orange River is lined with a dense system of mostly dry drainage lines. These drainage lines only flow during and shortly after heavy rains. Their contribution to the flow of the Orange River is insignificant. Most of the flow comes from the Lesotho Highlands and some from the Vaal River. However, many of these drainage lines have been transformed into engineered agricultural return flow furrows that carries the excess of over irrigation back to the Orange River. Agricultural return flow adds much to the nutrient load of the Orange River because runoff contains fertilizer. Nitrogen is added in large quantities. Since phosphorus readily binds to the soil, not much phosphorus is added.

Return flow can contain a heavy silt load, thereby elevating turbidity in the river.

It is suspected that pesticides in agricultural return flow have a heavy impact on biomonitoring results, significantly reducing the SASS5 score.

The banks of the Orange River in the area is densely overgrown with Spaanse Riet (*Arundo donax*). This is classified as an aggressive and exotic invasive plant, which effectively prevents access to the river. The reeds result in a homogeneous aquatic habitat. This lack of variation supresses the SASS5 score, with only a limited number of aquatic macroinvertebrate species present in this habitat.

Table 2 Biomonitoring in the Lower Orange River

Locality	Coordinates	Date	SASS 5	No Taxa	ASPT
Augrabies Lair trust	28°38’41.53S 20°26’08.49E	5/09/17	18	4	4.5
Augrabies Lair Trust	28°38’41.53S 20°26’08.49E	5/10/17	43	9	4.8
Groblershoop	28°52’31.80S 21°59’13.49E	14/8/18	41	7	5.9
Kakamas Triple D	28°45’08.37S 20°35’06.16E	15/8/18	50	9	5.6
Hopetown Sewer	29°36’05.07S 24°06’05.00E	7/10/18	29	7	4.1
Hopetown Sewer	29°36’08.06S 24°21’06.16E	7/10/18	29	8	3.6
Keimoes Housing	28°42’37.12S 20°55’07.81E	8/02/19	51	7	7.3
Upington Erf 323	28°27’11.91S 21°16’14.02E	12/2/19	56	9	6.2
Upington Affinity	28°27’11.91S 21°16’14.02E	20/5/19	54	9	6
Styerkraal	28°27’25.28S 21°15’01.87E	21/5/19	15	6	2.5
Grootdrink Bridge	28°17’15.30S 21°03’50.87E	17/5/20	34	7	5.3
Turksvy Dam		17/5/20	69	13	

13 Lower Orange River Biomonitoring Results

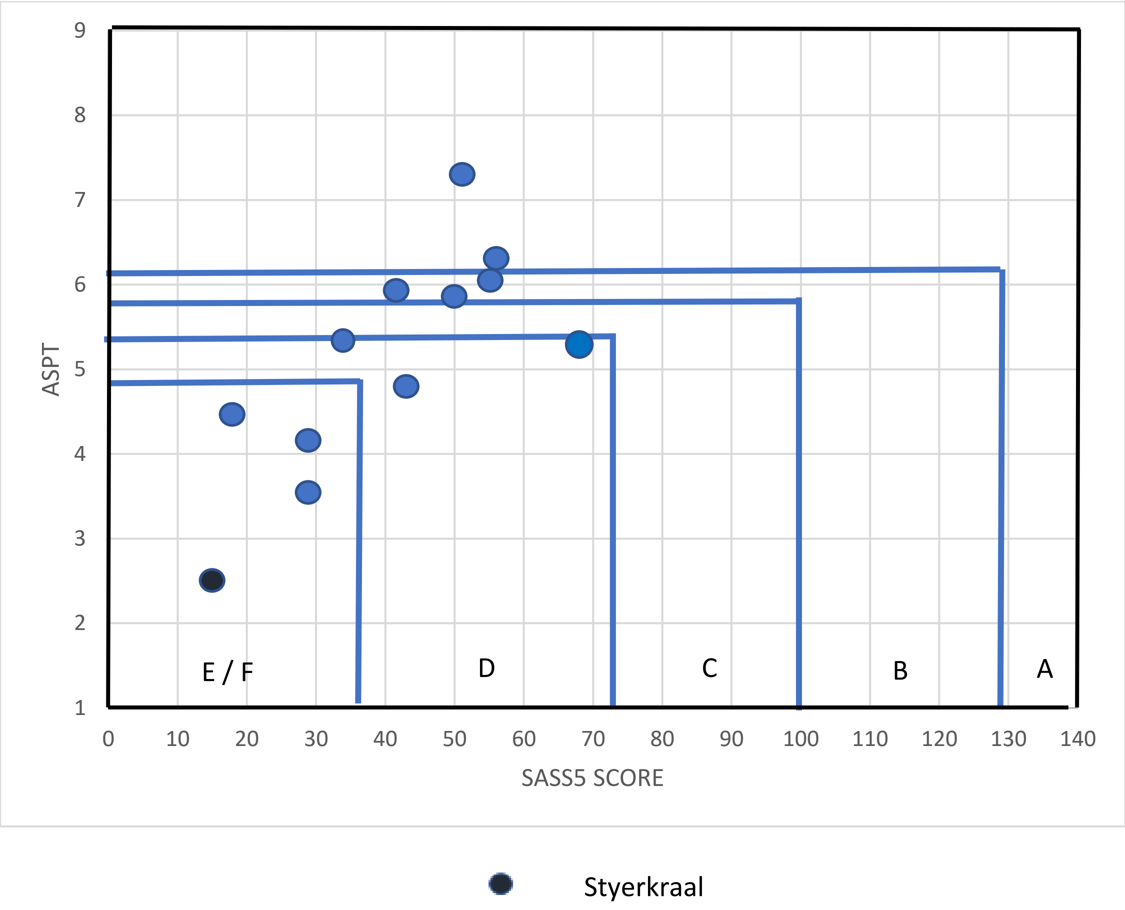
The biomonitoring results have been captured in Table 2 and depicted in Figure 12.

The classes from A to F in Figure 12 has been assigned for mature rivers on flood plains such as the Lower Orange River.

Only 2 of the samples were classified a good and relatively unimpacted (Class A). Four were in Class B and C, which can be regarded as acceptable under the circumstances of an impacted river reach. These classes can possible be labelled as the ideal, a compromise between agriculture and aquatic ecological functioning.

Four samples were poor (Classes E and F), an undesirable state of affairs.

The one sample downstream of the Augrabies Falls at Styerkraal was extremely poor.



Integrity Class	Description
A B C D E F	Pristine; not impacted Very Good; slightly impacted Good; measurably impacted with most ecological functioning intact Fair; impacted with some loss of ecological functioning Poor; loss of most ecological function Very Poor; loss of all ecological function

Figure 12 Biomonitoring results

14 Sampling Point

The river at the sampling point (Figure 13) was braided, with islands in the middle. There were a number of narrows, through which water was running fast, at perhaps a metre in a second. In the wider section, flow was much slower, at between 10 and 20ms^{-1}. There was emerging vegetation (*Phragmitis* reeds), submerged vegetation (trailing reeds and grasses). The bottom was muddy.

Figure 13 Sampling Point

At the time of sampling, the banks were wet, a sign that the river has recently burst it banks and that it was retracting to lower levels.

The oxygen concentration was high enough to support a high macrobenthos biodiversity, but this was not to be, as the biomonitoring score was the lowest ever recorded by WATSAN Africa in the Lower Orange River. More biomonitoring is required to come to a valid conclusion, but is seems that impacts from large-scale agriculture along the river increase downstream.

15 Present Ecological State

Table 3 Habitat Integrity according to Kleynhans, 1999

A	Unmodified, natural	90 – 100
B	Largely natural with few modifications. A small change in natural habitats and biota, but the ecosystem function is unchanged	80 – 89
C	Moderately modified. A loss and change of the natural habitat and biota, but the ecosystem function is predominantly unchanged	60 – 79
D	Largely modified. A significant loss of natural habitat, biota and ecosystem function.	40 – 59
E	Extensive modified with loss of habitat, biota and ecosystem function	20 – 39
F	Critically modified with almost complete loss of habitat, biota and ecosystem function. In worse cases ecosystem function has been destroyed and changes are irreversible	0 - 19

The PES protocol has been produced by Dr Neels Kleynhans (Table 3, 4 and 5) in 1999 of the then DWAF to assess river reaches. The PES is one of the evaluations that is prescribed for S21 (c) and (i) WULA's. The scores given are solely that of the practitioner and are based on expert opinion.

Most of the catchment area of the large drainage line is at a near-pristine state, with only a limited impact from the restricted animal husbandry that the arid climate allows. Only adjacent to the Orange River, some of the flow is restricted to the main drainage line and the lower tributaries have been cut off by the vineyards. The confluence with the Orange River is still intact, with some impact from agricultural return flow that stimulates the growth of higher vegetation.

Both the instream and riparian habitat scores an "A", or near pristine, not impacted, which is remarkable and unique, as most of the drainage lines along the Lower Orange River have been impacted by agriculture. This is despite of the large-scale vineyards in the lower part of the drainage line, which left the main channel of the drainage line intact.

Table 4 Present Ecological State of the Large Drainage Line

	Score	Weight	Product	Maximum score
Instream				
Water abstraction	25	14	350	350
Flow modification	23	13	299	325
Bed modification	23	13	312	325
Channel modification	23	13	312	325
Water quality	22	14	308	350
Inundation	23	10	210	250
Exotic macrophytes	20	9	180	225
Exotic fauna	20	8	160	200
Solid waste disposal	24	6	144	150
Total		100	2261	2500
% of total			90.4	
Class			A	
Riparian				
Water abstraction	24	13	312	325
Inundation	22	11	242	275
Flow modification	23	12	276	300
Water quality	22	13	286	325
Indigenous vegetation removal	24	13	312	325
Exotic vegetation encroachment	23	12	276	300
Bank erosion	23	14	322	350
Channel modification	20	12	240	300
Total			2266	2500
% of total			90.6	
Class			A	

The collection of small drainage lines has been ploughed over. This was more than 10 years ago, which was sufficient time to allow for the regeneration of much of the vegetation. This vegetation does not differ from anywhere else on these wash plains, with no plants that can be discerned as riparian vegetation or even higher vegetation because of the increased level of shallow ground water in these drainage lines. Only in the deeper depressions, where wash plains go over into faint drainage lines, such vegetation occurs. Seemingly, this combined sub-catchment is in a good condition and only in places the faint furrows of ploughing are visible. There were some goats grazing on the property. This is a dynamic area, if and when it rains, with sand being mobilized and re-deposited. This dynamic is enforced by strong, sand-moving winds, which is probably as important as water transport of sediments on these plains.

Table 5 Present Ecological State of the smaller drainage lines combined

Instream	Score	Weight	Product	Maximum score
Water abstraction	24	14	336	350
Flow modification	19	13	247	325
Bed modification	18	13	234	325
Channel modification	19	13	247	325
Water quality	21	14	294	350
Inundation	18	10	180	250
Exotic macrophytes	24	9	216	225
Exotic fauna	19	8	152	200
Solid waste disposal	24	6	144	150
Total		100	2050	2500
% of total			82.0	
Class			B	
Riparian				
Water abstraction	24	13	312	325
Inundation	18	11	198	275
Flow modification	19	12	228	300
Water quality	21	13	273	325
Indigenous vegetation removal	14	13	182	325
Exotic vegetation encroachment	21	12	252	300
Bank erosion	22	14	308	350
Channel modification	15	12	180	300
Total			1933	2500
% of total			77.3	
Class			C	

The instream habitat is only slightly impacted, despite of the ploughing over, thanks to the resting period of more than 10 years. The what can be termed as riparian vegetation is more impacted, but with most but scant ecological functioning still intact.

Obviously, when the wash plains are transformed into vineyards, nothing of the original ecological functioning would be left.

Much has been published on the ecological state of South African rivers and the Orange River is no exception. In fact, it seems somewhat arrogant to assess the Lower Orange River, even at the sampling point, with a team of one and with the financial backing of a single WULA. This is a large undertaking that is to be contemplated by a team of experts. Nevertheless, this is what the WULA requires.

Table 6 Present Ecological State Orange River

Instream	Score	Weight	Product	Maximum score
Water abstraction	15	14	210	350
Flow modification	15	13	195	325
Bed modification	20	13	260	325
Channel modification	22	13	286	325
Water quality	15	14	210	350
Inundation	12	10	120	250
Exotic macrophytes	18	9	162	225
Exotic fauna	15	8	120	200
Solid waste disposal	20	6	120	150
Total		100	1593	2500
% of total			63.7	
Class			C	
Riparian				
Water abstraction	15	13	195	325
Inundation	14	11	154	275
Flow modification	15	12	180	300
Water quality	15	13	195	325
Indigenous vegetation removal	20	13	260	325
Exotic vegetation encroachment	19	12	228	300
Bank erosion	23	14	322	350
Channel modification	22	12	264	300
Total			1798	2500
% of total			71.9	
Class			C	

The river at Styerkraal, as elsewhere, has been impacted by major dams, large-scale water abstractions, an influx of agricultural chemicals, encroachment of reeds and exotic macrophytes, translocated and exotic fish, levees, bridges and many other infarctions.

However, the river at Styerkraal was more impacted than further upstream. The river at Upington was stronger flowing, with much more water. The condition of the river gradually deteriorates as water abstraction and return flows increases downstream.

The river was scored a C (Table 6), which signifies that it has been impacted, but despite these impacts still exhibits appreciable ecological functioning. The situation is set to deteriorate to class D, with more large-scale agricultural developments planned along the river.

The riparian zone scores a C as well, even though the is higher than the upstream score. The river at Styerkraal is not flanked by the flood control walls that are so prominent upstream.

16 Ecological Importance

The Ecological Importance (EI) is based on the presence of especially fish species that are endangered on a local, regional or national level (Table 7).

There are no fish in the drainage line, as there is no permanent water. According to this assessment, which is prescribed for WULA's, the drainage lines are not important.

No other endangered species, either plant or animal, were detected in or near the drainage line.

Table 7 Ecological Importance according to endangered organisms (Kleynhans,1999).

Category	Description
1	One species or taxon are endangered on a local scale
2	More than one species or taxon are rare or endangered on a local scale
3	More than one species or taxon are rare or endangered on a provincial or regional scale
4	One or more species or taxa are rare or endangered on a national scale (Red Data)

As has been stated before, the higher vegetation in and around the drainage lines are of particular importance in these arid regions and add significantly to biodiversity. These should be considered as ecologically important.

The Orange River is most important, according to this assessment.

According to Skelton (1993) 12 species of indigenous fish occur in the Lower Orange River. Since 2011 another one was added, as well as 3 exotic species. These are the following:

Barbus trimaculatus
B paludinosus
B. hospus
Labeobarbus kimberleyensis (Near threatened)
L aenus
Labeo umbratus
L capensis
Austroglanis sclateri (Widespread elsewhere)
Clarias gariepinus
Pseudocrenilabrus philander (Threatened locally but abundant elsewhere)
Pseudobarbus quathlabae
Mesobola brevianalis (critically endangered)

Exotic and translocated fish:

Cyprinus carpio
Tilapia sparrmanii
Oreochromus mossambicus

Those in blue are endangered to a varying extent. Those indicated in red are exotic or translocated fish.

The only one that causes real concern in the largemouth yellow-fish *Labeobarbus kimberleyensis*. It is endemic to the Orange River system and hence is threatened not only on a local scale, but on a national scale as well. This puts the Lower Orange in category 4. This renders the Orange River as important.

According to the owners of the Kalahari River and Safari Co. along the northern bank of the Orange River on the Riemvasmaak Road, mature blue kurper *Oreochromus mossambicus* are regularly captured in increasing numbers. It now takes at least 4 man-days to capture a single yellow fish.

Yellow fish are generally infected with cestode bladder worms, while darters (*Anhinga rufa*) that predate on these fish are heavily infected with tape worms. It seems as if the translocated Tilapia are not affected by these parasites.

According to Mr Chris van der Post, a renown angling guide and the owner of the Gkhui Gkhui River Lodge near Hopetown, there are still many smallmouth-yellow fish around, but largemouth yellow-fish are scarce.

17 Ecological Sensitivity

Ecological Sensitivity (ES) is often described as the ability of aquatic habitat to assimilate impacts. It is not sensitive if it remains the same despite of the onslaught of impacts. Put differently, sensitive habitat changes substantially, even under the pressure of slight impacts.

The Ecological Sensitivity also refers to the potential of aquatic habitat to bounce back to an ecological condition closer to the situation prior to human impact. If it recovers, it is not regarded as sensitive.

17.1 Ecological Sensitivity Drainage Lines

The question arises**,** according to the ES definition, if the drainage lines would recover to its original ecological state prior to any human impact.

Upstream, between Boegoeberg and Augrabies, in the wine producing region of the Lower Orange River, drainage lines have been considered as sensitive, because in low rainfall areas it takes many decades if not more than a century for the vegetation to grow back, following the complete removal of vineyards. From this point of view, drainage lines were deemed as ecologically sensitive.

According to subsequent reasoning, intensive agriculture was here to stay and the land will never be restored to its original situation as long as humanity exists. From this point of view, drainage lines will never bounce back and therefore were regarded as sensitive.

In these regions ecological sensitivity apparently is linked to rainfall. Vegetation takes a much longer time to recuperate in lower rainfall areas. Towards the west, rainfall becomes less and the climate more desert-like, with much longer ecological succession period from disturbed to near-pristine. This renders the drainage lines at Styerkraal ecologically sensitive.

The collection of smaller drainage lines, which is more like a wash plain, shows re-growth of vegetation, which suggests a lower ecological sensitivity. This vegetation resembles that of the surrounding area and is not necessarily riparian. Again, once ploughed over and planted, it would probably take many decades for a drainage line to be morphologically re-established, with a discernible riparian vegetation.

17.2 Ecological Sensitivity Orange River

The Lower Orange River has absorbed numerous and deep-cutting human impacts. Yet is still functions as an aquatic ecosystem. In the highly improbable event of ceased human impact, the river here would probably bounce back to its previous glory. In this respect the river cannot be categorised as sensitive.

It is dreaded among conservation minded people that the Lower Orange River might have some more capacity to absorb further impact.

18 Possible Impacts

18.1 Construction Phase

The land will be ploughed over, probably deeply with a large bulldozer, as is standard practice for vineyards. The wash plain will be entirely transformed, with loss of ecological functioning. Because of the loose soil, there is a possibility that sediments may wash down the drainage lines and down the Orange River during the occasional high rainfall event, but because of the very low rainfall this is not likely to happen.

18.2 Operational Phase

There is always a possibility of agricultural return flow because of over-irrigation, down the drainage lines and then down the Orange River. This flow is laced with agri-chemicals, which may result in an even more prolific growth of *Phragmitis* reeds in and around the confluences of the drainage lines with the river and on the banks of the river as well. The possible presence of pesticides in the return flow will probably be noticeable as an even lower biomonitoring score.

It can be expected that the addition abstraction of water for irrigation further deleteriously impact on the Orange River, with a further reduction of flow and a longer stagnant, no-flow period. This, in turn, would be detrimental to aquatic biodiversity. However, it is accepted that the DWS has discounted this impact against the Ecological Reserve.

19 Mitigation Measures

Development should not take place closer that 32m from the main drainage line and from the Orange River. The buffer zone should be maintained.

Over-irrigation should be prevented at all costs. This can be achieved with contemporary soil moisture-measuring probes and a matching finely-tuned irrigation system to optimize yield, with no wastage of any water.

The footprint of the agricultural development should be limited to the designated area. Vehicles and machinery should not be allowed outside of this designated area.

The rocky areas within and around the development should be preserved and kept natural, with the impacts from the surrounding agriculture be limited.

The number of access roads should be limited. No new ones should be constructed.

No more water for irrigation should be abstracted than is allowed for by the Water Use License.

20 Impact Assessment

Some of the decision-making authorities, such as DEFF and DENC, prescribe an impact assessment according to a premeditated methodology (Table 28.4, Appendix).

The main benefit of this exercise is that it allows for the evaluation of mitigation measures. Later follows the Risk Matrix. This is different from the Impact Assessment as it does not attempt to weigh the success of mitigation measures.

The assessment indicates that the impacts are acceptable, provided that the mitigation measures are adequate to contain these impacts (Table 8).

No amount of mitigation measures is going to prevent the destruction of the wash plain. However, the riparian zones can be saved, subject to the implementation of mitigating measures.

Table 8 Impact Assessment

Description of impact Loosening of soil during construction phase, washing of soil down the drainage line and into the Orange River during a storm event **Mitigation measures** Construction only during the dry season, limit the foot print, vegetate disturbed areas.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Negative	Local	Medium	Short term	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Short term	Low	Unlikely	Sure	Reversible	Replaceable

Description of impact								
Impacts on the lower reach of the large drainage line as well as on the riparian zone of the Orange River								
Mitigation measures								
Maintain the 32m buffer zone Keep vehicles, agricultural equipment, farm animals and footpaths out of the riparian zones.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Negative	Local	Medium	Long term	Medium	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Long term	Low	Probable	Sure	Reversible	Replaceable

Description of impact								
Operation of new vineyard								
Mitigation measures								
Prevent agricultural return flow.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Negative	Local	Medium	Medium term	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative Cumulative	Local	Low	Medium term	Low	Unlikely	Sure	Reversible	Replaceable

21 Significance of Impacts

The DEFF's document No.5 in the series Integrated Environmental Management Information labelled "Impact Significance" in 2002 was an important milestone is the development of environmental practice in South Africa. It set out the principles on which assessment methodologies are based that are currently applied by environmental practitioners. The methodology is explained in the Appendix.

Table 9 Significance Score combined smaller drainage lines

Parameter	Score
Conservation value Likelihood Duration Extent Severity Significance	2 5 5 5 5 40

Table 10 Significance Score large drainage line

Parameter	Score
Conservation value Likelihood Duration Extent Severity Significance	4 4 5 1 2 48

Although the sheet-wash plain will be entirely altered, for as long as the vineyards exist, its ecological significance, according to Table 9, is rather low. This culminates in a score of 40, (see the formula in the appendix) which indicates that the loss of the wash plane is ecologically not significant and that the planned development should be authorized.

The impact is probably going to be medium (Table 10), not serious, but would require the project to stick to the mitigation measures, which are realistically attainable. Again, the significance score should not put the project into jeopardy and it therefore should be readily allowed.

22 Risk Matrix

The purpose of the Risk Matrix is to determine if a General Authorisation of a License is applicable.

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 11 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report. The numbers in Table 11 (continued) represent the same activities as in Table11, with sub-activities added.

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Table 11 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1	Establishment of new vineyard, loosening of soil	Mobilisation of sediments	Sediments washed down the drainage lines into the Orange River	28	Low
2	Trampling of the riparian zones	Grazing, vehicles and machinery	Loss of riparian habitat	52.5	Low
3	Operation of the new vineyards	Agrichemicals in water ways	Pollution, eutrophication	52.5	Low

Table 11 Continued Risk Rating

No	Flow	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Conse-quence
1	1	2	2	1	1.5	1	1	3.5
2	1	1	2	1	1.25	1	3	5.25
3	1	2	1	1	1.25	1	3	5.25

No	Frequency of activity	Frequency of impact	Legal issues	Detection	Likelihood	Significance	Risk Rating
1	1	1	5	1	8	28	Low
2	2	2	5	1	10	52.5	Low
3	2	2	5	1	10	52.5	Low

The methodology is tabled in the Appendix

The environmental risks are low, given that the impacts would be local, at the site and not far downstream from the site. However, the cumulative impacts of agriculture in the Lower Orange River is significant and the new development at Styerkraal will obviously add to the impact.

Nevertheless, the Risk Matrix indicates that a General Authorisation is the correct level of authorization and that a License is not called for.

23 Resource Economics

The goods and services delivered by the environment is a Resource Economics concept as adapted by Kotze *et al* (2009). The methodology was designed for the assessments of wetlands, but in the case of the drainage line the goods and services delivered are particularly applicable and important, hence it was decided to include it in the report.

The diagram (Figure 14 and 15) is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 12.

Table 12. Goods and Services

Goods & Services	Small drainage lines	Large drainage line
Flood attenuation	3	4
Stream flow regulation	3	4
Sediment trapping	3	4
Phosphate trapping	1	2
Nitrate removal	1	2
Toxicant removal	1	2
Erosion control	3	4
Carbon storage	1	2
Biodiversity maintenance	1	3
Water supply for human use	0	0
Natural resources	0	0
Cultivated food	1	1
Cultural significance	0	1
Tourism and recreation	0	0
Education and research	1	1

0	Low
5	High

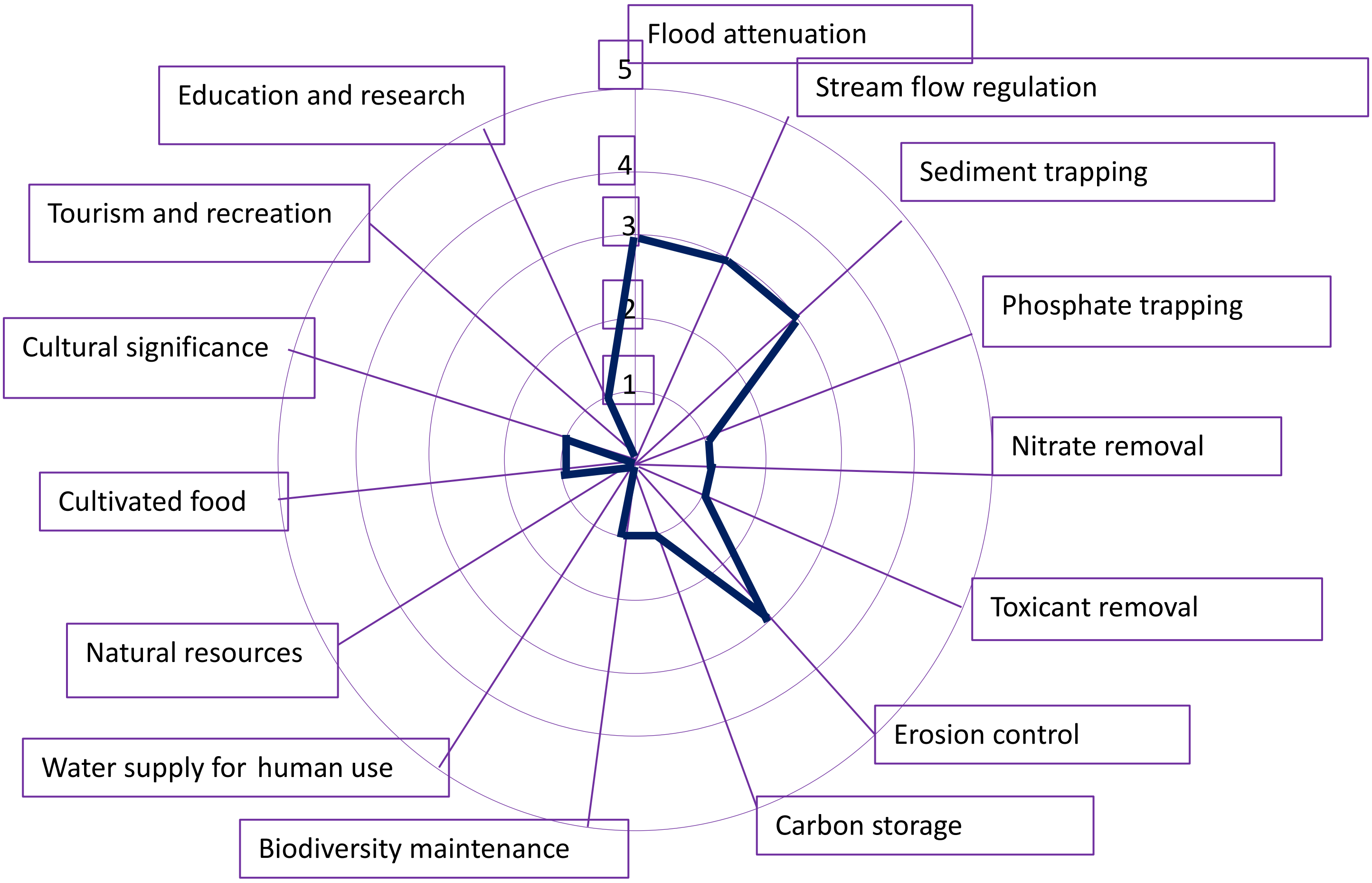

Figure 14. Resource Economics Footprint of the smaller drainage lines

The size of the star shape of Figure 14 and 15 is the attribute that attracts the attention of the decision-makers. These shapes (spider diagram) are small, indicating that the water courses have small economic foot prints. Apart from a small measure of flood attenuation, stream flow regulation and sediment trapping, both the small and large drainage lines are not important, from a resource economics point of view.

The resource economics spider diagram for the Orange River is a perfect round circle, with a score of 5 for all of the measured parameters.

The developments at Styerkraal Farm will probably not change the shape of the shape for the larger drainage line.

The smaller ones will be replaced by vineyards, leaving a landscape remote from the original sheet wash plane, with an entirely different resource economic footprint.

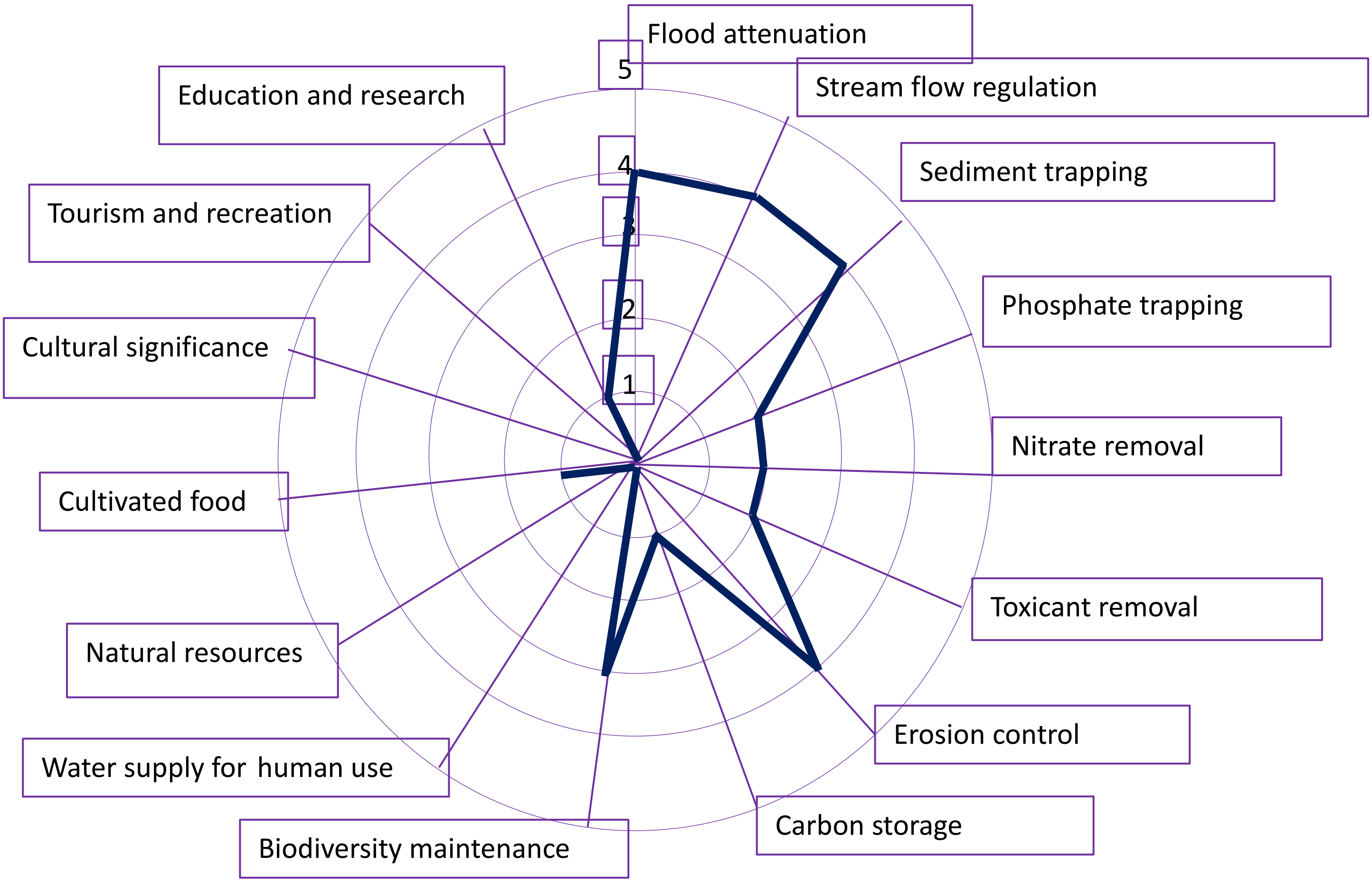

Figure 15. Resource Economics Footprint of the large drainage lines

24 Conclusions

Figure 16 has been adapted from one of the most recent DWS policy documents.

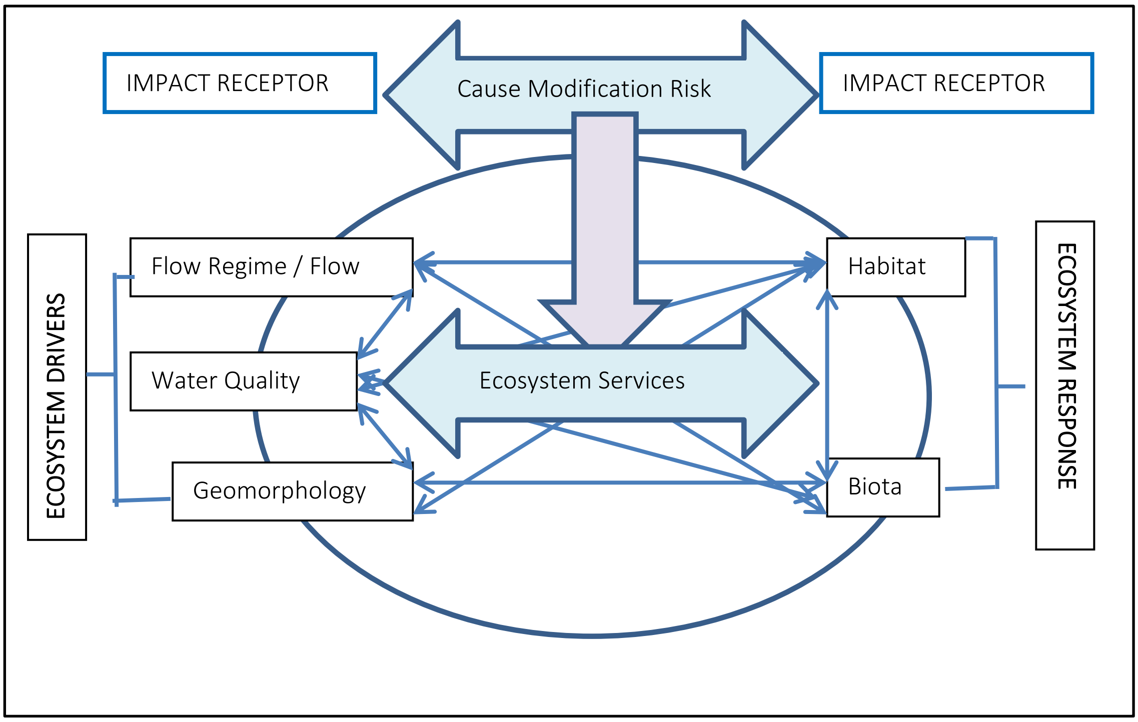

Figure 16 Minimum Requirements for a S21(c) and (i) Application

An anthropogenic activity can impact on any of the ecosystem drivers or responses and this can have a knock-on effect on all of the other drivers and responses. This, in turn, will predictably impact on the ecosystem services (Figure 16). The WULA and the EAI must provide mitigation measured for these impacts.

The driver of the drainage lines is the occasional flood that follows sudden and intense rainfall events. This is followed by prolonged droughts and intense summer heat that prevents the development of any viable aquatic habitat. This is apart from shallow ground water that explains the growth of a somewhat more prolific vegetation along the drainage lines.

The proposed new vineyard is not about to change any of the drivers.

Ironically, drainage lines add to at least environmental goods and services when vineyards are developed, because they act as traps for agricultural return flow as well as its chemical contents.

The possible impacts on the aquatic environment are small, if not negligible. These impacts are entirely insignificant if compared to the already impacts of a large-scale regional farming industry on the banks of the Orange River, together with its major water abstraction and massive irrigation return flow.

It is therefore suggested that the proposed development is authorised with a General Authorisation.

25 References

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Skelton, P. 1993. *Freshwater Fishes of Southern Africa*. Southern Book Publishers, Halfway House.

26 Declaration of Independence

I, Dirk van Driel, as the appointed independent specialist hereby declare that I:

- Act/ed as the independent specialist in this application
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct and;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management act;
- Have and will not have vested interest in the proposed activity;
- Have disclosed to the applicant, EAP and competent authority any material information have or may have to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the environmental Impact Assessment Regulations, 2010 and any specific environmental management act.
- Am fully aware and meet the responsibilities in terms of the NEMA, the Environmental Impacts Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R543) and any specific environmental management act and that failure to comply with these requirements may constitute and result in disqualification;
- Have ensured that information containing all relevant facts on respect of the specialist input / study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties facilitated in such a manner that all interested and affected parties were provided with reasonable opportunity to participate and to provide comments on the specialist input / study;
- Have ensured that all the comments of all the interested and affected parties on the specialist input were considered, recorded and submitted to the competent authority in respect of the application;
- Have ensured that the names of all the interested and affected parties that participated in terms of the specialist input / study were recorded in the register of interested and affected parties who participated in the public participation process;
- Have provided the competent authority with access to all information at my disposal regarding the application, weather such information is favourable or not and;
- Am aware that a false declaration is an offence in terms of regulation 71 of GN No. R543.

Signature of the specialist: D van Driel 5 October 2020

27 Résumé

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Experience

WATSAN Africa, Cape Town. Scientist — **2011 - present**

USAID/RTI, ICMA & Chemonics. Iraq & Afghanistan — **2007 -2011**
Program manager.

City of Cape Town — **1999-2007**
Acting Head: Scientific Services, Manager: Hydrobiology.

Department of Water & Sanitation, South Africa — **1989 – 1999**
Senior Scientist

Tshwane University of Technology, Pretoria — **1979 – 1998**
Head of Department

University of Western Cape and Stellenbosch University 1994- 1998 part-time

- Lectured post-graduate courses in Water Management and Environmental Management to under-graduate civil engineering students
- Served as external dissertation and thesis examiner

Service Positions

- Project Leader, initiator, member and participator: Water Research Commission (WRC), Pretoria.
- Director: UNESCO West Coast Biosphere, South Africa
- Director (Deputy Chairperson): Grotto Bay Home Owner’s Association
- Member Dassen Island Protected Area Association (PAAC)

Membership of Professional Societies

- South African Council for Scientific Professions. Registered Scientist No. 400041/96
- Water Institute of South Africa. Member

Reports

- Process Review Kathu Wastewater Treatment Works
- Effluent Irrigation Report Tydstroom Abattoir Durbanville
- River Rehabilitation Report Slangkop Farm, Yzerfontein
- Fresh Water and Estuary Report Erf 77 Elands Bay
- Ground Water Revision, Moorreesburg Cemetery
- Fresh Water Report Delaire Graff Estate, Stellenbosch
- Fresh Water Report Quantum Foods (Pty) Ltd. Moredou Poultry Farm, Tulbagh
- Fresh Water Report Revision, De Hoop Development, Malmesbury
- Fresh Water Report, Idas Valley Development Erf 10866, Stellenbosch
- Wetland Delineation Idas Valley Development Erf 10866, Stellenbosch
- Fresh Water Report, Idas Valley Development Erf 11330, Stellenbosch
- Fresh Water Report, La Motte Development, Franschhoek
- Ground Water Peer Review, Elandsfontein Exploration & Mining
- Fresh Water Report Woodlands Sand Mine Malmesbury
- Fresh Water Report Brakke Kuyl Sand Mine, Cape Town
- Wetland Delineation, Ingwe Housing Development, Somerset West
- Fresh Water Report, Suurbraak Wastewater Treatment Works, Swellendam
- Wetland Delineation, Zandbergfontein Sand Mine, Robertson
- Storm Water Management Plan, Smalblaar Quarry, Rawsonville
- Storm Water Management Plan, Riverside Quarry
- Water Quality Irrigation Dams Report, Langebaan Country Estate
- Wetland Delineation Farm Eenzaamheid, Langebaan
- Wetland Delineation Erf 599, Betty's Bay
- Technical Report Bloodhound Land Speed Record, Hakskeenpan
- Technical Report Harkerville Sand Mine, Plettenberg Bay
- Technical Report Doring Rivier Sand Mine, Vanrhynsdorp
- Rehabilitation Plan Roodefontein Dam, Plettenberg Bay
- Technical Report Groenvlei Crusher, Worcester
- Technical Report Wiedouw Sand Mine, Vanrhynsdorp
- Technical Report Lair Trust Farm, Augrabies
- Technical Report Schouwtoneel Sand Mine, Vredenburg
- Technical Report Waboomsrivier Weir Wolseley
- Technical Report Doornkraal Sand Mine Malmesbury
- Technical Report Berg-en-Dal Sand Mine Malmesbury
- Wetland Demarcation, Osdrif Farm, Worcester
- Technical Report Driefontein Dam, Farm Agterfontein, Ceres
- Technical Report Oewerzicht Farm Dam, Greyton
- Technical Report Glen Lossie Sand Mine, Malmesbury
- Preliminary Report Stellenbosch Cemeteries
- Technical Report Toeka & Harmony Dams, Houdenbek Farm, Koue Bokkeveld
- Technical Report Kluitjieskraal Sand & Gravel Mine, Swellendam
- Fresh Water Report Urban Development Witteklip Vredenburg
- Fresh Water Report Groblershoop Resort, Northern Cape
- Fresh Water Report CA Bruwer Quarry Kakamas, Northern Cape
- Fresh Water Report, CA Bruwer Sand Mine, Kakamas, Northern Cape
- Fresh Water Report, Triple D Farms, Agri Development, Kakamas
- Fresh Water Report, Keren Energy Photovoltaic Plant Kakamas
- Fresh Water Report, Keren Energy Photovoltaic Plant Hopetown
- Fresh Water Report Hopetown Sewer
- Fresh Water Report Hoogland Farm Agricultural Development, Touws River

- Fresh Water Report Klaarstroom Waste Water Treatment Works
- Fresh Water Report Calvinia Sports Grounds Irrigation
- Fresh Water Report CA Bruwer Agricultural Development Kakamas
- Fresh Water Report Zwartfontein Farm Dam, Hermon
- Statement Delsma Farm Wetland, Hermon
- Fresh Water Report Lemoenshoek Farms Pipelines Bonnyvale
- Fresh Water Report Water Provision Pipeline Brandvlei
- Fresh Water Report Erf 19992 Upington
- Botanical Report Zwartejongensfontein Sand Mine, Stilbaai
- Fresh Water Report CA Bruwer Feldspath Mine, Kakamas
- Sediment Yield Calculation, Kenhardt Sand Mine
- Wetland Demarcation, Grabouw Traffic Center
- Fresh Water Report, Osdrift Sand Mine, Worcester
- Fresh Water Report, Muggievlag Storm Water Canal, Vredenburg
- Fresh Water Report, Marksman's Nest Rifle Range, Malmesbury
- Biodiversity Report, Muggievlak Storm Water Canal, Vredenburg
- Strategic Planning Report, Sanitation, Afghanistan Government, New Delhi, India
- Fresh Water Report, Potable Water Pipeline, Komaggas
- Fresh Water Report, Wastewater Treatment Works, Kamieskroon
- Fresh Water Report Buffelsdrift Gravel Mine, George

28 Appendix

28.1 Biomonitoring

SASS5 Score Sheet										
Date	21 May 19	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**
Locality	Orange River	Porifera	5		**Hemiptera**			**Diptera**		
	Styerkraal	Coelenterata	1		Belostomatidae	3		Athericidae	10	
		Turbellaria	3		Corixidae	3	3	Blepharoceridae	15	
		Oligochaeta	1		Gerridae	5		Ceratopogonidae	5	
Coordinates	28°27' 25.28"	Huridinea	3		Hydrometridae	6		Chironomidae	2	2
	21°15'01.87"	**Crustacea**			Naucoridae	7		Culicidae	1	1
		Amphipodae	13		Nepidae	3		Dixidae	10	
DO mg/l	8.61	Potamonautidae	3		Notonectidae	3	3	Empididae	6	
Temperature °C	18.1	Atyidae	8		Pleidae	4		Ephydridae	3	
pH	8.7	Palaemonidae	10		Veliidae	5		Muscidae	1	
EC mS/m	47	Hydracarina	8		**Megaloptera**			Psychodidae	1	
		Plecoptera			Corydalidae	10		Simuliidae	5	
SASS5 Score	18	Notonemouridae	14		Sialidae	8		Syrphidae	1	
Number of Taxa	6	Perlidae	12		**Trichoptera**			Tabanidae	5	
ASPT	3,0	**Ephemeroptera**			Dipseudopsidae	10		Tipulidae	5	
		Baetidae 1 sp	4	4	Ecnomidae	8		**Gastropoda**		
Other Biota		Baetidae 2 sp	6		Hydropsychidae 1 sp	4		Ancylidae	6	
		Baetidae >3 sp	12		Hydropsychidae 2 sp	6		Bulinidae	3	
		Caenidae	6		Hydropsychidae <2 sp	12		Hydrobiidae	3	
		Ephemeridae	15		Phylopotamidae	10		Lymnaeidae	3	
		Heptageniidae	13		Polycentropodidae	12		Physidae	3	
		Leptophlebiidae	9		Psychomyidae	8		Planorbidae	3	
		Oligoneuridae	15		**Cased Caddis**			Thiaridae	3	
Comments		Polymitarcyidae	10		Barbarochthonidae	13		Viviparidae	5	
		Prosopistomatida	15		Calamoceratidae	11		**Pelecipoda**		
		Teloganodidae	12		Glossostomatidae	11		Corbiculidae	5	
		Trichorythidae	9		Hydroptilidae	6		Sphariidae	3	
		Odonata			Hydrosalpingidae	15		Unionidae	6	
		Calopterygidae	10		Leptostomatidae	10				
		Clorocyphidae	10		Leptoceridae	6				
		Chorolestidae	8		Petrothrincidae	11				
		Coenagrionidae	4		Pisulidae	10				
		Lestidae	8		Sericostomatidae	13				
		Platycnemidae	10		**Coleoptera**					
		Protoneuridae	8		Dyticidae	5				
		Aesthnidae	8		Elmidae Dryopidae	8				
		Corduliidae	8		Gyrinidae	5				
		Gomphidae	6		Haliplidae	5	5			
		Libellulidae	4		Helodidae	12				
		Lepidoptera			Hydraenidae	8				
		Pyralidae	12		Hydrophilidae	5				
					Limnichidae	10				
					Psephenidae	10				
Score				4			11			3

28.2 Eastern Gariep Rocky Desert

VT 33 Namaqualand Broken Veld (98%) (Acocks 1953). LR 51 Orange River Nama Karoo (99%) (Low & Rebelo 1996).

Distribution All the rocky desert areas along the Orange River, including Groot Pellaberge, Dabenorisberge, Abbasasberge and many smaller mountains between Pella and Vioolsdrif. Also some mountains mapped further south well away from the Orange River such as the Haramoebberge and Witberg. Altitude about 250–1 205 m at the highest peak of the Groot Pella.

Vegetation & Landscape Features Hills and mountains (up to 650 m of relative altitude from their base), mostly with bare rock outcrops and covered with very sparse shrubby vegetation in crevices. Separated by broad sheet-wash plains (Dg 9 Eastern Gariep Plains Desert). Habitats are mainly controlled by topography, aspect, local climate and lithology. On the Groot Pellaberg, for example, there is a sparse shrubland on the southern foothills (with, for example, *Aloe dichotoma*, *Rhigozum trichotomum* and *Petalidium setosum*) and a higher cover of plants in the southern ravines and rocky drainage lines (e.g. *Abutilon pycnodon*, *Asparagus suaveolens*, *Ficus cordata*, *Rhus populifolia* and *R. viminalis*). On the higher southern slopes *Justicia orchioides* is often dominant, with localised grassland directly below steep cliffs (*Enneapogon scaber*, *Triraphis ramosissima* and *Danthoniopsis ramosa*). The south-facing quartzite cliffs and steep slopes support chasmophytes (cremnophytes) such as *Ficus ilicina*, *Aloe dabenorisana* and *Bowiea gariepensis*. On the summits and higher northern slopes there is a much higher preponderance of succulent plants including *Euphorbia avasmontana*, *Aloe dichotoma*, *A. microstigma* subsp. *microstigma*, *Pelargonium aridum* and *Kleinia longiflora*. Succulent plants are also important on the northern foothills and also include *Aloe dichotoma*, *Euphorbia avasmontana*, *Sarcostemma viminale* and the diminutive *Lapidaria margarethae* (Van Jaarsveld 1985).

Geology & Soils In the east mainly leucocratic biotite gneiss and quartz-feldspar gneiss of the Stalhoek Complex and lesser amounts of leucocratic biotite gneiss occur, with intercalations of calc-silicate rocks, mafic gneiss, and a quartzite-schist association of the Hom Subgroup, Bushmanland Group. In the west the area consists of granodiorite, adamellite, leucogranite, tonalite and diorite of the Vioolsdrif Suite and intermediate and acid volcanics of the Haib Subgroup of the Orange River Group (all of the above of Mokolian age). Very rocky substrate, with little or no soils. Land type Ic.

Climate MAP about 45–80 mm with rainfall peak in late summer and early autumn, becoming more pronounced eastwards. Summer maximum temperatures often more than 40°C, occasionally reaching 50°C at low altitudes. Frost is very rare, but occurs at high altitudes.

Important Taxa ([W]Mainly western part, [E]Mainly eastern part) Succulent Tree: *Aloe dichotoma* (d). Small Trees: *Acacia mellifera*, *Boscia albitrunca*, *B. foetida*, *Ehretia rigida*, *Euclea pseudebenus*, *Maerua gilgii*, *Pappea capensis*. Stem-& Leaf-succulent Shrubs: *Brownanthus pseudoschlichtianus*, *Ceraria fruticulosa*, *Psilocaulon subnodosum*, *Ruschia barnardii.* Stem-succulent Shrubs: *Ceraria namaquensis*, *Commiphora capensis*[W], *C. cervifolia*[W], *C. gracilifrondosa*[E], *C. namaensis*, *Euphorbia avasmontana*, *E. friedrichiae*, *E. gariepina*, *E. gregaria*, *E. guerichiana*, *E. virosa.* Leaf-succulent Shrubs: *Aloe dabenorisana*, *A. gariepensis*, *Mesembryanthemum inachabense, Prenia tetragona*, *Trianthema parvifolia*, *Tylecodon rubrovenosus*, *Zygophyllum decumbens*, *Z. microcarpum*, *Z. rigidum.* Other Shrubs: *Adenolobus gariepensis*, *Antherothamnus pearsonii*, *Aptosimum tragacanthoides*, *Barleria lancifolia*[E], *B. rigida*, *Cadaba aphylla*, *Calicorema capitata*, *Diospyros acocksii*, *Dyerophytum africanum*, *Eriocephalus scariosus*, *Hermannia stricta*, *Justicia orchioides*, *Monechma mollissimum*, *Petalidium setosum*, *Rhigozum obovatum*, *Rhus populifolia*, *Sisyndite spartea.* Graminoids: *Enneapogon scaber*, *Schmidtia kalahariensis*, *Stipagrostis anomala*, *S. ciliata, S. obtusa*. Perennial Herbs: *Abutilon pycnodon*, *Chascanum garipense*, *Codon royenii*, *Rogeria longiflora*, *Tribulus cristatus.* Geophytic Herb: *Bowiea gariepensis*. Succulent Herb: *Mesembryanthemum guerichianum.* Annual Herbs: *Cleome angustifolia* subsp. *diandra*, *C. foliosa* var. *lutea.*

Endemic Taxa Small Tree: *Ozoroa namaquensis.* Leaf-succulent Dwarf Shrub: *Tylecodon sulphureus.*

Conservation Target 34%. None conserved in South Africa in statutory conservation areas. This unit also occurs north of the Orange River in Namibia where it is potentially conserved through the ownership of the Farm Tsams by the Namibian Ministry of Environment and Tourism.

Remarks The southernmost mapped mountains are transitional to Bushmanland Inselberg Shrubland. The higher mountains mapped in the unit, especially in the east such as the Pella Mountains, have considerably higher rainfall on the upper slopes with some plant species more characteristic of less hyperarid areas (e.g. *Triraphis ramosissima* on the higher southern slopes and *Euphorbia avasmontana* on the higher and lower northern slopes; Van Jaarsveld 1985). The unit comprises part of the Gariep CE (Van Wyk & Smith 2001). From a phytogeographical point of view, the area belongs to the Namaland Domain of the Nama-Karoo Floristic Region (Jürgens 1991), which approximates the Nama-Karoo Biome as defined by Rutherford & Westfall (1986), but not the Nama-Karoo Biome of Rutherford (1997) as well as in the present work. It may appear necessary to reconsider the current concept of the Eastern Gariep Rocky Desert and to split it into two (possibly near Goodhouse). This step would also corroborate the east-west difference in geology (see above). While the western half is floristically very similar to parts of some of the eastern Richtersveld mountain desert units, the eastern section has many species with a wider savanna- or Kalahari-related distribution.

28.3 Lower Gariep Alluvial Vegetation

Distribution Northern Cape Province: Broad alluvium (floodplains and islands) of the Orange (Gariep) River between Groblershoop and the mouth into the Atlantic Ocean at Oranjemund (Namibia). This river stretch is embedded within Desert (Oranjemund to roughly Pofadder) and Nama-Karoo (further upstream as far as Groblershoop). Altitude ranging from 0–1 000 m.

Vegetation & Landscape Features Flat alluvial terraces and riverine islands supporting a complex of riparian thickets (dominated by *Ziziphus mucronata*, *Euclea pseudebenus* and *Tamarix usneoides*), reed beds with *Phragmites australis* as well as flooded grasslands and herblands populating sand banks and terraces within and along the river.

Geology, Soil & Hydrology Recent alluvial deposits of the Orange River supporting soil forms such as Dundee and Oakleaf. The river cuts through a great variety of Precambrian metamorphic rocks. Ia land type. Subject to floods, especially in summer, caused by high precipitation on the highveld.

Climate Region with very arid (desert) to subarid (semidesert) climate and erratic, unimodal (winter-rainfall) regime in the extreme west (near the Orange River mouth) to bimodal, equinoctial with major peak in March and less pronounced peak in November in the extreme east (near Upington). MAP 40–150 mm and MAT between 15.4°C (Alexander Bay) and 20.5°C (Upington). See also climate diagram for AZa 3 Lower Gariep Alluvial Vegetation (Figure 13.2).

Important Taxa **Riparian thickets** Small Trees: *Acacia karroo* (d), *Euclea pseudebenus* (d), *Salix mucronata* subsp. *mucronata* (d), *Schotia afra* var. *angustifolia* (d), *Ziziphus mucronata* (d), *Acacia erioloba*, *Combretum erythrophyllum*, *Ficus cordata*, *Maerua gilgii*, *Prosopis glandulosa* var. *glandulosa*, *Rhus lancea*. Tall Shrubs: *Gymnosporia linearis* (d), *Tamarix usneoides* (d), *Ehretia rigida*, *Euclea undulata*, *Sisyndite spartea*. Low Shrub: *Asparagus laricinus*. Woody Climber: *Asparagus retrofractus*. Succulent Shrub: *Lycium bosciifolium*. Herb: *Chenopodium olukondae*. **Reed beds** Megagraminoid: *Phragmites australis* (d). **Flooded grasslands & herblands** Low Shrubs: *Tetragonia schenckii* (d), *Litogyne gariepina*. Graminoids: *Cynodon dactylon* (d), *Setaria verticillata* (d), *Cenchrus ciliaris*, *Cyperus laevigatus*, *Eragrostis echinochloidea*, *Leucophrys mesocoma*, *Polypogon monspeliensis*, *Stipagrostis namaquensis*. Herbs: *Amaranthus praetermissus*, *Coronopus integrifolius*, *Frankenia pulverulenta*, *Gnaphalium confine, Pseudognaphalium luteo-album*.

Conservation Endangered. Target 31%. About 6% statutorily conserved in the Richtersveld and Augrabies Falls National Parks. Some 50% transformed for agricultural purposes (vegetables and grapes) or alluvial diamond mining. *Prosopis* species, *Nicotiana glauca* and *Argemone ochroleuca* can invade the alluvia in places.

28.4 Methodology used in determining significance of impacts

The methodology to be used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks associated with the alternatives is provided in the following tables:

Table 28.4.1 Nature and type of impact

Nature and type of impact	Description
Positive	An impact that is considered to represent an improvement to the baseline conditions or represents a positive change
Negative	An impact that is considered to represent an adverse change from the baseline or introduces a new negative factor
Direct	Impacts that result from the direct interaction between a planned project activity and the receiving environment / receptors
Indirect	Impacts that result from other activities that could take place as a consequence of the project (e.g. an influx of work seekers)
Cumulative	Impacts that act together with other impacts (including those from concurrent or planned future activities) to affect the same resources and / or receptors as the project

Table 28.4.2 Criteria for the assessment of impacts

Criteria	Rating	Description
Spatial extent of impact	National	Impacts that affect nationally important environmental resources or affect an area that is nationally important or have macro-economic consequences
	Regional	Impacts that affect regionally important environmental resources or are experienced on a regional scale as determined by administrative boundaries or habitat type / ecosystems
	Local	Within 2 km of the site
	Site specific	On site or within 100m of the site boundary
Consequence of impact/ Magnitude/ Severity	High	Natural and / or social functions and / or processes are severely altered
	Medium	Natural and / or social functions and / or processes are notably altered
	Low	Natural and / or social functions and / or processes are slightly altered
	Very Low	Natural and / or social functions and / or processes are negligibly altered
	Zero	Natural and / or social functions and / or processes remain unaltered
Duration of impact	Temporary	Impacts of short duration and /or occasional
	Short term	During the construction period
	Medium term	During part or all of the operational phase
	Long term	Beyond the operational phase, but not permanently
	Permanent	Mitigation will not occur in such a way or in such a time span that the impact can be considered transient (irreversible)

Table 28.4.3 Significance Rating

Significance Rating	Description
High	High consequence with a regional extent and long-term duration High consequence with either a regional extent and medium-term duration or a local extent and long-term duration Medium consequence with a regional extent and a long-term duration
Medium	High with a local extent and medium-term duration High consequence with a regional extent and short-term duration or a site-specific extent and long-term duration High consequence with either local extent and short-term duration or a site-specific extent with a medium-term duration Medium consequence with any combination of extent and duration except site-specific and short-term or regional and long term Low consequence with a regional extent and long-term duration
Low	High consequence with a site-specific extent and short-term duration Medium consequence with a site-specific extent and short-term duration Low consequence with any combination of extent and duration except site-specific and short-term Very low consequence with a regional extent and long-term duration
Very low	Low consequence with a site-specific extent and short-term duration Very low consequence with any combination of extent and duration except regional and long term
Neutral	Zero consequence with any combination of extent and duration

Table 28.4.4 Probability, confidence, reversibility and irreplaceability

Criteria	Rating	Description
Probability	Definite	>90% likelihood of the impact occurring
	Probable	70 – 90% likelihood of the impact occurring
	Possible	40 – 70% likelihood of the impact occurring
	Unlikely	<40% likelihood of the impact occurring
Confidence	Certain	Wealth of information on and sound understanding of the environmental factors potentially affecting the impact
	Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact
	Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact
Reversibility	Reversible	The impact is reversible within 2 years after the cause or stress is removed
	Irreversible	The activity will lead to an impact that is in all practical terms permanent
Irreplaceability	Replaceable	The resources lost can be replaced to a certain degree
	Irreplaceable	The activity will lead to a permanent loss of resources.

Table 28.5 Conservation Value

Conservation Value		
Refers to the intrinsic value of the area or its relative importance towards the conservation of an ecosystem or species or even natural aesthetics. Conservation status is based on habitat function, its vulnerability to loss and fragmentation or its value in terms of the protection of habitat or species	Low 1	The area is transformed, degraded not sensitive (e.g. Least threatened), with unlikely possibility of species loss.
	Medium / Low 2	The area is in good condition but not sensitive (e.g. Least threatened), with unlikely possibility of species loss.
	Medium 3	The area is in good condition, considered vulnerable (threatened), or falls within an ecological support area or a critical biodiversity area, but with unlikely possibility of species loss.
	Medium / High 4	The area is considered endangered or, falls within an ecological support area or a critical biodiversity area, or provides core habitat for endemic or rare & endangered species.
	High 5	The area is considered critically endangered or is part of a proclaimed provincial or national protected area.

Table 28.6 Significance

Significance	Score	Description
Insignificant	4 - 22	There is no impact or the impact is insignificant in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site.
Low	23 - 36	An impact barely noticeable in scale or magnitude as a result of low sensitivity to change or low intrinsic value of the site, or will be of very short-term or is unlikely to occur. Impact is unlikely to have any real effect and no or little mitigation is required.
Medium / Low	37 - 45	Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved. Impacts may have medium to short term effects on the natural environment within site boundaries.
Medium	46 - 55	Impact is real, but not substantial. Mitigation is both feasible and fairly easily possible, but may require modification of the project design or layout. These impacts will usually result in medium to long term effect on the natural environment, within site boundary.
Medium High	56 - 63	Impact is real, substantial and undesirable, but mitigation is feasible. Modification of the project design or layout may be required. These impacts will usually result in medium to long-term effect on the natural environment, beyond site boundary within local area.
High	64 - 79	An impact of high order. Mitigation is difficult, expensive, time-consuming or some combination of these. These impacts will usually result in long-term change to the natural environment, beyond site boundaries, regional or widespread.
Unacceptable	80 - 100	An impact of the highest order possible. There is no possible mitigation that could offset the impact. The impact will result in permanent change. Very often these impacts cannot be mitigated and usually result in very severe effects, beyond site boundaries, national or international.

Table 28.7 Scoring system

Parameter	1	2	3	4	5
Conservation value Likelihood Duration Extent Severity	Low Unlikely Temporary Site specific Zero	Medium /Low Possible Short term Local Very low	Medium More possible Medium term Regional Low	Medium / High Probable Long term National Medium	High Definite Permanent International High

Significance = Conservation value (Likelihood + Duration + Extent + Severity)

28.8 Risk Matrix Methodology

RISK ASSESSMENT KEY (Referenced from DWA RISK-BASED WATER USE AUTHORISATION APPROACH AND DELEGATION GUIDELINES)

Negative Rating

TABLE 1- SEVERITY

How severe does the aspects impact on the environment and resource quality characterisitics (flow regime, water quality, geomorfology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means	

TABLE 2 – SPATIAL SCALE

How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catch	3
National (impacting beyond seconday catchment or provinces)	4
Global (impacting beyond SA boundary)	5

TABLE 3 – DURATION

How long does the aspect impact on the environment and resource quality?

One day to one month, PES, EIS and/or REC not impacted
One month to one year, PES, EIS and/or REC impacted but no change in status
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation
Life of the activity, PES, EIS and/or REC permanently lowered
More than life of the organisation/facility, PES and EIS scores, a E or F

TABLE 4 – FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

TABLE 5 – FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the environment?

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

TABLE 6 – LEGAL ISSUES

How is the activity governed by legislation?

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

TABLE 7 – DETECTION
How quickly can the impacts/risks of the activity be observed on the environment (water resourc
Immediately
Without much effort
Need some effort
Remote and difficult to observe
Covered

TABLE 8: RATING CLASSES		
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
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
A low risk class must be obtained for all activities to be considered for a GA		

TABLE 9: CALCULATIONS

Consequence = Severity + Spatial Scale + Duration
Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection
Significance \Risk= Consequence X Likelihood