WATER USE LICENSE APPLICATION
FOR THE CONSTRUCTION OF A NEW WASTEWATER TREATMENT WORKS
LOUBOS
FRESH WATER REPORT

A REQUIREMENT IN TERMS OF SECTION 21 OF THE NATIONAL WATER ACT
FEBRUARY 2019

Index

Abbreviations

Critical Biodiversity Area	CBA
Department of Environmental Affairs and Development Planning	DEA&DP
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
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
Wastewater Treatment Works	WWTW
Water Use License Application	WULA

List of Figures

List of Tables

1 Introduction

Loubos is in the remote Northern Cape, 14 km away from the Namibian border at Rietfontein and 47 km away from the Botswana border, as the crow flies. It is in the deep of the Kalahari Desert, 226 km north of Upington, again as the crow flies. This is an arid area, with only some 80mm of rain per year.

Loubas falls within the Dawid Kruiper Municipality, of which the largest city is Upington on the banks of the Orange River.

Loubos has only 800 residents. It is in dire need of a WWTW, as there are no facilities for the treatment of sewage other than that on nearby towns. BVi Consulting Engineers have been appointed to investigate the possibility of planning a WWTW at Loubos.

Subsequently BVi appointed Enviro Africa to conduct the legally required EIA for the project. Enviro Africa, in turn, appointed Dr Dirk van Driel of WATSAN Africa for the WULA. The WULA is required because the WWTW is to be constructed within 100m of a water course. The WULA also is an integral part of the EIA.

The WULA requires that a Fresh Water Report is submitted, which must provide adequate information for an informed decision pertaining to the approval of the envisaged WWTW. The report must contain the Risk Matrix, according to which the level of approval will be decided upon.

Loubos is 4.2 km away from the northern bank of Hakskeenpan, as the crow flies. In fact, Hakskeenpan is central to the approval of the WWTW. Hakskeenpan exhibits a delicate and complicated ecology, which demands the highest level of protection and conservation. A WWTW so close to its banks will predictably attract the attention of South African conservation authorities.

This report argues for the approval of a Licence, the highest level of approval, subject to the strictest conditions.

This report only deals with Section 21 (c) and (i) of the NWA. A WWTW is a declared activity, in terms of Section 21 (e) of the NWA. This report does not deal with S21 (e). For this a separate specialist report will have to be compiled.

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 pipeline is located on the banks of a drainage line. The drainage line could possibly be altered, should the development go ahead.

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

The proposed pipeline may alter the characteristics of the drainage lines.

S21 (e). The NWA makes provision for controlled activities. S37(1) declares WWTW’s such controlled activities, which should be officially authorised.

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. Likewise, no development may take place within 500m of a wetland without the consent of the DWS.

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

3 Askham Climate

http://www.saexplorer.co.za/south-africa/climate/askham_climate.asp

Askham is the closest locality to Loubos for which climatological data (Figure 1) has been made available on SA Explorer, some 70km away.

Askham normally receives about 84mm of rain per year, with most rainfall occuring mainly during summer. The chart below (lower left) shows the average rainfall values for Askham per month. It receives the lowest rainfall (0mm) in May and the highest (24mm) in February. The monthly distribution of average daily maximum temperatures (centre chart below) shows that the average midday temperatures for Askham range from 20°C in June to 33°C in January. The region is the coldest during July when the mercury drops to 2.9°C on average during the night.

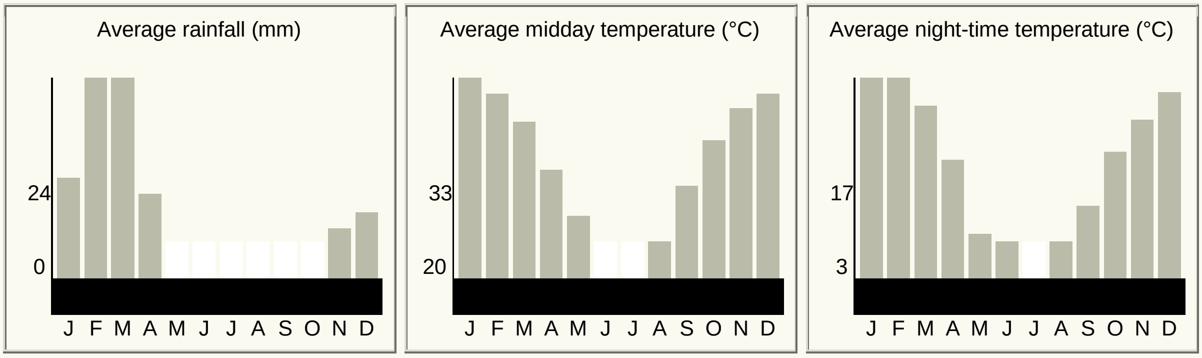

Figure 1 Askham Climate

These averaged rainfall figures are not realistic for the situation on the ground, where 80 to 100mm of rain can fall within a 24 hour-period during sudden and violent electric thunder storms.

The climate can be described as semi-arid. It is probably better described better as arid or desert, as is the Kalahari Desert of the Northern Cape.

4 Quaternary Catchment

Loubos is located in the D42B quaternary catchment.

5 Vegetation

The vegetation is listed as Kalahari Karoid Shrubland. None of this is endangered, according to the vegetation maps on the SANBI webpage.

The area south and adjacent to Loubos has been identified as NFEPA's. These are Nama Karoo Bushmanland Unchanelled Valey Bottom Wetlands (Figure 2).

Figure 2 NFEPA's (SANBI)

6 Sub-Catchments

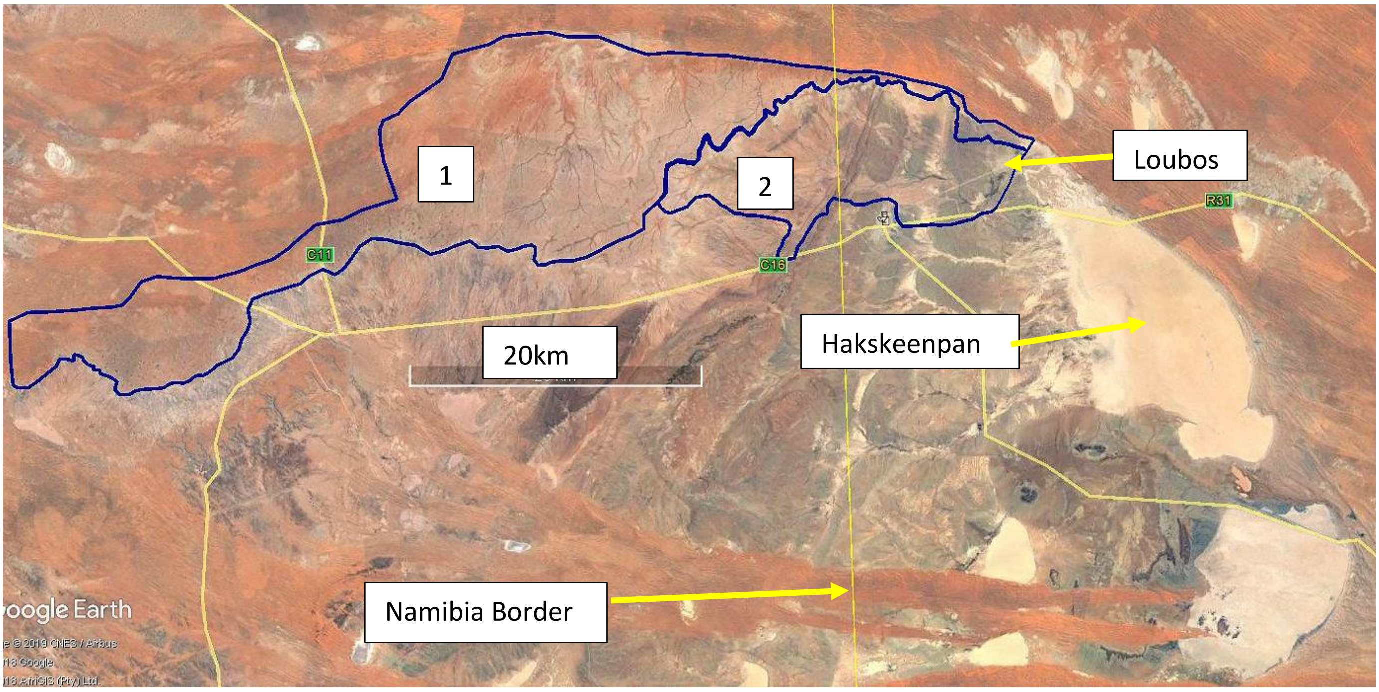

Figure 3 Sub-Catchment

Table 1 Sub-Catchment surface area

Part	Surface Area ha	Length km	Width km	Circumference km
Sub-Catchment 1 Sub-Catchment 2	43000 16200	141 51	15 23	183 75

There are five prominent drainage lines that enter Hakskeenpan of which the upper two are depicted in Figure 3. Dimensions are given in Table 1.

Loubos is located in Sub-Catchment 2.

The sub-catchments stretch far into Namibia across the border.

The northern boundary of Sub-Catchment 1 is marked by a red Kalahari sand dune (Figure 4). The sand dune stretches al the wat to the west into Namibia. It forms a natural barrier that diverts runoff into Hakskeenpan. It is a prominent feature of the local landscape. The wide drainage line along the dune is known among the local people as the “Voorduin”.

The highest point in Sub-Catchment 1 is 1063masl and where it enters Hakskeenpan is on 819masl. This represents a slope of 0.3m in 100 horizontal metres. The slope of Sub-Catchment 2 is similar. With such a slight slope it is not obvious where the preferential flow paths are and it is quite possible and even likely for runoff from the larger Sub-Catchment 1 flows over into Sub-catchment 2, especially in the narrow area of Sub-Catchment 1 next to the dune.

With such a very slight slope is seems unlikely that flowing water down the catchment would reach adequate velocity to move sediments. But then it does, for everywhere, even outside of drainage lines on seemingly level ground, there are signs of sediment erosion and subsequent deposition.

Figure 4 Kalahari Sand Dune

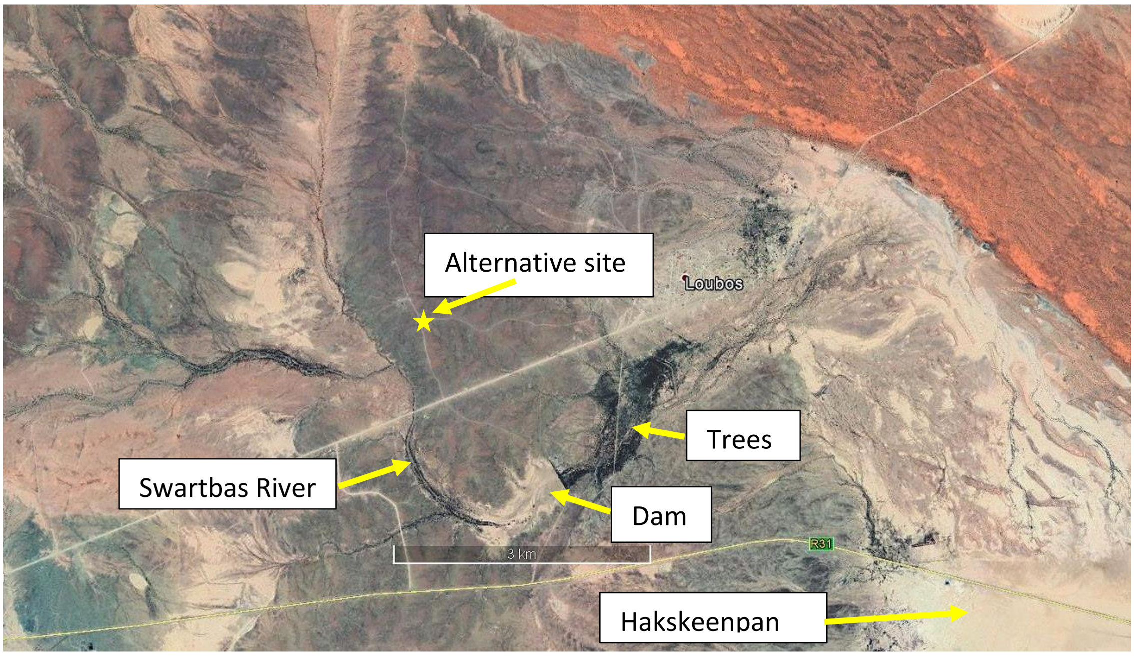

Figure 5 Swartbas River

The drainage line of Sub-Catchment 2 is known among the local people as the Swartbas River. It is the biggest of the drainage lines on the dirt road between Rietfontein and Loubos (Figure 5 and 6).

Figure 6 Swartbas River Bridge

The Swartbas River first flows into a small dam (Figure 6) before it discharges into the Hakskeenpan in the same area as Sub-Catchment 1. Downstream and adjacent to the dam is a patch of trees that undoubtedly exist because of seepage out of the dam and the replenishment of ground water. These trees are visible on the Google Earth image (Figure 5).

7 Swartbas River Tributaries

There are a number of smaller tributaries of the Swartbas River crossing the dirt road from Rietfontein to Loubos (Figure 7 and 8).

Apart from pipes there are more crossings or ‘drifts” were the occasional flood cross the dirt road. For such a dry area, these drainage lines are surprisingly close to one another, is some places three of them in less than two kilometres.

Figure 7 Storm water pipe under dirt road

Figure 8 Another storm water pipe

8 Riparian Zone

The Kalahari Desert is a sparse country, with mostly short vegetation, such as scrub and grasses. The Kalahari around Hakskeenpan is blessed with the iconic camelthorn trees (*Vachellia erioloba*), which dots the landscape. Apart from these trees, vegetation is sparse. The drainage lines have water only during and shortly after the occasional thunder storm. The shallow groundwater along drainage lines lingers on for longer, thereby allowing for lines of trees crossing the landscape. An example is green line which marks the Swartbas River (Figure 9).

The smaller tributaries of the Swartbas River, as the many other similar drainage lines, carry smaller trees and scrub, but still markedly higher than that of the surrounding area (Figure 10).

These lines of higher vegetation are an extremely important part of the Kalahari ecology, as it constitutes habitat for a variety of habitat to organisms such as reptiles and birds, which would have been absent, were it not for the drainage lines. The drainage lines are important as a food source and cover for a variety of mammals.

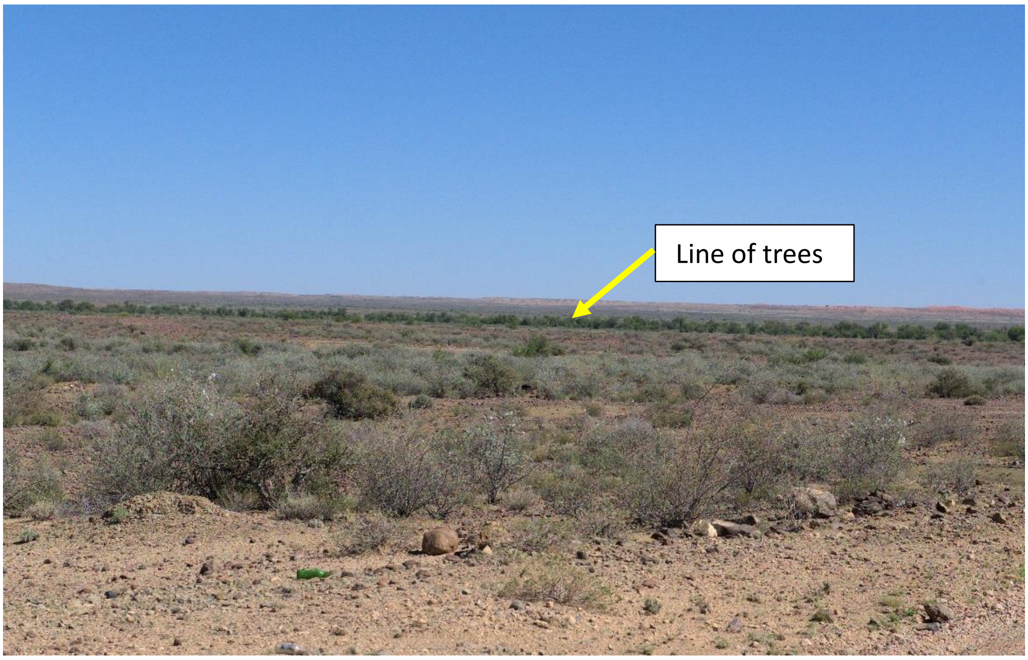

Figure 9 Swartbas River green line of vegetation

Figure 10 Smaller Tributary Vegetation

9 Hakskeenpan

Hakskeenpan is flat (Figure 11). Among other flat places on the planet, Hakskeenpan draws the attention as being even larger and flatter.

It was created during geological times by the uplifting of the landscape to 800m above sea level. The rising of the land locked in runoff. Instead of flowing to the ocean a series of land-locked lakes were created, of which Hakskeenpan is one. Sudden and intense rain storms flooded the lake and suspended the fine sediments of the underlying shales. Re-deposited sediments levelled out the ground over a period of millions of years. Rocks that stuck out above the landscape were soft and were easily eroded by the harsh desert winds. This all contributed to the formation of Hakskeenpan.

Figure 11 Hakskeenpan

Hakskeenpan (Figure 11) is located in the remoteness of the Kalahari Desert of the Northern Cape in South Africa close to the Namibian border. It is some 22 km long and 11km wide.

Ground water movement is from the mostly dry Aoub River south westerly towards Mier and Hakskeenpan. Ground water is in the secondary aquifer in the Dwyka formation tillites. Yields differ widely, even 10m apart. Ground water quality is very poor with high conductivity and exceeds the 60 mSm^{-1} drinking water level. The saltiness is mostly the results of high concentrations of chlorides. The formation underlying Hakskeenpan is largely impermeable and floodwater evidently does not "leak" into the ground water.

10 Hakskeenpan: Current Limnological Knowledge

The question is often asked if Hakskeenpan qualifies as a valid wetland, considering that it is devoid of any water or moist most of the time, that the submerged period is brief and that aquatic life forms bear little resemblance to that of regular fresh water habitats. In many ways science still has to find a spot as to where to position Hakskeenpan and the like in the array of aquatic habitats that occur on the planet.

National Research Foundation (NRF) is an agency of the South African national government Department of Science and Technology. It advertised on-line

(http://www.saeon.ac.za/2016%20Postdoc%20Ad%20SAEON%20-%20Landscape%20Ecology%20of%20Pans.pdf)

for a post-doctoral position. This was to study the ecology of ephemeral pans of the Northern Cape.

"The SAEON Arid Lands node offers opportunities for detecting changes in ephemeral pans across the Northern Cape Province. Though usually dry and only briefly wet from time to time, these pans are possibly the most sensitive ecosystems in this area, potentially supporting many species of conservation significance, and probably acting as key ecosystem structures for numerous species. Despite this, the pans of the Karoo (Bushmanland) and southern Kalahari (Hakskeenpan Complex; Ghaap Plateau; Kimberley) have received little attention in terms of research. By comparison, the geomorphology and biodiversity of ephemeral pans in less arid regions of South Africa are better studied and serve as good comparison. This postdoc project sets out to characterize pans, including the use of maps and remote sensing, and gather historic data on wetting. Samples of pans will be selected for more detailed data collection, which will then feed into a model incorporating abiotic (geomorphological, climatic, hydrological) and biotic (biodiversity, life histories, metapopulation dynamics, food-webs and community ecology) features and processes in their landscape context. This will include both aquatic and alternating dormant phases, as well as the interrelationship between pans to adjacent terrestrial ecosystems. The model should incorporate drivers and indicators of environmental changes of pans and make management recommendations for pans in their landscapes context in view of potential anthropogenic developments and in relation to global change."

The closing date was 30 June 2016.

From this advertisement is evident that there was very little known about the ecology of Hakskeenpan. Since then Dr Betsie Milne was appointed and she subsequently devoted her time towards the study of habitat selection of crustaceans in the Bushmanland ephemeral pans, according to her presentation on a conference in 2018.

Nevertheless, it can be deducted from the advertisement that Hakskeenpan is mostly dry. When it rains the pan suddenly floods, which only happens occasionally.

When flooded, so is surmised, an entire ecology springs to life. Micro-algae (primary producers) reproduce rapidly in the nutrient-laden water to form a source of food for the microbial grazers (secondary producers) and a complicated chain of microbial predators, with macro-invertebrates at the top of the food chain. These may be dense clouds of swimming fairy shrimps (Crustacea, Anacostraca).

The pan dries up as suddenly as it flooded. As the last of the moist evaporates, the planktonic organisms perish, but leaving behind a wealth of spores and eggs. These sink into the red soil, in among the cracks that typically develop in these drying pans, to sub-terraneously withstand the scorching temperatures of the harsh Kalahari sun and the sub-zero temperatures of winter nights for months and even years on end.

These are very special organisms with highly adapted life cycles. They successfully survive in their dormant state under extreme conditions on the floor of the pan, ready to explode into life at the next flood event.

If one reads through the advertisement it is evident that birds are important. These birds feed on the macro-invertebrates and include flamingos and Palearctic waders. Piscivorous pelicans have been noticed on a flooded Hakskeenpan, but these moved on within days as there was no fish to feed on.

For flamingos on the pan, visit http://www.news24.com/Green/News/flamingos-turn-kalahari-pan-pink-in-once-in-a-lifetime-spectacle-20160307. This was in January 2016, when the pan was flooded for several weeks following 100mm of rain in just 2 days.

Much of the above is mere speculation, based on research in ephemeral pans in other parts of the world. On the other hand, much of the above description of this ecological marvel is probably quite true, but needs to be confirmed by meticulous scientific research.

Meanwhile there is little to go on to produce the required Technical Report.

Meanwhile we assume that Hakskeenpan is indeed a legitimate water resource that answers to the definition of the National Water Act, even though the only acknowledged user of the resource is nature. Because of the dormant but very much alive biota in the bone-dry soil, it is indeed a water resource, even though there is no water during the dry part of the cycle.

Australians have collected much more information on their ephemeral pans. As long ago as 1983 De Decker published an account on the vast body of basic research on Australia's saline pans.

(http://people.rses.anu.edu.au/dedeckker_p/pubs/120.pdf).

Professor Brian Timms of the University of New South Wales has devoted a lifetime of research on Australian salt pans (conference, Kimberley, 2018).

From this it is clear that the driver that sets the food web going when flooded is phytoplankton. This is followed by microbial grazers and planktonic predatory organisms on various trophic levels.

From then research developed into population dynamics. They determined that the number of predatory invertebrate species increases as flood water recedes and that more trophic levels are introduced into the food web. The food web becomes more complicated as the hydroperiod nears its end. Community structure is determined by the frequency of flooding and the depth of the pan.

There is no reason to believe that the population dynamics of Hakskeenpan is any different from that of the Australian situation. In order to assess any impact on the ecosystem is necessary this level of knowledge is available. Meanwhile we the need to assess possible impacts on Hakskeenpan remains and we will have to do with assumptions, but assumptions based on scientific knowledge and verified research.

11 The Flood

The Kalahari is an arid region, from semi-desert to one of the driest deserts in the world. Likewise, the drainage lines around Loubos are mostly dry. The only sign of the presence of surface water are the sandy sediments that have been mobilised by moving water and subsequently deposited further down the slopes.

Rainfall is highly variable. It is characterised by sudden and violent summer thunder storms.

Droughts between these storms may last for years. The intense summer heat is overwhelming, as is usual for deserts such as the Kalahari.

In 2016 no less than 100mm of rain fell within 24 hours in the Hakskeenpan catchment. Dry river beds are dramatically transformed into raging torrents with standing waves and white water. Hakskeenpan was filled up to the brink . In most places it was up to 1.5m deep. This water lasted for at most 8 weeks, after which Hakskeenpan returned to its usual arid state.

In January 2019 more than 80mm of rain was measured at Loubos. Shortly after the site visit took place. It was extremely fortunate to photograph Hakskeenpan (Figure 12) during its short, wet phase. At the time there was still water standing in the drainage lines.

Interesting and important, Hakskeenpan filled up from the northern corner out of the Voorduin, from where the water passed through the culverts underneath the R31 trunk road to the larger southern section of Hakskeenpan.

The standing water in the Voorduin was particularly impressive (Figure 13). To see so much water in a desert was a sight to remember.

Moreover, even on the level ground away from the drainage lines there were signs of moving water, sediment erosion and deposition. Closer to the drainage lines proper there were areas with much braided water ways up to 100m wide (Figure 14).

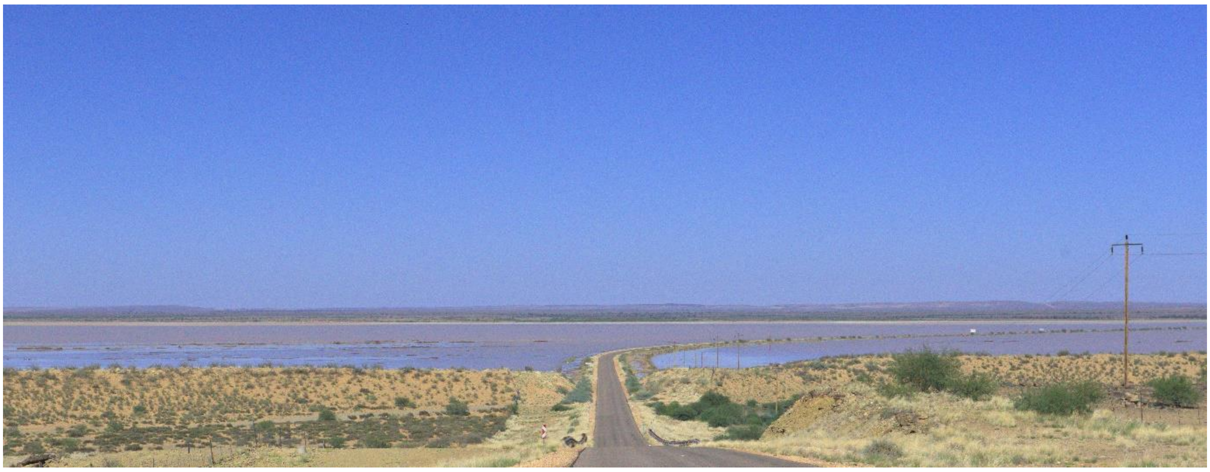

Figure 12 Hakskeenpan Flooded

Figure 13 Voorduin flooded, from top of the dune

Figure 14 Voorduin flooded.

Figure 15 Braided water way

At the time of the site visit water was still standing in the drainage lines next to the access road to Loubos (Figure 16). The Swartbas Dam was full, as seen from the R31 trunk road south of Hakskeenpan (Figure 17).

Figure 16 Water in a drainage line

Figure 17 Swartbas Dam

Figure 18 Partially collapsed gabions

Figure 19 Road flood damage

The erosion potential of these moving waters was obvious (Figure 18 and 19). Storm water infrastructure along the roads were damaged.

This particular hydrological situation is most relevant to the construction of the envisaged WWTW at Loubos. Even if constructed on level ground away from any drainage line, it would occasionally still be subjected to moving flood water. Smaller drainage lines are close together and it would hardly be possible to construct the envisaged WWTW 100m away, as is specified in GN905.

12 Current Situation

Currently sewage is collected with tanker trucks and transported to the Rietfontein WWTW some 10km away. The transport costs are too much to bear for the small Loubos population. Moreover, the Rietfontein WWTW is currently working very close to its design capacity.

In the recent past some of the sewage reportedly found its way into the local waste disposal site (Figure 20). In a sensitive environment such as the Hakskeenpan catchment area, this is entirely unacceptable. Fortunately, the practice was stopped.

In fact, the waste disposal site depicted in Figure 1 should not be permissible in the Hakskeenpan catchment, as it constitutes a threat to the aquatic environment. It should be replaced by a properly sited and well-operated facility.

Figure 20 Waste Disposal Site

13 The Project

At this stage the project is in the planning phase. It has not been decided exactly where the WWTW will be located. The alternatives are indicated on Figure 21. Alternative 1 seems to be the preferred location, but this may change as the project develops.

From a hydrobiological and aquatic environment conservation perspective, it does not really matter which one of the locations are eventually decided upon, as all are subject to moving water during high rainfall events.

Any runoff from the illustrated sites essentially will flow into Hakskeenpan through Sub-Catchment 2.

Unfortunately, it will not end up in the Swartbas River to flow into the dam. The dam could act as a buffer, a measure to contain mishaps and spills from the WWTW, but is it stands now, all of the locations are downstream of the dam. From this perspective it would be advantageous to relocate the WWTW to upstream of the dam. The closest locality for this purpose is 2.5km away (Figure 5), which would add to the transport costs, as no pipeline will be constructed.

Sewage will be collected with tanker trucks in Loubos and subsequently dumped into the proposed WWTW.

However, the 2.5km would help to sedate fears about the odour, if compared to the sites closer to Loubos.

At this stage it is not known if the WWTW will be a horizontal reed bed or anaerobic ponds.

Locality 4 and 5 are too close to NFEPA's to be considered.

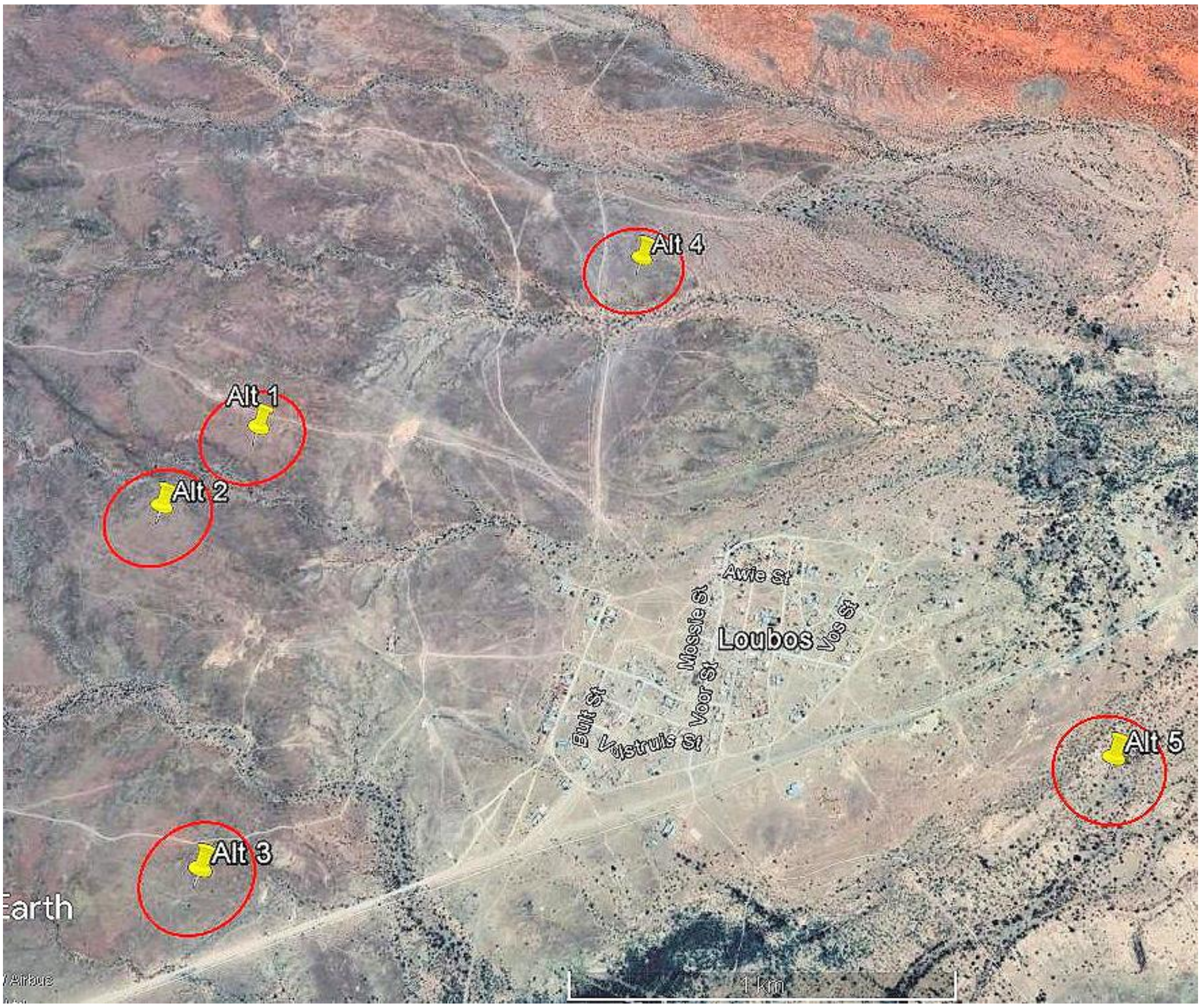

Figure 21 Locality of new WWTW alternatives

14 Present Ecological State (PES)

Table 2 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 and EIS are protocols that have been produced by Dr Neels Kleynhans (Table 2 and 3) 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.

The decision on what water ways are to be evaluated for this particular WULA deserves some deliberation.

Alternative 1 and 2 share the same drainage line. It passes Loubos's northern boundary. Alternative 3 is to the south of Loubos and the drainage line there is less affected by the housing. Alternative 4 is further to the north and is even less affected, as is the drainage line of Alternative 5, which is way to the south east. The drainage lines are all about 5km long and not part of the main water way above the Swartbas Dam. They all connect to the Hakskeenpan downstream of the Swartbas Dam.

The area around is grazed and trampled. The size of this area is approximately 2km by 2km, a significant part of the 4 small drainage lines. It impacts on these drainage lines. It has a negligible effect on the Swartbas catchment, but the impact is noticeable on the smaller drainage lines.

For a full perspective and a proper evaluation, it seems necessary to assess the Swartbas River, the 4 drainage lines under consideration, as well as the Hakskeenpan.

Table 3 Present Ecological State Swartbas River

Instream	Score	Weight	Product	Maximum score
Water abstraction	20	14	280	350
Flow modification	15	13	195	325
Bed modification	18	13	234	325
Channel modification	19	13	247	325
Water quality	24	14	336	350
Inundation	19	10	190	250
Exotic macrophytes	22	9	198	225
Exotic fauna	22	8	176	200
Solid waste disposal	23	6	138	150
Total		100	2003	2500
% of total			80.1	
Class			B	
Riparian				
Water abstraction	20	13	312	325
Inundation	18	11	198	275
Flow modification	16	12	192	300
Water quality	24	13	312	325
Indigenous vegetation removal	24	13	312	325
Exotic vegetation encroachment	18	12	216	300
Bank erosion	22	14	308	350
Channel modification	18	12	216	300
Total			2066	2500
% of total			82.6	
Class			B	

Table 4 Present Ecological State Alternatives Drainage Lines

Instream

	Score	Weight	Product	Maximum score
Water abstraction	24	14	280	350
Flow modification	24	13	195	325
Bed modification	19	13	234	325
Channel modification	19	13	247	325
Water quality	19	14	336	350
Inundation	24	10	190	250
Exotic macrophytes	23	9	198	225
Exotic fauna	19	8	176	200
Solid waste disposal	12	6	138	150
Total		100	2003	2500
% of total			80.1	
Class			B	

Riparian

Water abstraction	24	13	312	325
Inundation	14	11	154	275
Flow modification	24	12	288	300
Water quality	19	13	247	325
Indigenous vegetation removal	18	13	234	325
Exotic vegetation encroachment	18	12	216	300
Bank erosion	22	14	308	350
Channel modification	22	12	264	300
Total			2023	2500
% of total			80.9	
Class			B	

Table 5 Present Ecological State Hakskeenpan

	Score	Weight	Product	Maximum score
Instream				
Water abstraction	25	14	350	350
Flow modification	19	13	247	325
Bed modification	24	13	312	325
Channel modification	24	13	312	325
Water quality	25	14	350	350
Inundation	24	10	240	250
Exotic macrophytes	25	9	225	225
Exotic fauna	24	8	192	200
Solid waste disposal	25	6	150	150
Total		100	2378	2500
% of total			95.1	
Class			A	
Riparian				
Water abstraction	25	13	325	325
Inundation	24	11	264	275
Flow modification	19	12	228	300
Water quality	25	13	325	325
Indigenous vegetation removal	24	13	312	325
Exotic vegetation encroachment	24	12	288	300
Bank erosion	24	14	336	350
Channel modification	24	12	288	300
Total			2366	2500
% of total			94.6	
Class			A	

Table 6 Summary of PES

	Instream		Riparian	
Swartbas River	80.1	B	82.6	B
Alternatives Drainage Lines	80.1	B	80.9	B
Hakskeenpan	95.1	A	94.6	A

The Swartbas River is probably the most impacted one of the five drainage lines that flow into the Hakskeenpan. It is probably the near-pristine ecological state of the other four drainage lines that maintains Hakskeenpan's A classification. If the Swartbas River is allowed to deteriorate further, it would predictably affect Hakskeenpan's status.

15 Ecological Importance

15.1 Ecological Importance Loubos Drainage lines

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 lines, 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. Camel thorn *Vachellia erioloba* is listed as "least concern" on the SANBI Red List, but is not particular associated with the riparian zone of drainage lines.

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)

15.2 Ecological Importance of Hakskeenpan

Hakskeenpan does not harbour any fish either, but then it is an ephemeral endoreic wetland, for which other criteria should apply, criteria directed at specifically this sort of habitat.

Based on scientific knowledge on other similar wetlands and based on inferences, it is assumed that Hakskeenpan harbours highly specialised organisms adapted to this particular habitat, some of which may be new to science. It is assumed that the population dynamics of Hakskeenpan organisms would reveal fascinating pathways still unknown to science. It is not known if any organisms are endangered by virtue of their small distribution range. Some of them my only occur in Hakskeenpan and nowhere else. It can only be assumed that, with the looming increase of human settlement on its banks, that these organisms can potentially become endangered and that Hakskeenpan is, from this angle, most important, in an ecological and conservation sense.

16 Ecological Sensitivity

16.1 Ecological Sensitivity of Loubos 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. If Loubos and its associated infrastructure were to be removed, along with the livestock, would the drainage lines recover?

The in-stream habitat, with its sandy bottom, would probably resemble its current characteristics, even though it might have shifted over time across the sandy landscape, as water ways do.

This is an arid region, with vegetation recovery rates very slow, it would take many decades, perhaps a couple of centuries, for the impacted riparian habitat around Loubos to recover. However, this is not a realistic scenario. Loubos is here to stay, together with its impacts. From this point of view the drainage lines can be listed as ecologically sensitive.

Moreover, the drainage lines are currently taken over by the exotic and invasive Mesque trees, *Prosopis* species.

16.2 Ecological Sensitivity of Hakskeenpan

The last WULA pertaining to Hakskeenpan for the Bloodhound Supersonic Car (WATSAN, 2016). It was surmised that once the Bloodhound event was concluded, the track would return to its original status, in perhaps a couple of years or a decade. It was assumed that if the dirt roads and road embankments were to be removed, the affected habitat would eventually return to its original state, given that a couple of flood events would reset the pan. It can even be surmised that if the R31 trunk road was to be removed and the area landscaped to its original elevation, the pan would probably return to a state close to its unimpacted condition. It was concluded that Hakskeenpan was not sensitive to the Bloodhound SCC event.

With the Loubos WWTW WULA new perspectives came to light. If sewage, sludge or even treated effluent would ever reach Hakskeenpan, the phosphorus that would be introduced would bind to the bottom sediments, as phosphorus does and would be re-introduced into the water column when flooded. This would be a permanent satiation, as numerous eutrophication studies over a number of decades have shown. This would cause untold ecological damage, the scope of which can only be guessed.

Hakskeenpan can be classified as ecologically most sensitive to any leakage from a WWTW.

From this is can be deducted that ecological sensitivity is related to and dependent on the type of impact. Hakskeenpan is likely to be rather insensitive the Bloodhound SCC, but most sensitive to the Loubos WWTW.

This aspect will be further discussed under the following "Impact Assessment" heading.

17 Loubos WWTW Possible Impacts

The contamination of Hakskeenpan with sewage, sewage sludge or even treated sewage effluent poses a serious threat to its delicate and unique ecology. The deleterious effects of sewage and resulting eutrophication in natural bodies of water are well studied and widely documented. Only a slight mishap in this sensitive aquatic environment is potentially dangerous.

Apart from Loubos, Rietfontein, Philandersbron, Klipkolk and even Arouab in Namibia are located in Hakskeenpan's catchment area. These towns are small, but may grow in future. Their combined impact can prove catastrophic for Hakskeenpan's aquatic organisms of which many are still waiting to be described and of which the aquatic community and population dynamics are still to be scientifically investigated. The precautional principle should emphatically apply, until such time the capacity of this environment to absorb impacts is fully understood.

17.1 Construction Phase

During the construction phase some of the drainage lines and its riparian zones could be removed or damage, not only where the new WWTW is constructed, but also along the access routes.

Loosened sediments and building rubble can be washed down the drainage lines and eventually end up in Hakskeenpan.

17.2 Operational Phase

The one aspect of concern is that sudden flood large floods have the capacity to damage earth works, as with roads, bridges and culverts. The new WWTW can be vulnerable, wherever it is located in the catchment area.

The transport of sewage in trucks could result in spillages along the route.

Anaerobic ponds will eventually, after many years of service, be de-sludged. This sludge can end up in the aquatic environment, if not properly managed.

Sewage or partially treated sewage can end up in the aquatic environment of the WWTW overflows, or is damaged, for whatever reason.

At this stage it is unknown what will be done with the treated sewage effluent. It could potentially be washed down the drainage lines. So could contaminated soils.

18 Mitigation Measures

The new WWTW should be sited as far as possible from drainage lines. If possible at all it should not be sited in a drainage line. As it stands now, it would be hard to find a locality at least 100m away from drainage lines, as these are densely distributed over the landscape. Drainage lines migrate over time across the sandy landscape. Even where there are no drainage lines, signs of water movement are evident. The siting of the new WWTW poses challenges and demand serious consideration.

The new WWTW should be located as far as possible from the banks of Hakskeenpan.

If possible at all the new WWTW should be sited in the catchment area of the Swartbas Dam. The dam could serve as a buffer, in case of an accidental spillage.

During the construction phase only one access route should be allowed. Vehicles should not be allowed to move anywhere but on the access road. The footprint should be kept as small as possible.

Likewise, the WWTW's site should be kept as small as possible, with construction activities limited to a demarcated area.

Riparian zones should be kept intact, as far as possible. Where damaged, rehabilitation should takeplace.

Special care should be taken during the design of the new WWTW with regard to storm water management. Cut-off berms and erosion resistant materials should be included in the design. The design should make provision for a worst-case scenario.

At least 500mm freeboard should be maintained in the ponds at all times. Additional ponds should be considered prior to the reaching of the design capacity of the new WWTW.

Written contingency plans should be drafted for implementation, should a spill ever occur.

Clean-up kits should be available, in case of a spill from tanker trucks.

The de-sludging of anaerobic ponds poses special challenges. A new pond should be ready for use prior to the de-sludging operation. The pond in need of maintenance should be allowed to properly dry out before the sludge is removed. Sludge should preferably not be disposed of in the direct Hakskeenpan catchment area, but should be moved elsewhere so that there is no chance left for any of it to move into Hakskeenpan during floods.

Given the ecological realities, treated sewage effluent should preferably not be used for irrigation of crops in the Hakskeenpan catchment area. The effluent should rather be allowed to evaporate from a pond designed for this purpose. The very high evaporation rate of the Kalahari Desert would aid the process.

An ECO should be appointed for the construction of the new WWTW.

Staff operating the WWTW should be properly qualified and experienced.

Three-banded plovers (*Charadrius tricollaris*) on the Rietfontein WWTW invariably die, according to municipal staff, probably because of avian botulism. Likewise, waders visiting the envisaged Loubos WWTW would suffer a similar fate. Research is needed to find ways of preventing mortalities among wader birds on these remote WWTWs.

19 Impact Assessment

Table 8 Impact Assessment

<table>
<tr><td colspan="9">Description of impact

Loosening of soil during construction phase, washing of soil down the drainage lines and into the Hakskeenpan during a storm event

Mitigation measures

Construction only during the dry season.
Keep footprint as small as possible.
Prevent damage to riparian zones
Appoint ECO</td></tr>
<tr><td>Type Nature</td><td>Spatial Extent</td><td>Severity</td><td>Duration</td><td>Significance</td><td>Probability</td><td>Confidence</td><td>Reversibility</td><td>Irreplaceability</td></tr>
<tr><td colspan="9">Without mitigation</td></tr>
<tr><td>Direct</td><td>Regional</td><td>Medium</td><td>Temporary</td><td>Medium</td><td>Probable</td><td>Certain</td><td>Reversible</td><td>Replaceable</td></tr>
<tr><td colspan="9">With mitigation measures</td></tr>
<tr><td>Negative</td><td>Local</td><td>Low</td><td>Medium</td><td>Low</td><td>Unlikely</td><td>Sure</td><td>Reversible</td><td>Replaceable</td></tr>
</table>

Description of impact								
Flood damage during operational phase, Washing of sewage, sludge or treated sewage effluent down the drainage lines and into Hakskeenpan, Leakage and overflowing of WWTW Irrigation with treated sewage effluent								
Mitigation measures								
Construction of storm water management structures Proper operation of WWTW according to SOP Evaporation of treated effluent								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Permanent	High	Probable	Certain	Irreversible	Irreplaceable
With mitigation measures								
Negative	Local	Low	Short term	Very Low	Unlikely	Sure	Reversible	Replaceable

Description of impact								
Maintenance of WWTW Desludging op anaerobic ponds,								
Mitigation measures								
Proper planning and operation of desludging								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Permanent	High	Probable	Certain	Irreversible	Irreplaceable
With mitigation measures								
Negative	Local	Low	Short term	Very Low	Unlikely	Sure	Reversible	Replaceable

Description of impact Transport of raw sewage Spillage from tanker trucks **Mitigation measures** Proper maintenance of trucks Clean up spillage from tanker trucks								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	Low	Medium term	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Very Low	Short term	Very Low	Unlikely	Sure	Reversible	Replaceable

Some of the decision-making authorities prescribe an impact assessment according to a premeditated methodology (Table 26.1, 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 if sewage, sludge or treated effluent find its way down the drainage lines into Hakskeenpan, the impact would be severe. The probability of this happening is assessed in the following Risk Matrix.

The impact assessment does not indicate in any way that the project should not go ahead. The no-go option is neither indicated nor promoted. However, the quality of management pertaining to the implementation of mitigation measures is crucial to the project.

20 Risk Matrix

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 9 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report.

The original risk assessment as on the DWS webpage has been submitted on the included DVD.

Table 9 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1.1	Construction of WWTW	Mobilisation of sediments	Sediments in drainage line and Hakskeenpan	26	Low
1.2		Destruction of riparian zone	Habitat destruction	32	Low
2	Operation of WWTW	Leakage of sewage, sludge or treated effluent	Eutrophication of Hakskeenpan	154	Moderate
3	Maintenance of WWTW	Desludging	Eutrophication	132	Moderate
4	Transport of raw sewage	Sewage in streets	Health Hazard	72	Moderate

Table 9 Continued Risk Rating

No	Flow	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Conse-quence
1.1	1	1	2	1	1.25	1	1	3.25
1.2	1	1	3	3	2	1	1	4
2	1	3	3	5	3	3	5	11
3	1	3	3	5	3	3	5	11
4	1	1	1	1	1	1	4	6

No	Frequency of activity	Frequency of impact	Legal issues	Detection	Likelihood	Significance	Risk Rating
1.1	1	1	5	1	8	26	Low
1.2	1	1	5	1	8	32	Low
2	3	3	5	3	14	154	Moderate
3	2	2	5	3	12	132	Moderate
4	3	3	5	1	12	72	Moderate

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

The methodology is set out in the Appendix. It has been copied directly out of the DWS webpage.

The risks are "Low" during the construction phase. The moment sewage is introduced into the equation, the risks are elevated to "Moderate" and even "High", even though mitigation measures are in place.

The Risk Matric indicate that a Licence should be considered and that a General Authorisation should not be considered.

21 Resource Economics

The goods and services delivered by the environment, in this case the Loubos WWTW, 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 22 and 23) is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 10.

The resource economics footprints of the drainage lines pertaining to the alternative sites for the envisaged WWTW and Hakskeenpan have been drafted separately (Figure 22 and 23).

Table 10. Goods and Services Loubos Alternative Sites Drainage Lines

Goods & Services	Score
Flood attenuation	5
Stream flow regulation	5
Sediment trapping	5
Phosphate trapping	3
Nitrate removal	3
Toxicant removal	3
Erosion control	4
Carbon storage	3
Biodiversity maintenance	5
Water supply for human use	0
Natural resources	0
Cultivated food	2
Cultural significance	1
Tourism and recreation	0
Education and research	1

0	Low
5	High

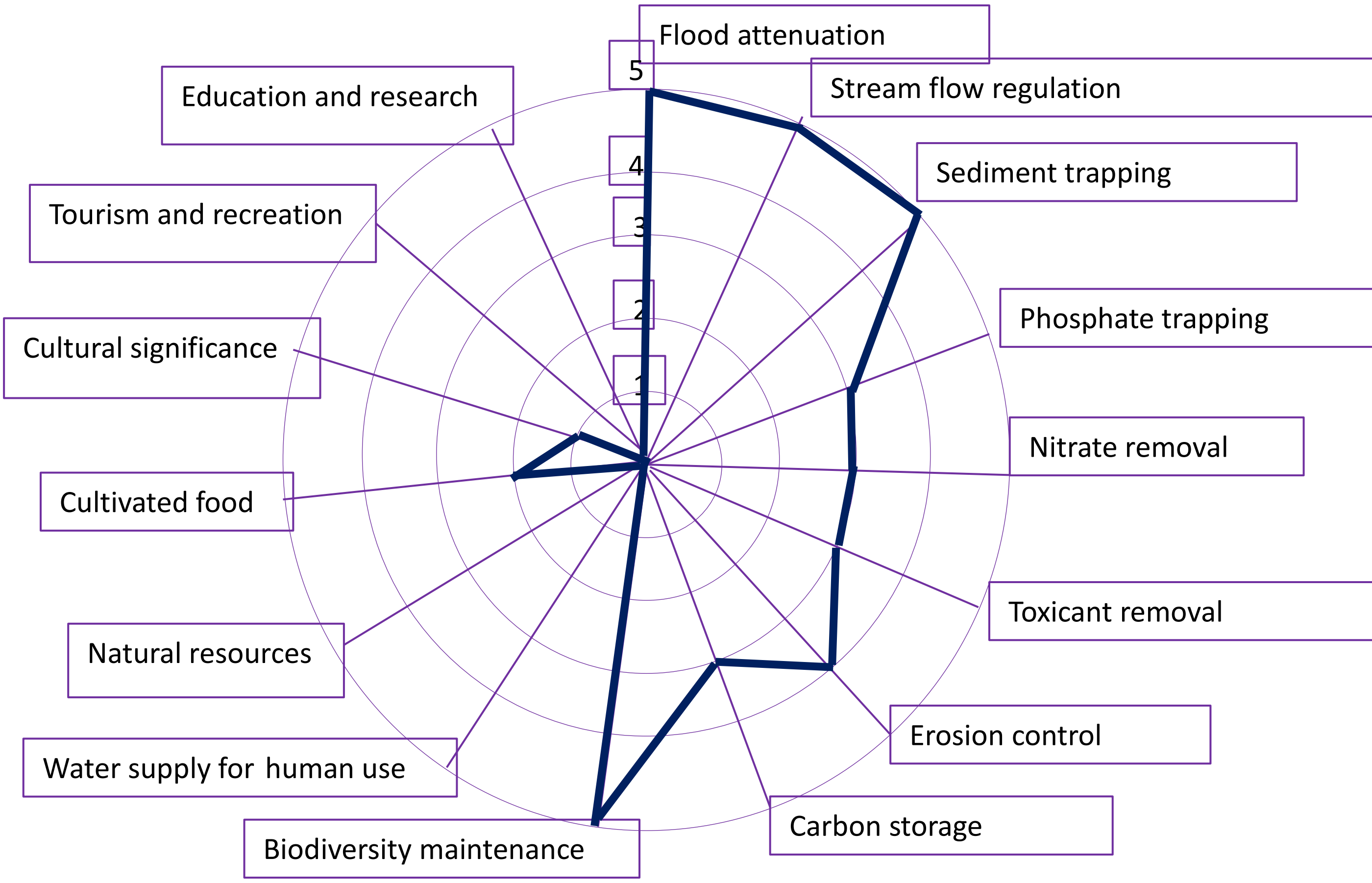

Figure 22. Resource Economics Footprint of the Loubos Alternative Sites Drainage Lines

The size of the star shape in Figure is the feature that attracts the attention of the decision-makers. Apart from flood attenuation, stream flow regulation and sediment trapping, the drainage lines do not have a particularly large footprint, although the maintenance of biodiversity would certainly be regarded as most important.

Table 11. Goods and Services Hakskeenpan

Goods & Services	Score
Flood attenuation	5
Stream flow regulation	5
Sediment trapping	5
Phosphate trapping	5
Nitrate removal	5
Toxicant removal	5
Erosion control	5
Carbon storage	5
Biodiversity maintenance	5
Water supply for human use	0
Natural resources	3
Cultivated food	0
Cultural significance	2
Tourism and recreation	5
Education and research	5

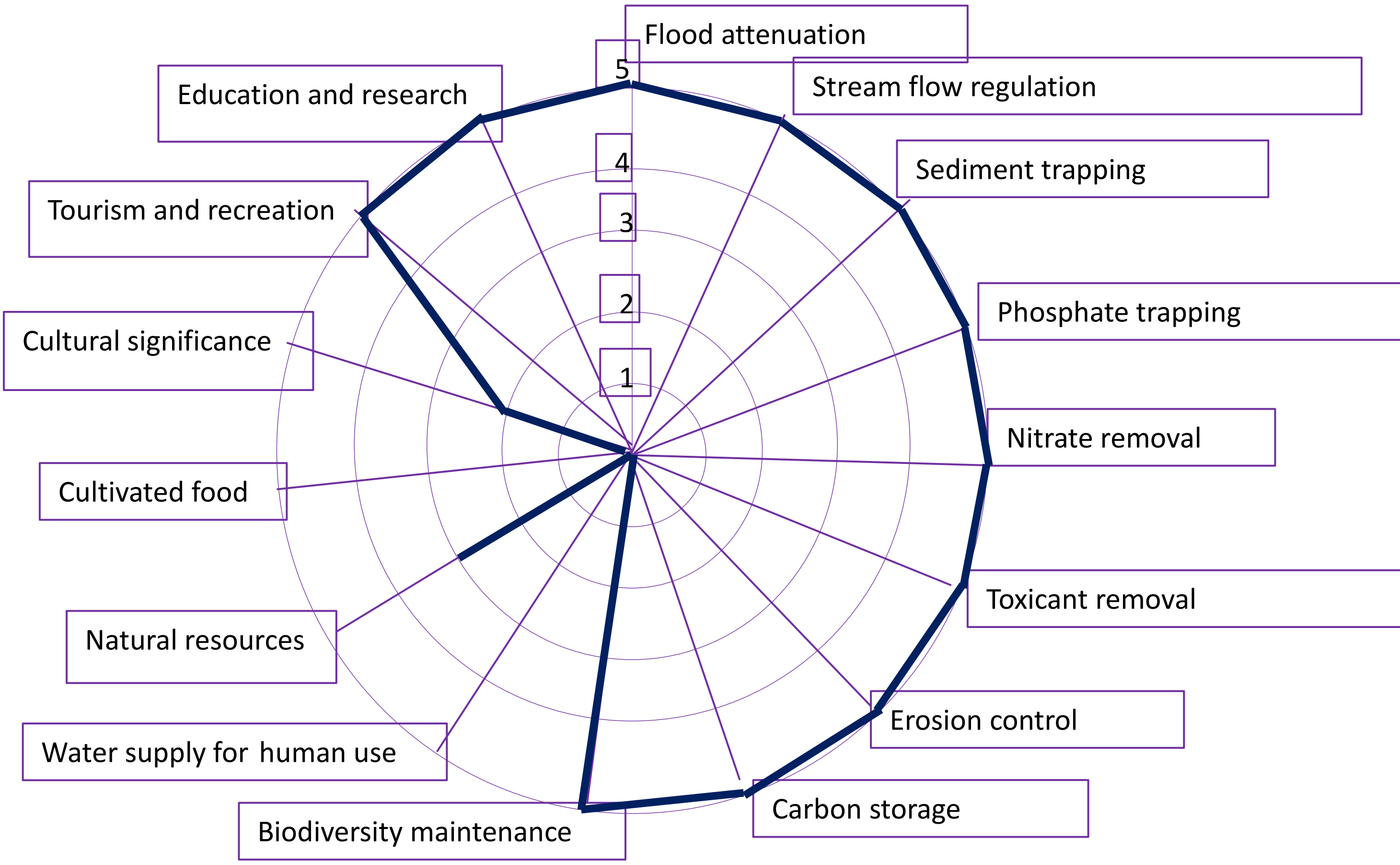

Figure 23. Resource Economics Footprint Hakskeenpan

The star shape of Hakskeenpan is large, with a deflated corner (Figure 1). The large size would be considered as significant and it can be expected that the authorities would give due consideration for the preservation of services that Hakskeenpan has on offer.

22 Conclusions

Figure 24 has been adapted from one of the most recent DWS policy documents.

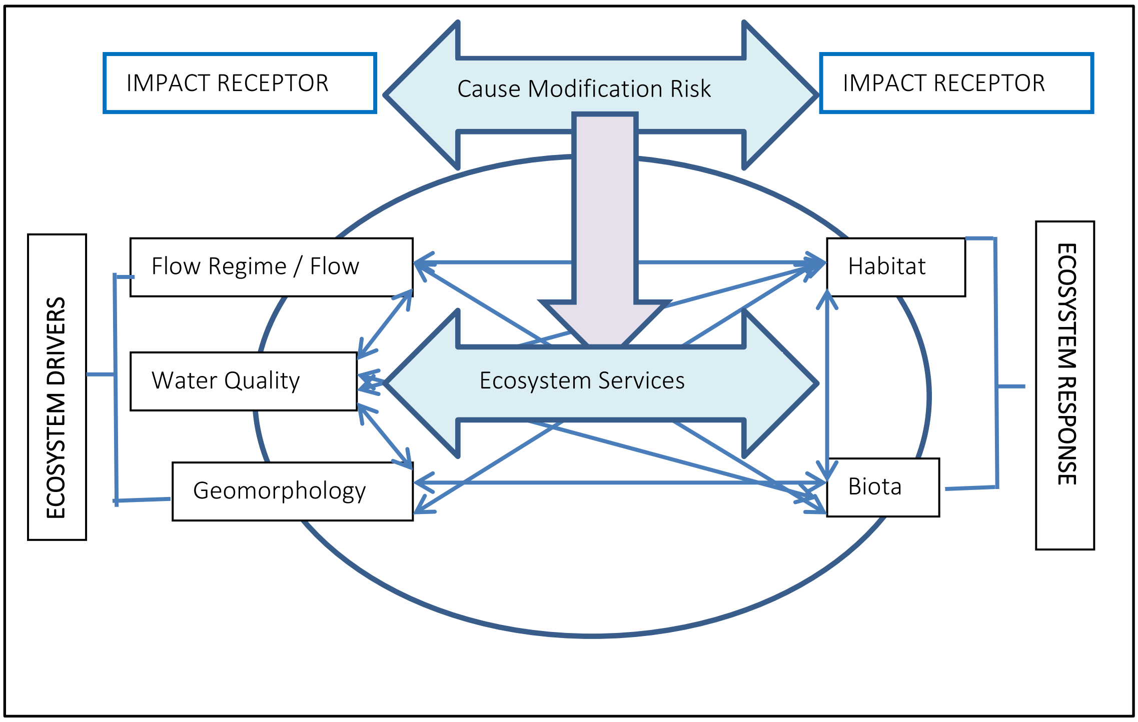

Figure 24 Minimum Requirements for a S21(c) and (i) Application

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 24). The WULA and the EAI must provide mitigation measured for these impacts.

The driver of the mostly dry 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 vegetation along the drainage lines that provides habitat in an arid region where habitat and habitat variability is hard to come by.

Likewise, Hakskeenpan is mostly dry and apparently barren, for the most without vegetation. The driver again are the sudden and violent major floods that come through, most years but not every year. The flooded pan then springs to life, with a prolific aquatic biota and complicated ecology. The other driver of the system is the drought that follows, drying up the pan, with life forms retreating into the sediments, sometimes for years on end, until the next flood.

Decision-making authorities regard drainage lines and Hakskeenpan as legitimate water resources. In the past these authorities have applied preservation measures and in the case of the Loubos WWTW it can be expected that the DWS will look very much in a similar way to the Loubos WWTW.

The Impact Assessment as well as the Risk Matrix do not suggest that the WWTW should be disallowed. It does however, if approved, that the mitigation measures should be meticulously implemented. This is particularly important for the protection and preservation of Hakskeenpan, with its unique ecology.

The Risk Matrix indicates that a License is applicable and that a General Authorisation should not be considered.

23 References

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Kotze, G., G. Marneweck, A. Batchelor, D. Lindley & Nacelle Collins. 2009. *A technique for rapidly assessing ecosystem services supplied by wetlands.* Water Research Commission, Pretoria.

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Van Driel, D. 2016. *Bloodhound Project. Technical Report. Water Use Licence Application.* WATSAN, Cape Town

24 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 27 February 2019

25 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

Recent Reports &
Water Use License Applications

- 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 Grabouw Cell Phone Tower
- Fresh Water Report Louisvale Sewer and Pump Station, Upington
- Fresh Water Report Calvinia Treated Sewage Effluent Irrigation Pipeline

26 Appendix

26.1 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 26.1.1 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 26.1.2 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 26.1.3 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 26.1.4 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.

26.2 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