Appendix D: Freshwater Specialist Report

THEMBELIHLE

Incorporating the towns of Strydenburg and Hopetown
Northern Cape Province, Republic of South Africa

TOGETHER WE CAN

WATER USE LICENSE APPLICATION FOR THE CONSTRUCTION OF A NEW WASTEWATER PIPELINE AT HOPETOWN

FRESH WATER REPORT

A REQUIREMENT IN TERMS OF SECTION 21 OF THE NATIONAL WATER ACT
OCTOBER 2018

bvi 50 YEAR CELEBRATION EST 1967-2017
• ENGINEERING • PROCUREMENT • MANAGEMENT

EnviroAfrica
Environmental Management and Impact Assessment
Omgewingsbestuur en Impakbeoordeling

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Index

1 Introduction

Hopetown is located on the northern edge of the semi-arid Great Karoo on the slope of the Lower Orange River valley in the Northern Cape. The town now resorts under the auspices of the Thembelihle Local Municipality. It is necessary to construct a new sewerage pipeline from the northern edge of town to a pump station adjacent and south of the wastewater treatment works (WWTW, Figure 1). At this stage of the planning it is unsure exactly where the pipeline will be routed. Several options are indicated in Figure 1.

The Hopetown WWTW has a design capacity of 3.5 megalitres a day and is an anaerobic pond system.

It is, however, sure that the envisaged pipeline "triggers" several sections of the National Water Act (NWA, 36 of 1998) as well as regulations that have been promulgated in terms of the National Environmental Management Act (NEMA, 107 of 1998). It is clear that the applicable legislation requires an Environmental Impact Assessment (EIA).

The local municipality requested the engineering company BVi of Upington to come up with a design for the new pipeline. BVi, in turn, appointed Enviro Africa of Somerset West near Cape Town to conduct the EIA.

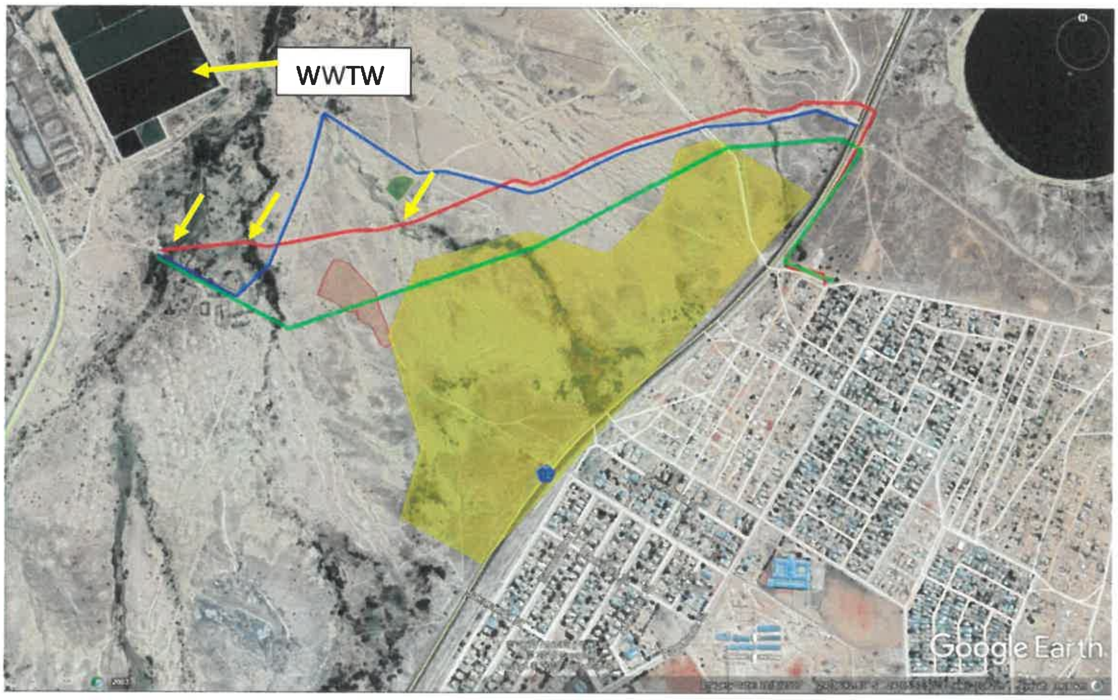


Figure 1 Envisaged Pipeline

The new pipeline would intersect a drainage line and two of its tributaries. The crossings are indicated by the yellow arrows on Figure 1. The one on the very left is of the most concern, as it will receive the most storm water from the largest part of the sub-catchment.

Although these drainage lines are minor water ways, they are nevertheless valid water resources in terms of current legislation and therefore demand the required attention and care.

The impacts on the aquatic habitat must be considered according to premeditated methodologies, among others a Risk Matrix, as is available in the national Department of Water and Sanitation's webpage. The outcome of the Risk Matrix must determine if the pipeline should be approved of by means of a General Authorisation (GA) or a License. The risk assessment must be substantiated by a Fresh Water Report. Finally, a set of prescribed forms must be submitted to the DWS, all part of the Water Use License Application (WULA).

Dr Dirk van Driel of WATSAN Africa in Cape Town has been appointed to conduct the WULA. This then is the Fresh Water Report, which now has been dubbed the Technical Report. This report must provide the decision-making authorities with adequate information to make an informed decision with regard to the new pipeline.

The Hopetown Wastewater Treatment Works (WWTW) discharges its treated effluent into the Orange River. An additional purpose of the Fresh Water Report is to establish if the Hopetown Wastewater Treatment Works or does not have an impact on the water quality of the Orange River. No impact or an insignificant impact would suggest that alterations such as the proposed pipeline would be in order. An obvious impact would suggest that current operation procedures would have to be upgraded prior to alterations.

The Fresh Water Report should, first and foremost, contain adequate information for the authorities to make an informed decision.

2 Quaternary Catchment

The Hopetown drainage line is in the D33G quaternary catchment.

3 Vegetation Type

The vegetation types listed on the South African Biodiversity Institute's webpage are Upper Gariep Alluvial vegetation and Kimberley Thornveld. None of these are endangered or scarce in any way.

4 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 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.*

The proposed pipeline 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 Government Notice 509. No development may 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, 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. The proposed pipeline is in a drainage line, which fully qualifies as a water course. Consequently, this regulation is relevant to this application.

5 Climate Hopetown

Hopetown normally receives about 199mm of rain per year, with most rainfall occurring mainly during autumn. The chart below (lower left, Figure 2) shows the average rainfall values for Hopetown per month. It receives the lowest rainfall (0mm) in July and the highest (48mm) in March. The monthly distribution of average daily maximum temperatures (centre chart below) shows that the average midday temperatures for Hopetown range from 17.7°C in June to 32°C in January. The region is the coldest during July when the mercury drops to 1°C on average during the night.

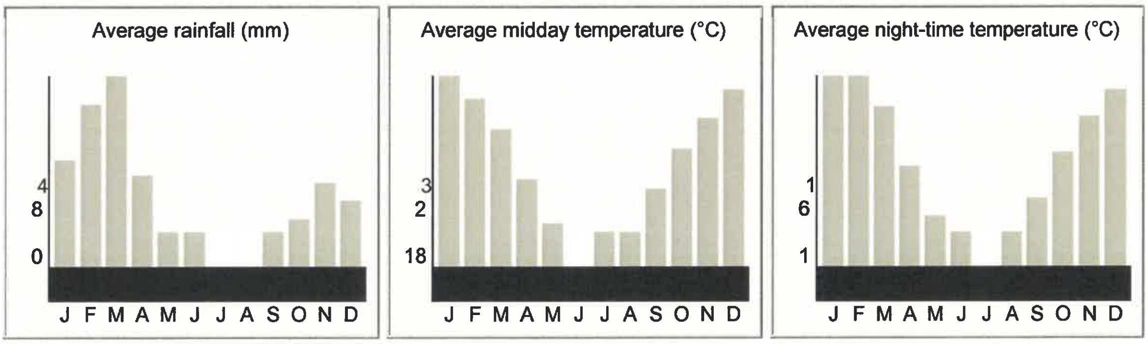


Figure 2 Hopetown Climate

The region is dry and can be described as semi-arid. For 2 months of the year there is no measurable rainfall at all. The regional economy is driven by water abstraction out of the Orange River for irrigation of agriculture.

6 The Sub-Catchment

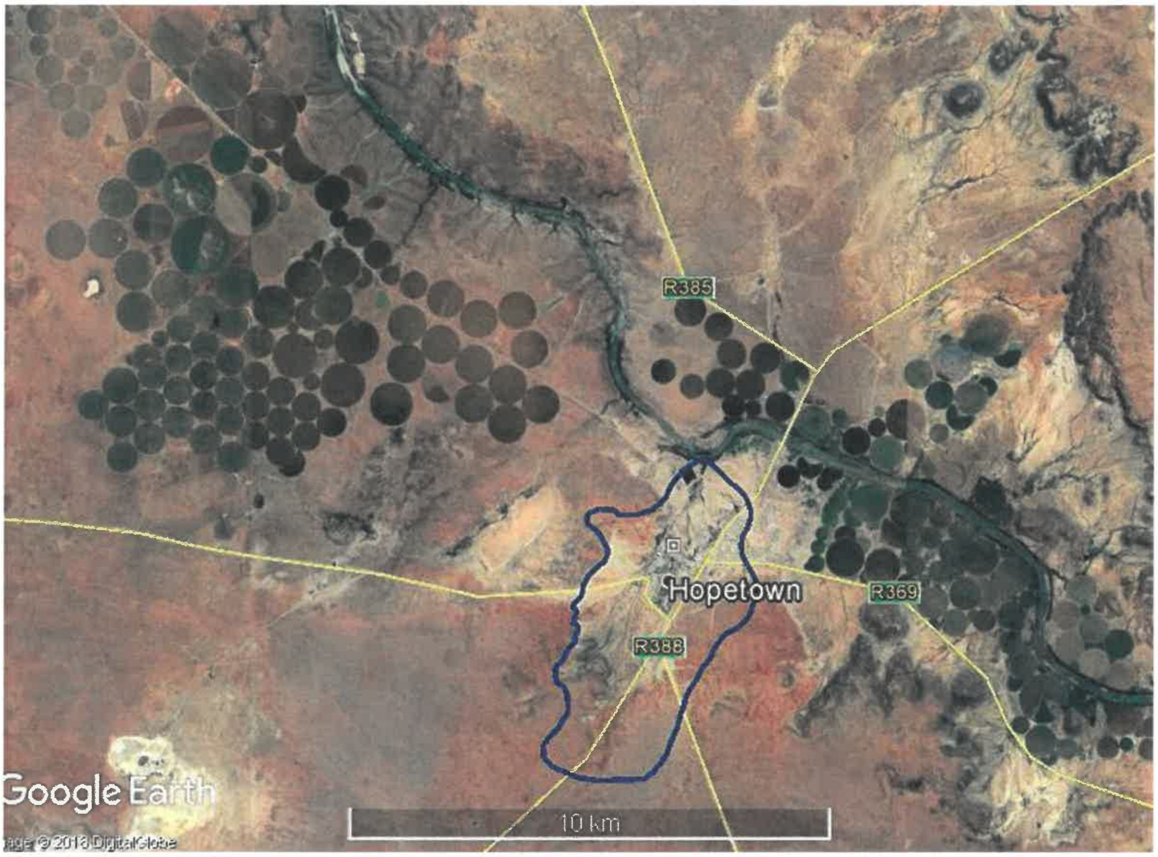


Figure 3 Hopetown Location

Hopetown is located to the south of the Orange River in the Northern Cape (Figure 3). The area is dotted with large centre pivot irrigation systems, all supplied with water from the Orange River. This drives the local economy and Hopetown's existence. Hopetown is on the R388 trunk road (part of the N12) on the way to Kimberley to the north, 126 km away.

The Lower Orange River in the region is flanked by numerous very dry drainage lines. The town of Hopetown is located along one of these drainage lines (Figure 3). A part of the drainage line's sub-catchment (Figure 4) has been developed and altered into residential area and its infrastructure. The N12 trunk road stretches through the length of the sub-catchment.

The sub-catchment can be demarcated by connecting the highest points around the drainage line with Google Earth Pro. Google Earth's polygon function gives the sub-catchment's surface area.

The sub-catchment covers a surface area of 1736 hectares. It is 7km long and 3km wide.

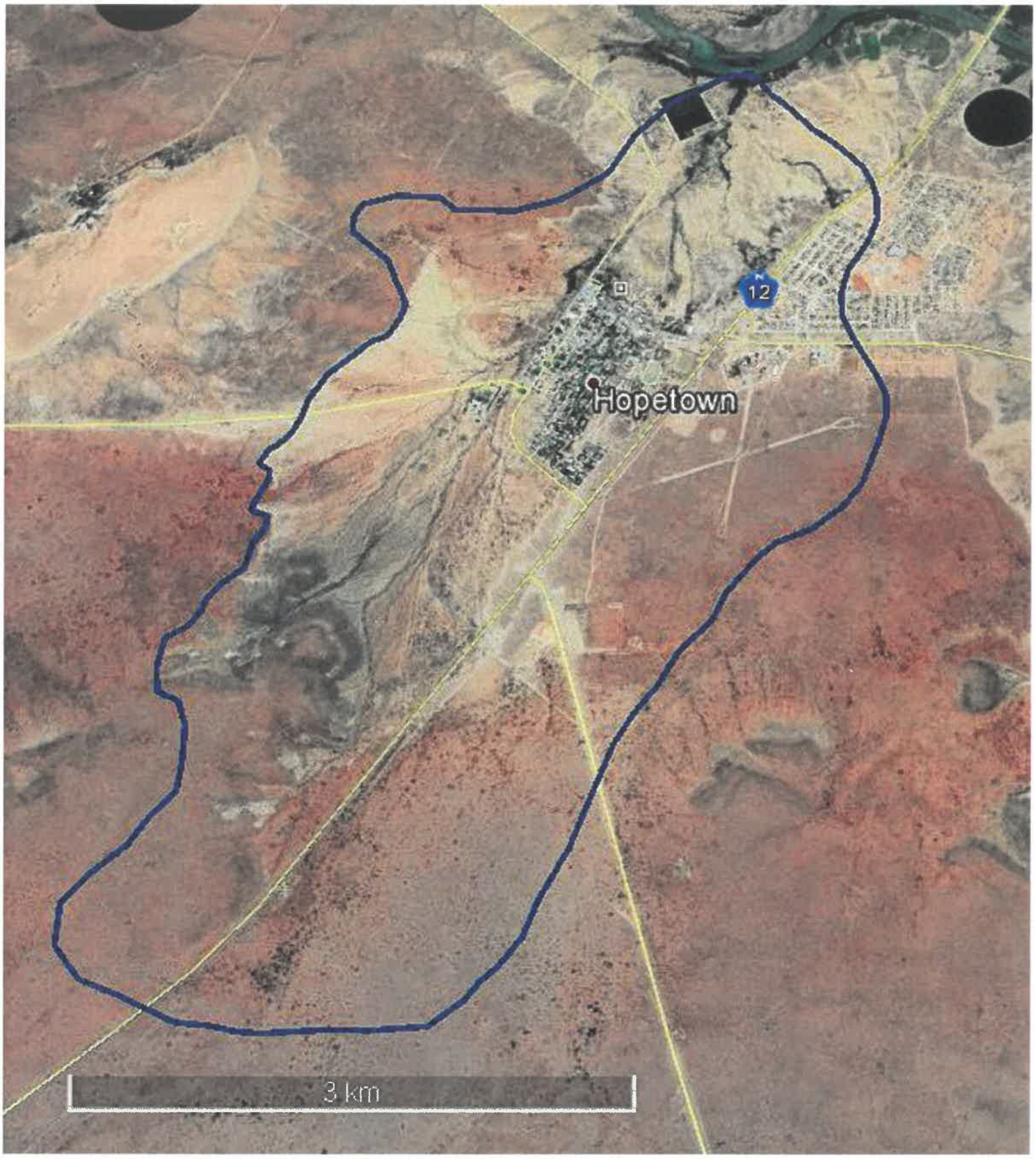


Figure 4 Sub-Catchment

The sub-catchment is marked by the following coordinates:

29°39'43.67"S and 24°03'53.33"E

where the N12 trunk road crosses its boundary in the south west and

29°36'11.64"S and 24°05'35.87"E

where the drainage line discharges into the Orange River.

The highest point in the sub-catchment is on the boundary at the N12 and the lowest at the discharge point. The elevation varies from 1157m to 1065m above sea level. This is a drop of 92m over a distance of 7km. This comes down to a slope of only 1.3m over a distance of 100m, which is a gentle slope and not conducive to the transport of large quantities of sediment and soil erosion. Despite of the slope the drainage line is eroded and incised in some places, possibly because of the urban runoff combined with high rainfall events (Figure 5).

Figure 5 Incised Drainage line

Hopetown's wastewater treatment works is located downstream of the town close to the banks of the Orange River. It is an anaerobic pond system (Figure 6).

Figure 6 Hopetown Wastewater Treatment Works

Adjacent to the town, downstream and to the north, is the waste disposal site (Figure 7).

Figure 7 Hopetown Waste Disposal Site

The water purification works is located on the northern verge of the town (Figure 8)

Figure 8 Hopefield Water Purification Works

Despite the semi-arid conditions there was standing water in the drainage line (Figure 9), most likely because of the return flow out of the urban area. This was in contrast with other drainage lines in the region, which were bone dry.

Figure 9 Water in Drainage Line

The vegetation is listed as Kimberley Thornveld on the BGIS webpage of the South African National Biodiversity Institute (SANBI). Where the drainage line meets the Orange River, Upper Gariep Alluvial Vegetation is listed, even though most of it has been transformed into manicured agriculture. There is a small Upper Nama Karoo Unchanneled Valley Bottom Wetland in the upper sub-catchment of the drainage line to the east of the trunk road. This wetland, as well as the Orange River, has been classified as a National Freshwater Ecosystem Priority Area (NFEPA). None of this is listed as endangered in any way.

The drainage lines are poorly demarcated by the vegetation. The scrub and small trees are the same as those further afield away from the drainage lines. Only the stand of higher vegetation is denser around drainage lines. Benches and terraces, as described in DWAF wetlands and riparian zone field guide, are ill defined or absent, with only a wide floodplain in which transported sediment has been deposited.

7 Sub-Catchment Runoff

The following is an attempt to estimate the volume of water that would pass down the drainage line into the Orange River during a storm event. This should be repeated by an experienced and qualified hydrologist with an acknowledged numerical, computer-based hydrological model. Nevertheless, at this stage of the project it is apt to consider the type of measures that are required to withstand a flood and the sort of materials to be used for the construction of the envisaged pipeline.

Table 1 Catchment Runoff

Rainfall (mm/day)	Total runoff m^3x1000	Runoff 70% m^3x1000
10	17	12
20	34	24
30	52	36
40	69	48
50	87	61

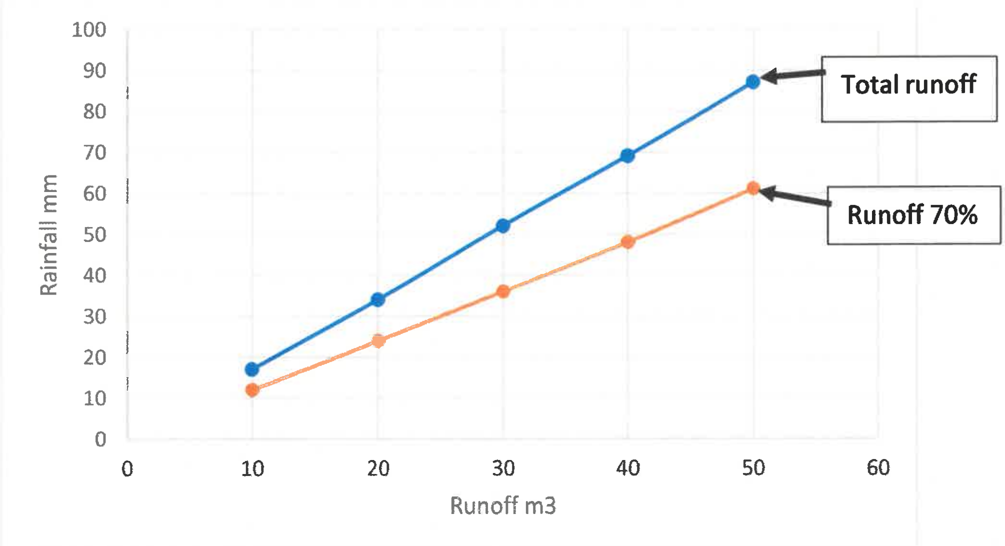


Figure 10 Catchment runoff

Above all, a breakage of the pipeline with the concomitant large sewage spill must be prevented as a result of a large flood with a recurrence of once in 50 or 100 years. This is the largest environmental threat with the highest impact and risk.

The production of runoff under increasing daily rainfall events is shown in Table 1 and depicted in Figure 10. If assumed that 30% of the runoff will never reach the point of discharge because of soil penetration, there is still going to be 36 000m^3 of water passing down the drainage line with a daily rainfall event of 30mm. Given the huge variability in the reginal rainfall, this is not an unlikely scenario.

The crossing in the main drainage line (Figure 1) will receive most of this runoff. It is not possible to arrive at a valid hydrograph for this crossing because of the time and money available for the WULA, but if only half of this volume of storm water passes the crossing in a 12 hour-period, the threat becomes eminent.

Likewise, it is not possible to arrive at the velocity this water would travel, but 2 to 5 ms^{-1} has been witnessed in many of these dry water courses following a major downpour.

It is obvious that the engineering design of the pipeline crossing should receive due attention.

8 Orange River Biomonitoring Sampling Points

8.1 Upstream Sampling Point

The upstream sampling point was selected adjacent to the N12 road bridge over the Orange River.

At the time of the site visit on 7 October 2018 the bridge was under construction and the river bank was greatly disturbed, with no vegetation and with an embankment of loose soil pushed into the river (Figure 11). The only macroinvertebrate organism found was a chironomid.

Figure 11 Embankment

Hence the sampling was moved further downstream, as indicated on Figure 12. The bench (terrace) next to the water's edge was manicured into a lawn for holiday makers (Figure 13). This was flanked by a natural embankment of some 15 meters high.

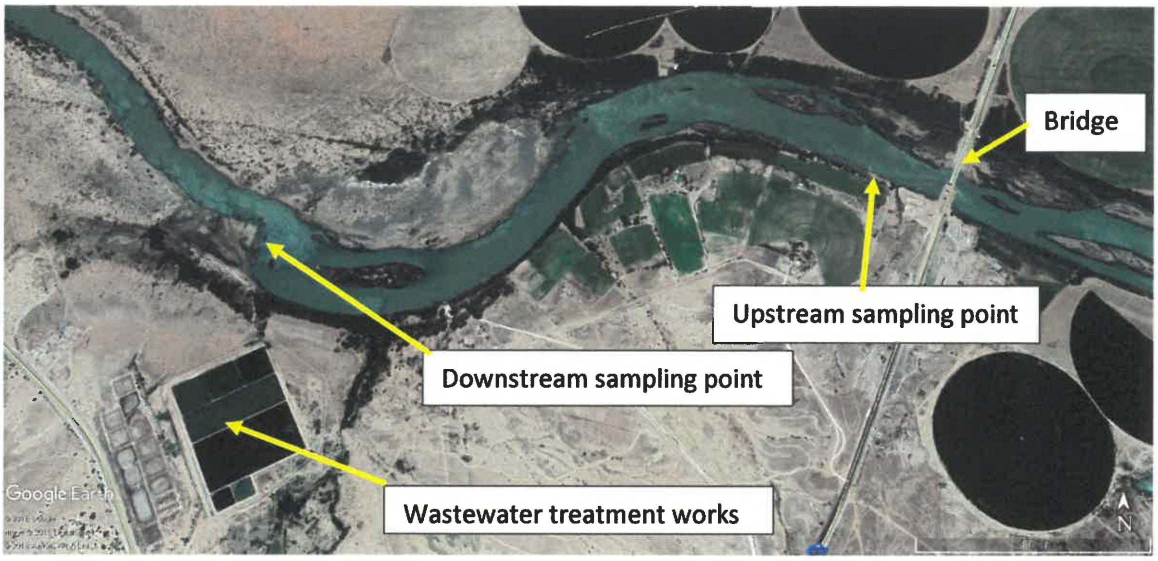


Figure 12 Sampling Points

The flow in the centre of the river was strong, more than 1ms^{-1}, but much slower near the banks, perhaps 5cms^{-1}.

The river here was 150m wide and if the islands are counted in, 250m wide.

The visibility under water was limited to some 5 to 10 cm near the surface. The water was turbid.

The sampled habitat consisted of submerged vegetation (*Potamogeton pectinatus*), emerging vegetation (*Phragmitis australis*) and some drowned grasses because of a rising water level. The river bottom is of a fine mud becoming a course submerged gravel nearer to the banks. A couple of rocks made the stones-out-of-current habitat. The habitat was described as limited and it was hard work to find the macroinvertebrates for this assessment.

Figure 13 Upstream Sampling Point

8.2 Downstream Sampling Point

The downstream sampling point (Figure 14) was chosen 480m downstream of the wastewater treatment works treated effluent release into the Orange River. The distance from the upstream sampling point, following the curve of the river, is 2.25km. The slope is 0.22% or a drop of 1m over 450m. Despite this slight and even slope, there were two rather fierce rapids over the distance.

The river here was flowing very fast through a long set of rapids, which are visible of Figure 14.

The river here was braided, with fast flowing streams along the banks.

Figure 14 Downstream Sampling Point

The riparian zone is wide and is demarcated with a natural embankment overgrown with a dense stand of *Vachellia* (*Acacia*) and *Searsia* trees. The riparian zone was wet, with ground water surfacing everywhere. This very much resembled agricultural return flow, but since there was no agriculture going on higher up the incline, the emerging ground water could only have been from the wastewater treatment works. This created a swampy area. The *Phragmitis* reeds were kept short by grazing cattle. Other wetland plants were *Berula erecta* (tooth ache root), tall rushes such as *Juncus effuses* (soft rush) and sedges such as *Schoenoplectus corybosus* (tall cylindrical sedge).

The sampled habitat was varied and abundant, with submerged and emerging vegetation, submerged gravel and mud in and out of the current and with very shallow, swampy backwater and deeper moving water.

Closer to the wastewater treatment works and across the river on an island a stand of mature eucalyptus trees (Figure 15) bore testimony of the nutrients that were made available by the release of treated wastewater into the river. These exotic trees were absent elsewhere along the banks of the Orange River in the region.

Figure 15 *Eucalyptus* Trees

At the time of sampling there were at least 10 of the local people fishing for yellow fish. Some of them used throw nets. Many more children were fishing as well, even in the shallow water with spears made of sharp sticks. Largemouth yellow-fish is the species they target. Figure 16 shows a smallmouth yellow fish, which fortunately is more plentiful.

Figure 16 Smallmouth Yellow-fish *Labeobarbus aeneus*

8.3 Drainage Line

A sampling point was selected in the drainage line for the purpose of measuring the water quality in a stagnant pool next to the road leading out of Hopetown towards the north west to the town of Douglas. The pool was about 20m long, 2m wide and 0.5m deep, with clear water, but overgrown on the downwind side with *Microcystis* blue green algae. There were predacious diving beetles (Dytiscidae) in the pond.

The coordinates of the sampling points are given in Table 2.

Table 2 Sampling Points Coordinates.

Sampling Point	Coordinates	Elevation masl
Upstream	29°36'56.07" S; 24°05'08.00"E	1060
Downstream	29°36'08.06" S; 24°05'21.06"E	1052
Drainage Line	29°36'57.80" S; 24°05'07.66"E	1075

9 Orange River Biomonitoring Results

The biomonitoring methodology as described by Dickens & Graham (2002) was followed. The results are given in the SASS5 worksheets in the Appendix and are summarised in the following table:

Table 3 Biomonitoring Results

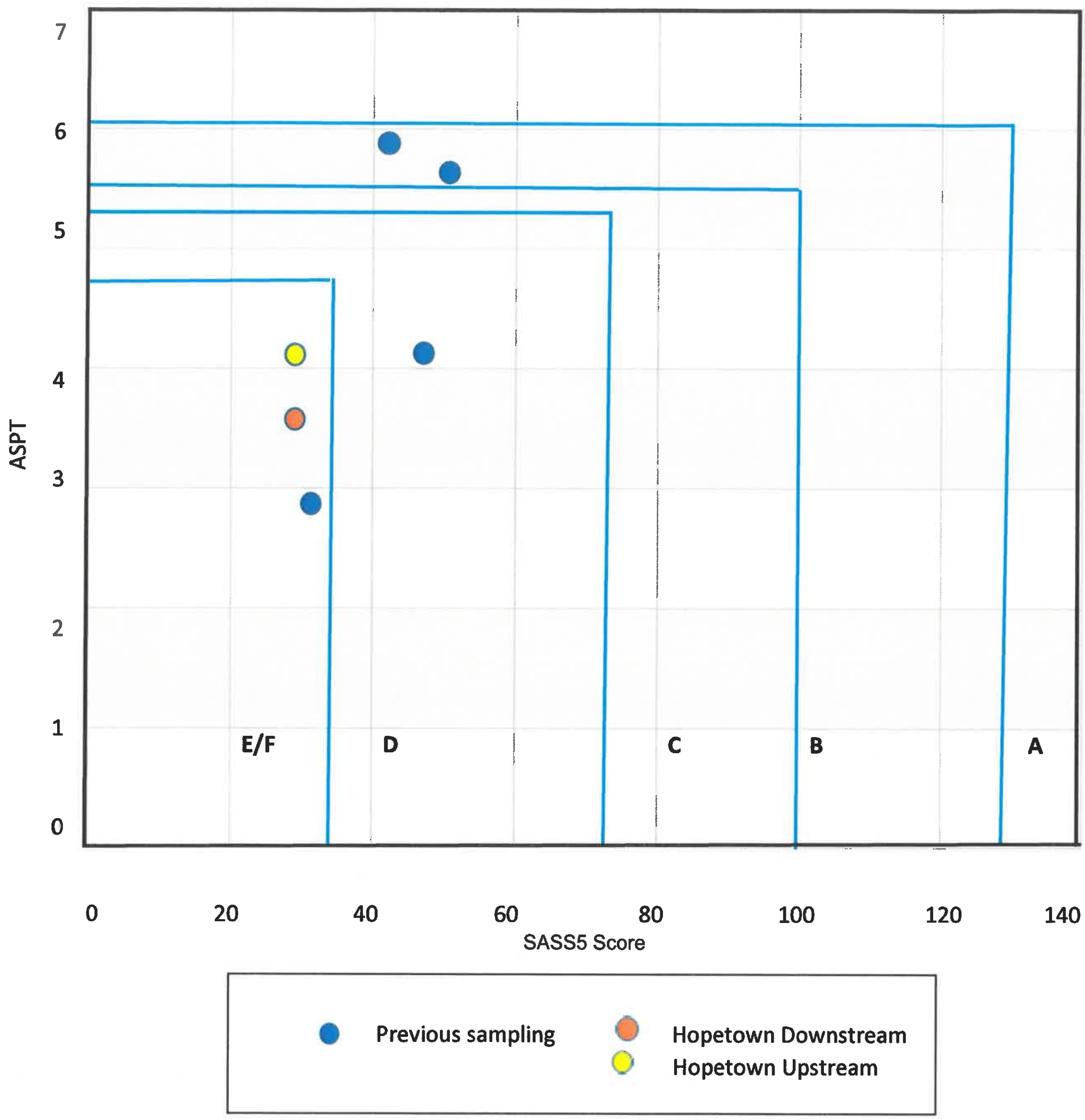
Sampling Point	Upstream	Downstream
SASS5 score ASPT	29 4.1	29 3.6

Both of the results, for the upstream and downstream sampling point, result in an E score (Figure 17), which is poor, with a serious loss of ecological functioning. For the upstream sampling point this can be attributed to the construction activities at the bridge, apart from the possible agricultural return flow from further upstream.

For the downstream sampling point the impact of the treated sewage effluent can be added. This did not reduce the SASS5 score, which remains the same on 29 as of the upstream sampling point. It reduced the average score per taxon (ASPT), to a paltry 3.6.

Of the 6 samples that were taken for various projects in the Lower Orange River, only one was worse than the ones at Hopetown. Three were better. Only one was in the C category, which can be deemed as the desired status for the Lower Orange River.

With a small difference in the results between the upper and lower sampling points it can be deducted that the wastewater treatment works did not significantly impact on the biodiversity of the river. This is possibly because of the massive flow of the river, which diluted the effluent to such an extent that the impact was reduced to hardly noticeable with biomonitoring techniques. Even the seepage from the anaerobic ponds did not result in a noticeable deleterious effect.



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

Figure 17 Lower Orange River Biomonitoring Results

10 Water Quality

Water samples were taken on the morning of 11 October 2018. The bacteriological samples were delivered on the same morning at UIS Laboratories in Kimberley. The samples for water quality analysis were frozen and delivered to Quantum Laboratories in Malmesbury. The results are given n Table 4. The temperature, pH, electrical conductivity and dissolved oxygen was measured with a YSI field instrument.

Table 4 Water Quality

Parameter		Upstream	Downstream	Drainage Line
Temperature	°C	18.0	20.1	19.3
pH		8.85	8.8	8.8
Electrical Conductivity	mSm^{-1}	16.4	30.5	628
Dissolved Oxygen	mgl^{-1}	9.0	8.2	4.3
Turbidity	NTU	30	27.7	52
Ammonia	mgl^{-1}	<0.16	0.17	<0.16
Nitrite	mgl^{-1}	<0.02	0.02	<0.02
Nitrate	mgl^{-1}	1.3	0.8	1.0
Total Nitrogen	mgl^{-1}	<10	<10	<10
Total Phosphorus	mgl^{-1}	<0.5	<0.5	<0.5
E. coli	counts per 100ml	20	41	5
Feacal coliforms	$c100ml^{-1}$	89	109	5

The pH deviates from the neutral point of 7. The alkaline conditions are probably because of the regional geology and the leaching of compounds into the river as it passes over successive formations. The aquatic ecology seems to be fully adapted to these conditions.

The dissolved oxygen in the river is adequate to support aquatic life. The oxygen concentration in the drainage line is probably too low to support a varied aquatic biodiversity.

The salt content of the water in the river is well within the range of drinking water for human consumption and is adequately fresh to support a thriving aquatic ecology. This is despite the doubling of the electric conductivity (EC) downstream of Hopetown. This is probably because of the salts that are leached out of the shales of the Karoo region. These shales have been deposited during geological times in marine conditions and are known for releasing salts when leached. This explains the salt crust in patches on the river bank at the downstream sampling point (Figure 18). However, the doubling of the EC does not seem to have any effect on the ambient SASS5 score, as the vast volume of the flow in the river dilutes the salts to tolerable levels in the shallows next to the river bank. This is a localised phenomenon and would not be noticeable in the main stream.

The saltiness of the water in the drainage line is very high, as indicated by the EC (Table 4).

Figure 18 Salts

A rise in the ammonia concentration can be expected downstream of the wastewater treatment works. This did not show up in the analytical results. The ammonia concentration borders onto the detection limits of the analytical laboratory instruments and it is too low to have any affect on the biodiversity of the river. Likewise, the natural nitrification / denitrification breakdown of ammonia is rapid enough to result in low concentration of nitrite and nitrate.

High concentrations of total nitrogen can generally be expected in an active agricultural area such as the Lower Orange River. This is as a result of the release of fertilisers along with the agricultural return flow into the river. The total nitrogen was below the detection limits of the analytical laboratory instruments. The very low concentration can be the result of either very good farming practices or the gross dilution of any pollutants by the strong flow down the river at the time of sampling. This encouraging result can change during times of low flow, when return flow will probably have a more pronounced effect on the river's water quality.

Phosphorus that is administered to vineyards is known to firmly bind to the soil and is not prone to leaching. However, concentration below the laboratory's detection limits were not expected. Again, this was probably the result of dilution because of the strong flow of the river during the time of sampling.

There was no new flow from Hopetown's built-up area. The pool from which sampling took place was entirely isolated from any flow out of the town. Hence the water quality was good, given the type of habitat, a small, supposedly polluted storm water conduit. This can change when it rains, with fresh runoff from the town.

The bacteriological analysis was undertaken by SANAS accredited UIS Laboratories in Kimberley. The samples were kept on ice during transport and delivered at the laboratories within 4 hours of sampling.

The *E. coli* counts upstream were low. Even though the value downstream of the wastewater treatment works doubles, it was still low. It seems as if the impact of the wastewater treatment works on the bacteriological water quality was acceptable. The values are well within the limits of 100 counts per 100 ml for contact recreation (swimming) and 1000 for non-contact recreation such as fishing (South African Water Quality Guidelines). These low counts are of no consequence to the aquatic environment.

Since there was no flow in the drainage line, there was no hydraulic connectivity between the return flow out of Hopetown and no replenishment of the bacteriological load. The counts were very low. This could change during rain events, which are few and far between.

For the sake of comparison, it would be obvious to look at the DWS's water quality data, as collected in terms of the National Water Quality Monitoring Programme. Unfortunately, the closest sampling point (No. 186614) in the Lower Orange River is near the bridge to Douglas on the R357 some 77km downstream from Hopetown, following the curve of the river. This is too far away to be useful.

11 Present Ecological State (PES)

The PES is a protocol that have been produced by Dr Neels Kleynhans (Table 5 and 6) in 1999 of the then DWAF to assess river reaches. The scores given are solely that of the practitioner and are based on expert opinion.

11.1 Present Ecological State Hopetown Drainage Line

The upper drainage line sub-catchment is impacted by the trunk road, but the remaining part is near-pristine. The lower part is heavily impacted. This complicates an assessment that would reflect the general state of the sub-catchment. Nevertheless, the best effort is given in Table 5.

Water is not abstracted from the drainage line, but rather water is added as urban return flow. This changed the flow regime, as it should be dry under natural conditions. The drainage line is eroded and incised. If it rains, the occasional flow cannot overflow into the riparian area to connect to any damp areas anymore.

Table 5 Present Ecological State of the Hopetown Drainage Line

Instream	Score	Weight	Product	Maximum score
Water abstraction	24	14	336	350
Flow modification	8	13	104	325
Bed modification	14	13	182	325
Channel modification	15	13	195	325
Water quality	5	14	70	350
Inundation	5	10	50	250
Exotic macrophytes	20	9	180	225
Exotic fauna	15	8	120	200
Solid waste disposal	5	6	30	150
Total		100	1267	2500
% of total			50.7	
Class			D	

Riparian				
Water abstraction	24	13	312	325
Inundation	14	11	154	275
Flow modification	8	12	96	300
Water quality	5	13	65	325
Indigenous vegetation removal	20	13	260	325
Exotic vegetation encroachment	20	12	240	300
Bank erosion	6	14	84	350
Channel modification	6	12	72	300
Total			1283	2500
% of total			51.3	
Class			D	

The natural vegetation in the riparian zone has neither been lost, nor has it been infiltrated by exotic vegetation. It consists of a somewhat heavier stand of the same scrub as elsewhere, probably because of the somewhat-more shallow ground water available around the drainage line.

During the site visit the area was drought-stricken, with no signs of riparian vegetation, connected wetlands or anything that could indicate hydromorphic conditions. It is conceivable that the drainage line would overflow its banks during a flood with a recurrence of once in 50 or 100 years, but it is surmised that the arid nature of the area does not allow for the presence of wetlands adjacent to the drainage line. The only wetland is the small ephemeral pan at the top of the sub-catchment. Even though the flow and inundation regimes have been changed because of the urban area and it storm water runoff, the aridity of the region does not allow for much connectivity with surrounding wetlands.

The area downstream of the town is disturbed in many places. There is a lot of litter and rubble.

The construction of the proposed pipeline, if done according to the recommendations that are to follow, will not change the PES of the Hopetown drainage line.

Table 6 Habitat Integrity according to Kleynhans, 1999

Category	Description	% of maximum score
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

11.2 Present Ecological State Orange River

Table 7 Present Ecological State Orange River at Hopetown

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	15	13	195	325
Exotic vegetation encroachment	15	12	180	300
Bank erosion	20	14	280	350
Channel modification	18	12	216	300
Total			1595	2500
% of total			63.8	
Class			C	

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.

The river at Hopetown, 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 Hopetown was less impacted than further downstream, as at Kakamas. The river at Hopetown was stronger flowing, with much more water. The condition of the river gradually deteriorates as water abstraction and return flows increases downstream.

Hence the river was scored a C (Table 7), which signifies that it has been impacted, but despite these impacts still exhibits appreciable ecological functioning. The riparian zone scores a C as well.

There is a good chance that other practitioners would score the river very much the same.

Importantly, the proposed improvement to the Hopetown Wastewater Treatment Works is not about to change the PES of the Orange River at Hopetown, as it is not foreseen that the quality and the volume of the treated effluent will change in any way because of the pipeline.

12 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 8).

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 line is not important.

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

Table 8. 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)

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.

13 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.

13.1 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.

13.2 Ecological Sensitivity Drainage Line

The question arises, according to the ES definition, if the drainage line would recover to its original ecological state prior to any human impact. If Hopetown and the WWTW were to be removed, would the drainage line recover? The answer is probably yes, even though it would take many decades in this semi-arid region. However, this is not a realistic scenario. Hopetown is here to stay, together with its impacts.

From this point of view the drainage line cannot be regarded as ecologically sensitive. Such a point of view would only hold if the new pipeline is to be constructed with due consideration for the drainage line and its ecological considerations. If the new pipeline blocks the drainage line, it would probably never recover and in this sense, it could be viewed as sensitive. This scenario need not be, as construction can be carried out without significant impacts to the drainage line.

14 Possible Impacts of the Proposed Pipeline

The proposed pipeline is not about to add to the 3.5 megalitres per day treatment capacity of the existing WWTW. It will not change the quality and quantity of the treated effluent that is released into the Orange River. There would be no additional impacts than the current ones. In order for the WULA to be successful, this pertinently needs to be stated in the Fresh Water Report.

The construction of the pipeline can possibly impact on the drainage line. The flow can be obstructed, which could prove to be hazardous. A sudden and large flood, as occurs in these parts from time to time, can wash the pipeline away, after which a large sewage spill would be eminent. Smaller flows can result in storm water breaking the banks to submerge areas that were dry before. This would disturb the natural ecology, even though this would not be a serious infarction.

During the construction phase the soil will be loosened. The next flood can take the soil away, downstream and into the Orange River. This will predictably leave a track of erosion where the pipeline passes through the drainage line.

15 Mitigation Measures

The crossing of the new pipeline over the drainage line is an engineering feat, of which the technical details are not to be considered here. Only the design as it pertains to ecological issues is mentioned.

The new pipeline can possibly pass underneath the drainage lines. In this event the pipeline should be buried deep enough that storm water can pass over it without washing away the back fill to denude the pipeline. The back fill should be compacted and preferably be of reinforced material that will stay in place in event of a flood.

Alternatively, the pipeline could cross overhead high enough that a flood would pass underneath. In this event the supports should be constructed out of the drainage line bed and away from the riparian zone. From an aquatic environmental perspective, this would be the preferred option.

No activities should be allowed outside of the demarcated construction area. Machinery, waste and rubble should not be allowed to accumulate anywhere in the natural vegetation.

Construction should be affected during the dry season, when the likelihood of sudden thunder storms is at its least.

Any signs of erosion in the altered drainage line should be addressed immediately after downpours. Eroded areas should be filled in and the compacted. It should be planted with suitable vegetation. Irrigation may be required to establish this vegetation.

The flow path of the drainage line should remain the same as far as possible.

Rubble, waste and litter should not be allowed to pass down the channel.

Vehicles and other disturbances should be kept out of the altered drainage lines as to prevent any disturbance that could result in erosion.

16 Impact Assessment

Table 9 Significance of Impacts

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** Compact back-fill. Use suitable back-fill material. Construction only during the dry season.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	Medium	Medium	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Direct	Local	Low	Medium	Low	Possible	Sure	Reversible	Replaceable
With out-of-drainage line supports and pipeline overhead, no instream loosening of soil								
Negative	Site Specific	Very low	Short term	Very low	Unlikely	Sure	Reversible	Replaceable

Description of impact Pipeline failure, sewage spill, as a result of a large flood **Mitigation measures** Construct the pipeline on high supports overhead.								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Temporary	High	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Medium	Low	Unlikely	Sure	Reversible	Replaceable

Description of impact Building material, rubble and litter washing down the drainage line and into the Orange River **Mitigation measures** Best industry practices, due diligence, cleaning up of site following construction								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Long term	Low	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Low	Temporary	Very Low	Unlikely	Certain	Reversible	Replaceable

Description of impact								
Destruction of riparian vegetation								
Mitigation measures								
Construct supports outside riparian vegetation, keep footprint as small as possible								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Local	Medium	Medium term	Low	Definite	Certain	Reversible	Replaceable
With mitigation measures								
Negative	Local	Very Low	Temporary	Very Low	Unlikely	Sure	Reversible	Replaceable

Some of the decision-making authorities prescribe an impact assessment according to a premeditated methodology (Table 9).

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 and that the mitigation measures are adequate to contain these impacts (Table 9).

17 Risk Matrix

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. Table 10 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report. The numbers in Table 10 (continued) represent the same activities as in Table 10, with sub-activities added.

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

This assessment has been designed to assist in the decision if a General Authorisation or a License is required, should the development be allowed.

The risk rating according to this assessment is generally low. This suggests that a General Authorisation should be in order.

This only applies if all of the mitigation measures are in place.

The most worrisome risk is that the pipeline could break in event of a major flood. With the pipeline constructed over the surface of the drainage line without any protection, relying on the inherent strength of modern construction materials and the resilience of a ductile iron, HDPE or PVC pipeline, the high risk indeed is unacceptable. However, with the pipeline buried 2m underground the changes of this happening are remote. With the pipeline high overhead, the changes are even less. This risk assessment is supposed to be with the mitigation measures in place. It was carried out assuming that the pipeline would cross the drainage lines high overhead, with the supports outside of the riparian zone, and with the supports sturdy enough to withstand a major flood. Under these conditions the risks were found to be negligible.

The environmental risks to the aquatic habitat are extremely low, which begs the question if a Risk Matrix was required in the first place, other than for administrative and legal reasons.

A letter of consent or a General Authorisation should be order. A License is not called for.

Table 10 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1	Construction phase, loosening of soil	Mobilisation of sediments	Sediments in drainage line and Orange River	28	Low
2	Trench pipeline in drainage line	Mobilisation of sediments	Sediments in drainage line and Orange River	28	Low
3	Construct supports for overhead line	Destruction of riparian vegetation	Riparian habitat destruction	26	Low
4	Pipeline failure during major flood	Sewage spill	Pollution of Orange River	26	Low
5	Construction phase: rubble washing downstream	Rubble in Orange River	Pollution of Orange River	26	Low

Table 10 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	2	2	1	1.5	1	1	3.5
3	1	1	1	1	1	1	1	3
4	1	1	1	1	1	1	1	3
5	1	1	2	2	1	1	1	3

No	Frequency of activity	Frequency of impact	Legal issues	Detection	Likelihood	Significan-ce	Risk Rating
1	1	1	5	1	8	28	Low
2	1	1	5	1	8	28	Low
3	1	1	5	1	8	24	Low
4	1	1	5	1	8	24	Low
5	1	1	5	1	8	24	Low

18 Resource Economics

The goods and services delivered by the environment, in this case the Hopetown drainage line, 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 19) is an accepted manner to visually illustrate the resource economic footprint the drainage line, from the data in Table 11.

Table 11. Goods and Services

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

0	Low
5	High

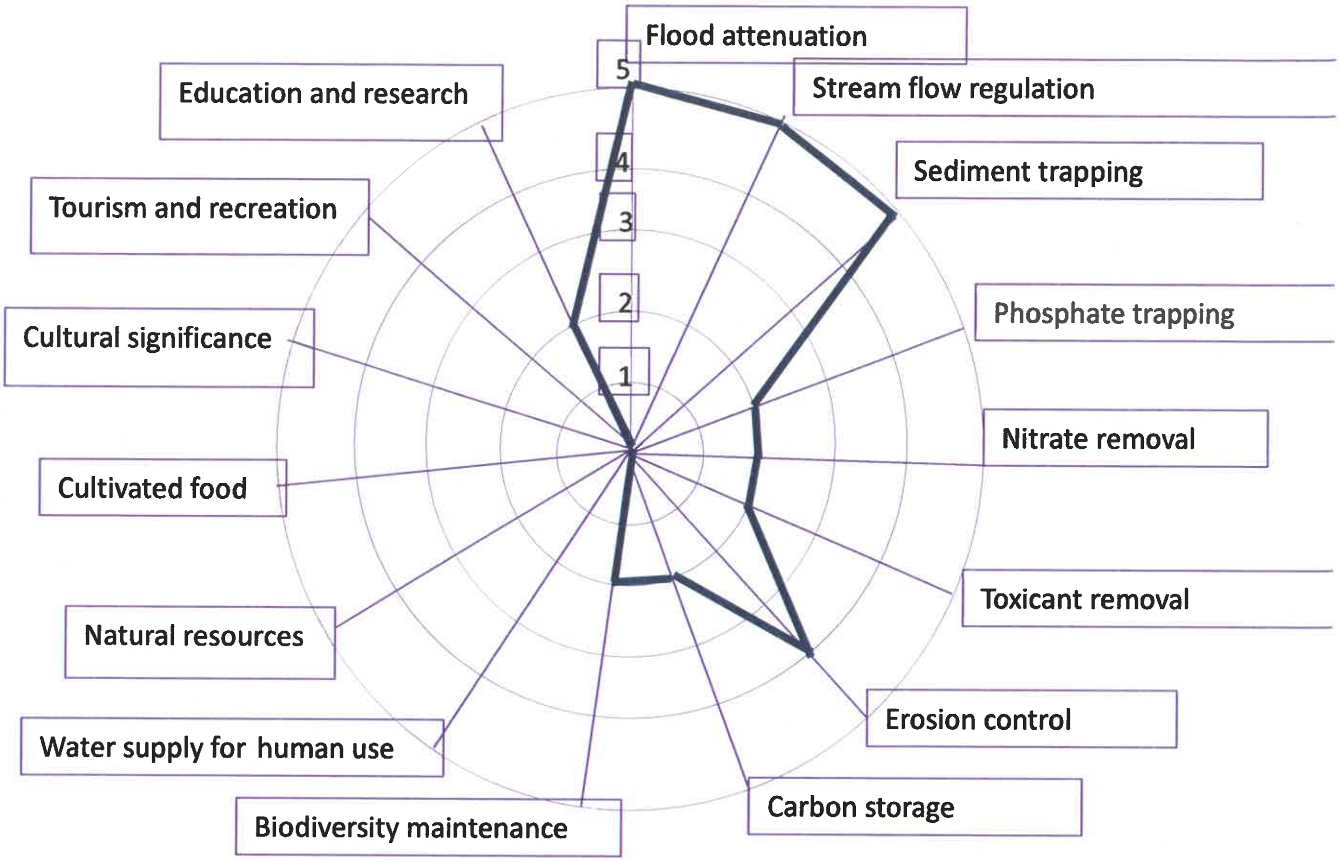


Figure 19. Resource Economics Footprint of the Hopetown drainage line

The size of the star shape of Figure 19 attracts the eyes of the decision-makers. This shape is small, indicating that the water course has a small economic foot print. Apart from flood attenuation, stream flow regulation and sediment trapping, the drainage line is not important, from a resource economics point of view.

19 Conclusions

Figure 20 has been adapted from one of the most recent DWS policy documents.

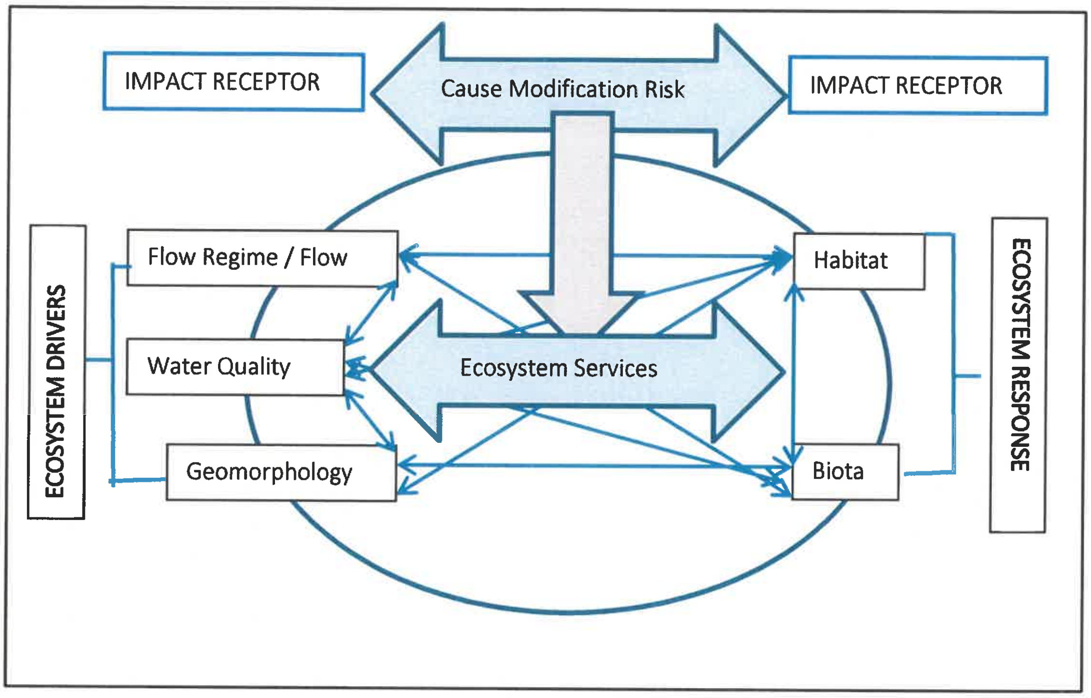


Figure 20 Minimum Requirements for a S21(c) and (i) Application

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

The driver of the drainage line 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. These plants are by no means an indication of aquatic or riparian habitat.

The proposed pipeline is not about to change the ecological factors and its dynamics. It would not reduce the ability of the drainage line and surrounds to render the listed environmental services. An overhead pipeline would have some visual impact, but in an already degraded area, but the aquatic environmental impacts are negligible, if the mitigation measures are adhered to.

A letter of consent or General Authorisation is recommended.

20 References

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21 Appendix

21.1 Biomonitoring Score Sheet

SASS5 Score Sheet

Date	07 Oct 18	Taxon	Weight	Score	Taxon	Weight	Score	Taxon	Weight	Score
Locality	Orange River	Porifera	5		**Hemiptera**			**Diptera**		
	Hopetown	Coelenterata	1		Belostomatidae	3	3	Athericidae	10	
	Upstream	Turbellaria	3		Corixidae	3		Blepharoceridae	15	
		Oligochaeta	1		Gerridae	5		Ceratopogonidae	5	5
Coordinates	29°36' 56.07"	Huridinea	3		Hydrometridae	6		Chironomidae	2	2
	24°05'08.00"	**Crustacea**			Naucoridae	7		Culicidae	1	
		Amphipodae	13		Nepidae	3		Dixidae	10	
DO mg/l	9.0	Potamonautidae	3		Notonectidae	3		Empididae	6	
Temperature °C	18.0	Atyidae	8		Pleidae	4	4	Ephydridae	3	
pH	8.85	Palaemonidae	10		Veliidae	5		Muscidae	1	
EC mS/m	16.4	Hydracarina	8		**Megaloptera**			Psychodidae	1	
		Plecoptera			Corydalidae	10		Simuliidae	5	5
SASS5 Score	29	Notonemouridae	14		Sialidae	8		Syrphidae	1	
Number of Taxa	7	Perlidae	12		**Trichoptera**			Tabanidae	5	
ASPT	4,1	**Ephemeroptera**			Dipseudopsidae	10		Tipulidae	5	
		Baetidae 1 sp	4		Ecnomidae	8		**Gastropoda**		
Other Biota		Baetidae 2 sp	6	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	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				
		Libellulidae	4		Helodidae	12				
		Lepidoptera			Hydraenidae	8				
		Pyralidae	12		Hydrophilidae	5				
					Limnichidae	10				
					Psephenidae	10				
Score				10			7			12

SASS5 Score Sheet

Date	07 Oct 18	Taxon	Weight	Score	Taxon	Weight	Score	Taxon	Weight	Score
Locality	Orange River	Porifera	5		**Hemiptera**			**Diptera**		
	Hopetown	Coelenterata	1		Belostomatidae	3		Athericidae	10	
	Downstream	Turbellaria	3		Corixidae	3	3	Blepharoceridae	15	
		Oligochaeta	1		Gerridae	5		Ceratopogonidae	5	5
Coordinates	29°36' 08.06"	Huridinea	3		Hydrometridae	6		Chironomidae	2	2
	24°05'21.06"	**Crustacea**			Naucoridae	7		Culicidae	1	
		Amphipodae	13		Nepidae	3		Dixidae	10	
DO mg/l	8.6	Potamonautidae	3		Notonectidae	3	3	Empididae	6	
Temperature °C	20.1	Atyidae	8		Pleidae	4	4	Ephydridae	3	
pH	8.8	Palaemonidae	10		Veliidae	5		Muscidae	1	
EC mS/m	30.5	Hydracarina	8		**Megaloptera**			Psychodidae	1	
		Plecoptera			Corydalidae	10		Simuliidae	5	
SASS5 Score	29	Notonemouridae	14		Sialidae	8		Syrphidae	1	
Number of Taxa	8	Perlidae	12		**Trichoptera**			Tabanidae	5	
ASPT	3,6	**Ephemeroptera**			Dipseudopsidae	10		Tipulidae	5	
		Baetidae 1 sp	4	4	Ecnomidae	8		**Gastropoda**		
Other Biota	Clarias gariepinis	Baetidae 2 sp	6		Hydropsychidae 1 sp	4		Ancylidae	6	
	Tilapia sparrmanii	Baetidae >3 sp	12		Hydropsychidae 2 sp	6		Bulinidae	3	3
	Colembola	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	5			
		Aesthnidae	8		Elmidae Dryopidae	8				
		Corduliidae	8		Gyrinidae	5				
		Gomphidae	6		Haliplidae	5				
		Libellulidae	4		Helodidae	12				
		Lepidoptera			Hydraenidae	8				
		Pyralidae	12		Hydrophilidae	5				
					Limnichidae	10				
					Psephenidae	10				
Score				4			15			10

21.2 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 21.2.1 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 21.2.2 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 21.2.3 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 21.2.4 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.

21.3 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 9 November 2018

21.3 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