Wagenboomrivier Irrigation Board

Darlingbrug Irrigation Board

PROPOSED WATER OFFTAKE WEIR
on
PORTION 2 OF THE FARM SNELRIVIER 602, WORCESTER

FRESH WATER REPORT

WATER USE LICENSE APPLICATION

A requirement of Section 21 of the National Water Act (36 of 1998)

Revised November 2020

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Omgewingsbestuur en Impakbeoordeling

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Abbreviations

Critical Biodiversity Area	CBA
Breede-Gouritz Catchment Management Agency	BGCMA
Department of Environmental Affairs and Development Planning	DEADP
Department of Environment, Forestry and Fisheries	DEFF
Department of Mineral Resources	DMR
Department of Water and Sanitation	DWS
Ecological Importance	EI
Ecological Sensitivity	ES
Ecological Support Area	ESA
Environmental Management Plan	EMP
Environmental Impact Assessment	EIA
Electronic Water Use License Application (on-line)	eWULAA
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Mean annual runoff	MAR
Metres Above Sea Level	masl
National Environmental Management Act (107 of 1998)	NEMA
National Freshwater Environment Priority Area	NFEPA
National Environmental Management Act	NEMA
National Water Act (36 of 1998)	NWA
Mean Annual Runoff	MAR
Present Ecological State	PES
Section of an Act	S
South Africa National Biodiversity Institute	SANBI
Water Use License Application	WULA

1 Introduction

The Waboom River is a tributary of the upper Breede River in the Western Cape between the towns off Worcester and Wolseley. It rises high on the peaks of the Waaihoek Mountains and is heavily utilised for the irrigation of an extensive agricultural industry.

Water for irrigation is to be taken from the Snel River with the following structure:

- Following several iterations, the final option is to construct a wall right across the stream just upstream of the bridge at the upper sampling point. The entire stream will be channelled into an off-stream division box where water will be taken out of the stream for irrigation. This will have to be a sturdy structure able to withstand the onslaught of boulders and stones as they are washed down the Snel River during floods.
- Another aspect of the project is the construction of a 2.8km long pipeline for the conveyance of water down the valley. The pipe will have to follow the river bed.
- A temporary diversion weir will be constructed upstream of the construction site, along with a channel, to take the flow of the river away from the construction site during the building operation. The weir and channel will be removed after construction has been completed.
- Another weir will have to be constructed upstream of the construction site. From here a pipe will convey water from the river into the existing water provisioning system to keep the farming operation going until the weir and division box have been completed. Thereafter the weir and the pipe will remain as a back-up, should the weir for an unforeseen reason fail.

Several design options were considered. The first preliminary report to address S21 (c) & (i) of the NWA was submitted in February 2018. The current report is essentially the same as the original preliminary report, but based on the latest and evidently the final design. Construction is set to start shortly and due to be completed before the end of the current dry season.

Moreover, the content and structure of the Fresh Water Report has developed and changed since the first report was submitted. This called for a revision of the report.

For the planned weir and the pipeline, the required Risk Matrix as prescribed in Government Notice 267 of 24 March 2017 will have to be completed and submitted, along with the Water Use Licence Application (WULA). It is meant to aid the DWS to decide what level of approval is appropriate, a formal licence or a lesser form of approval such a General Authorisation or letter of consent.

The following firms have been appointed to conduct the work:

- The engineering firm Sarel Bester Engineers CC of Ceres was appointed by the Wagenboomrivier Irrigation Board and the Darlingbrug Irrigation Board as consulting engineers for the envisaged project.
- Sarel Bester Engineers appointed EnviroAfrica to conduct the environmental impact assessment.
- EnviroAfrica, in turn, appointed Watsan Africa to produce the Fresh Water Report, compile the Risk Matrix and to submit the WULA with the Breede Gouritz Catchment Management Agency (BGCMA).

According to the current legislative framework a certain volume of water is to be left in the river and not taken out for agriculture on any other acknowledged water use. The minimum volume of water that is to be left in a river known as the Ecological Reserve and is officially set according to a premeditated and elaborate methodology (Kleynhans, 1999). Likewise, rivers are classified according to a specific methodology to typify their conservation status. These aspects have been addressed in various Department of Water and Sanitation (DWS) documents.

However, leaving water in the Waboom River was subsequently contested in court. The court ruled that despite of the promulgated articles of the NWA, water that has previously been allocated to land owners in terms of the old Water Act (54 of 1956) cannot be taken back to augment the Ecological Reserve. This was branded as a test case, which is likely to have legislative consequences. Meanwhile this report has been moulded around current legislation, as it stands now in the NWA.

2 Legal Framework

The proposed weir "triggers" sections of the National Water Act. These are the following:

S12 (1) *Water resources must be classified*

Accordingly, the Wabooms River has been classified.

S16 *The "Reserve" must be determined for each water resource.*

Accordingly, the Reserve has been determined for the Wabooms River.

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

The proposed construction of the weir and the diversion canals will have a permanent effect on the flow of the river.

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

The proposed weir will permanently change the characteristics of the river.

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. These will have a profound bearing on the construction of the proposed weir in the Waboom River.

3 Waboom River Valley

Figure 1 Waboom River

The Waboom River is a tributary of the Breede River in the Western Cape. As the grow flies it is 9 km south of the town of Wolseley and along the R43 trunk road the distance is 16 km (Figure 1).

The upper reach is known as the Snel River ("snel" in Afrikaans means fast), probably because of the velocity of the water running down the steep slope of the Waaihoekberge (Waaihoek Mountains).

The Waboom River Valley is in one of the most picturesque areas in South Africa and probably in the world, with a high tourist potential. Likewise, it has cultural significance, with a rich heritage left by generations of farmers, wine makers, naturalists and researchers.

4 Waboom River Catchment

Figure 2 Waboom River Catchment

The upper catchment is wedged into a deep bowl in the mountains of the Matroosberg Mountain Catchment (Figure 2). The distance from the top of the catchment to the confluence with the Breede River is only 11km, following ground contours. The surface area is 37 km^2. It is by all measures a small sub-catchment and is one of many along the Breede River.

The highest point in the sub-catchment is 2005 m above sea level. The confluence with the Breede River is only at 226m above sea level. This difference in elevation over such a short distance is responsible for the dramatic landscape (Figure 3).

Figure 3 Waboom River Landscape

5 Agriculture

Apart from the upper parts against the very steep slopes of the mountains, the catchment area is developed into agricultural land. Grapes for the wine industry and fruit is extensively farmed with every available patch of land groomed into high-yielding crops. The Waboom River valley forms a part of a much larger agricultural industry all along the Breede River. Farms have been in existence since the early days of human settlement in the Western Cape and some farms have been family property for literally a hundred years and more.

Agriculture is very much dependent on irrigation. Most of this is drip irrigation that utilises the latest technology.

The natural environment is heavily impacted upon. The Cape Fynbos is still evident up against the high mountain slopes, but down in the valley just about all of it has made way for large-scale farming. Likewise, the aquatic environment is largely affected over-abstraction. The river has been straightened and deepened to decrease flow resistance. The banks have been lined with berms of cobbles (Figure 4). This was done to prevent flooding of the vineyards and orchards. The river is not allowed to meander naturally.

The Waboom River is impacted upon by agricultural return flow. The return flow contains nitrogen, phosphorus and insecticides that can have deleterious effects on aquatic life.

Figure 4 Berms of Cobbles

6 Climate

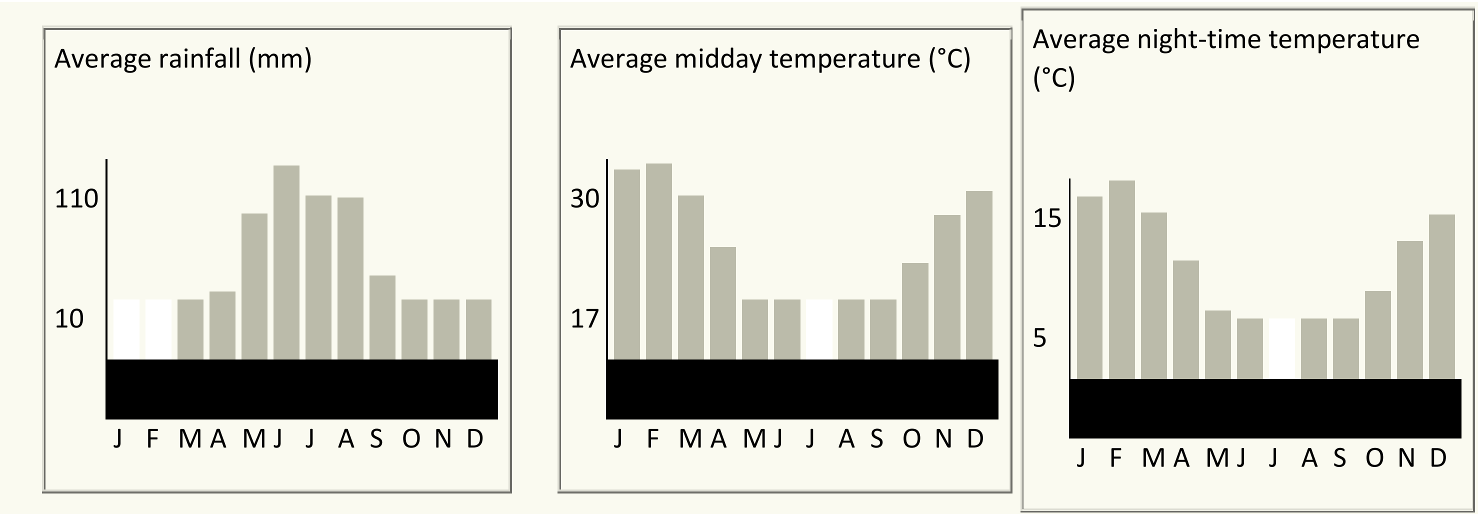


Figure 5 Climate Wolseley

Wolseley normally receives about 575mm of rain per year and because it receives most of its rainfall during winter it has a Mediterranean climate. Figure 5 shows the average rainfall values for Wolseley per month. It receives the lowest rainfall (10mm) in January and the highest (107mm) in June. The monthly distribution of average daily maximum temperatures (centre chart below) shows that the average midday temperatures for Wolseley range from 16.7°C in July to 29.7°C in February. The region is the coldest during July when the mercury drops to 4.7°C on average during the night. Consult the chart below (lower right) for an indication of the monthly variation of average minimum daily temperatures.

The rainfall on the high peaks and ridges of the Waaihoek Mountains is much higher and can vary between 1500 and 2000mm per year. The Waaihoek and adjacent

Matroosberg are known for its heavy snowfalls. These occur several times during the winter as the cold fronts and associated weather systems move from west to east over the country.

7 Quaternary Catchment

According to the classification of the DWS (Anonymous, 2017) the Waboom River is in the Upper Breede, in the H10F quaternary catchment.

The DWS established localities or sites in rivers where the ecological reserve, ecological category and environmental water requirement was established. These locations were name hydrological nodes. The node of importance for this report is in the Waboom River just upstream of its confluence with the Breede River. The node was allocated the code Niv6.

8 Waboom River Management Classes

According to the DWS (Ann., 2013) the upper third of the Waboom River was assigned the code Br.Gr.2a and was classified as Management Class 1, which signified that it was minimally used at the time.

The lower two thirds of the Waboom River were assigned the code Br.Gr.2 and was classified as Management Class 3, which indicated at the time that the river was heavily used.

9 Hydrology

The Hydrology of the Waboom River is summarised in Table 1 in the Appendix, as it was copied out of the DWS desktop study in 2009.

The mean annual runoff (MAR) was set as 8.362 million m^3. This flow was highly variable, as one standard deviation was 76.3% of the mean flow. The Waboom River, as other rivers in the region, can be a raving torrent during flood conditions, only to be a mere trickle the year thereafter.

In fact, for 10 of the 12 months of the year the standard deviation is greater than the mean value, meaning that the river can be dry at times. Under natural drought conditions the river could have been dry some years for 4 or 5 months at point of discharge at the confluence with the Breede River.

10 Ecological Reserve

The desktop study rendered an Ecological Water Requirement (EWR) of 17.51% of the MAR. This is a volume of 1.464 million m^3 (Table 1, Appendix). This is to maintain an Ecological Category D (Table 1).

The drought flow is only 10.29 % of the MAR or 0.862 million m^3. This volume of water must be allowed to flow down the river right down to the point of discharge. This volume is not to be abstracted under any circumstances, dry weather flow or even drought flow, according to the National Water Act, and should always be left in the river.

11 Sampling Points

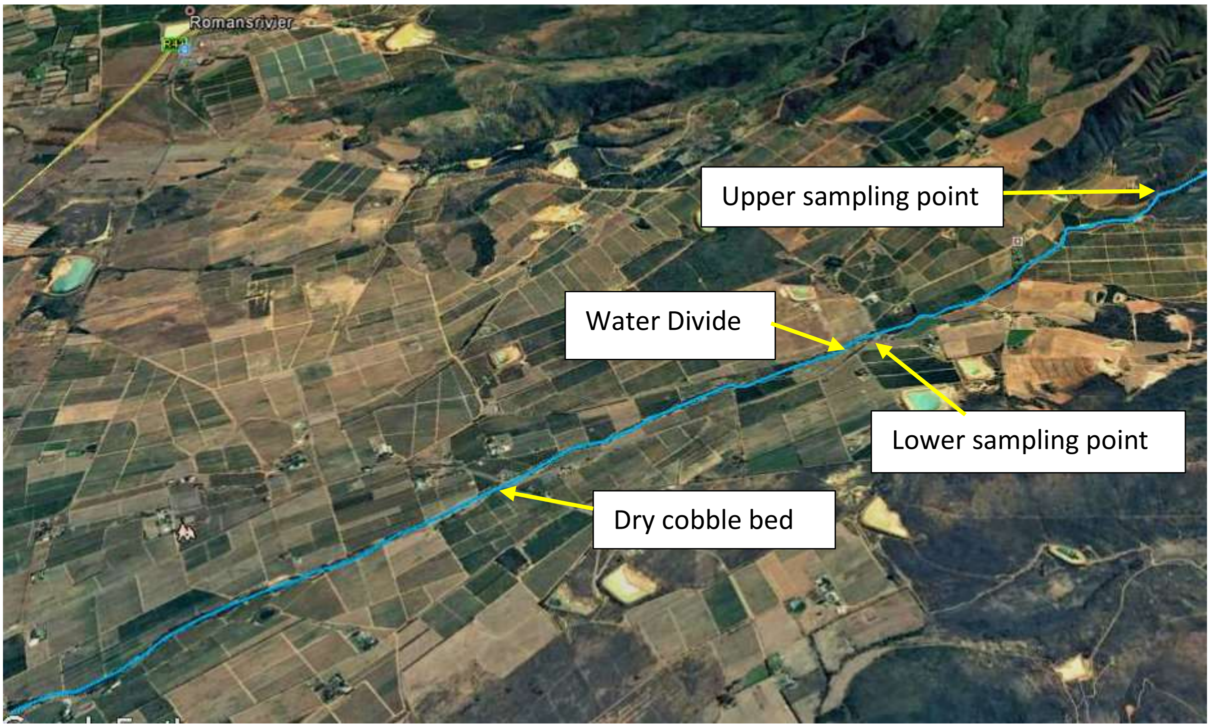


Figure 6 Sampling Points

The location of the sampling points is depicted in Figure 6 and the coordinates and elevation is given in Table 1.

Table 1 Location of sampling points

Sampling point	Latitude	Longitude	Elevation masl
Upper Lower Cobble bed	33°29' 52.46" 33°30' 34.03" 33°31' 09.28"	19°16'48.18" 19°15'27.40" 19°14'07.53"	541 391 308

11.1 Upper Sampling Point (Figure 7)

Figure 7 Upper sampling point

The upper mountain stream is a cobble bed up against the mountain side with fast flowing water. The water was clear and does not have the vegetation-stained brown colour that is so typical of waters in the mountain Fynbos. The incline is steep, with sandstone bedrock, stones in and out of current and a small pool with turbulent water. The vegetation consisted of a few patches of moss and one small patch of threat-like algae.

The stream was approximately 5m wide. The depth varied from a couple of centimetres in the riffles to a meter in the pool. There was only a little gravel on the bottom next to the one side of the stream.

Adjacent and downstream of the sampling point is a one-track bridge (Figure 8). Inside the sampling point was a take-off point for irrigation. This was a 100mm pipe fitted with filter to keep out debris.

Figure 8 Bridge downstream of upper sampling point

The riparian zone was heavily infested with alien invasive trees such as black wattle (*Acacia mearnsii*), *Eucalyptus* gum trees (Figure 9) and thorny brambles (*Rubus fruticosus*).

Figure 9 Eucalypts

11.2 Lower Sampling Point (Figure 10)

Figure 10 Lower sampling point

The lower sampling point can be typified as a fast-flowing lower mountain stream of approximately 5m wide. The incline more gradual than up the mountain. The water was clear. The extensive cobble bed had some large rocks that can go through as bedrock, in and out of the current. There was much emerging vegetation (sedge *Cyperus denudatus*) growing right into the stream. The depth varied from a few centimetres to about 10cm in the deeper parts of the cobble bed. There was a patch of gravel of less than a m^2.

Downstream and adjacent to the sampling point was a road bridge with ample concrete foundations (Figure 11).

The riparian zone was much degraded, with the sides banked up with cobbles to form berms along much of the stream. The stream was straightened out since the start of farming in the area for literally a hundred years and more to allow for formal agriculture. The vineyards and orchards were right up to the banks of the stream. Much of the banks were taken over by black wattle, interspersed by the indigenous taaibos trees (*Searsia* species).

The SASS5 score is, against expectations, rather low. There was adequate habitat of ample variability to allow for a high score. The low score indicates a deterioration in water quality down the Wabooms River that can be attributed to agricultural return flow, which was evident all along the river.

Figure 11 Bridge downstream of lower sampling point

The spraying of crops with tractor driven spraying equipment was in full swing in the orchards. The costs of laboratory testing for insecticides for a project like this one is prohibitive. It remains a question if this could be the absence of dragon fly larvae, with the exception of a number of Gomphidae in the gravel of the sample, as the habitat was suitable for these insects.

11.3 Cobble Bed

Figure 12 Cobble bed

Downstream from the lower sampling point, where a road crosses the Waboom River, there is no water at all in the river. It is just a dry cobble bed (Figure 12). All of the water is abstracted for agricultural purposes and none is left in the river.

12 Biomonitoring Results

The data of Table 2 is illustrated in a graph format (Figure 13) that is often used to evaluate biomonitoring results. The data carried over from the SASS5 score sheets in the appendix.

Table 2 Biomonitoring results

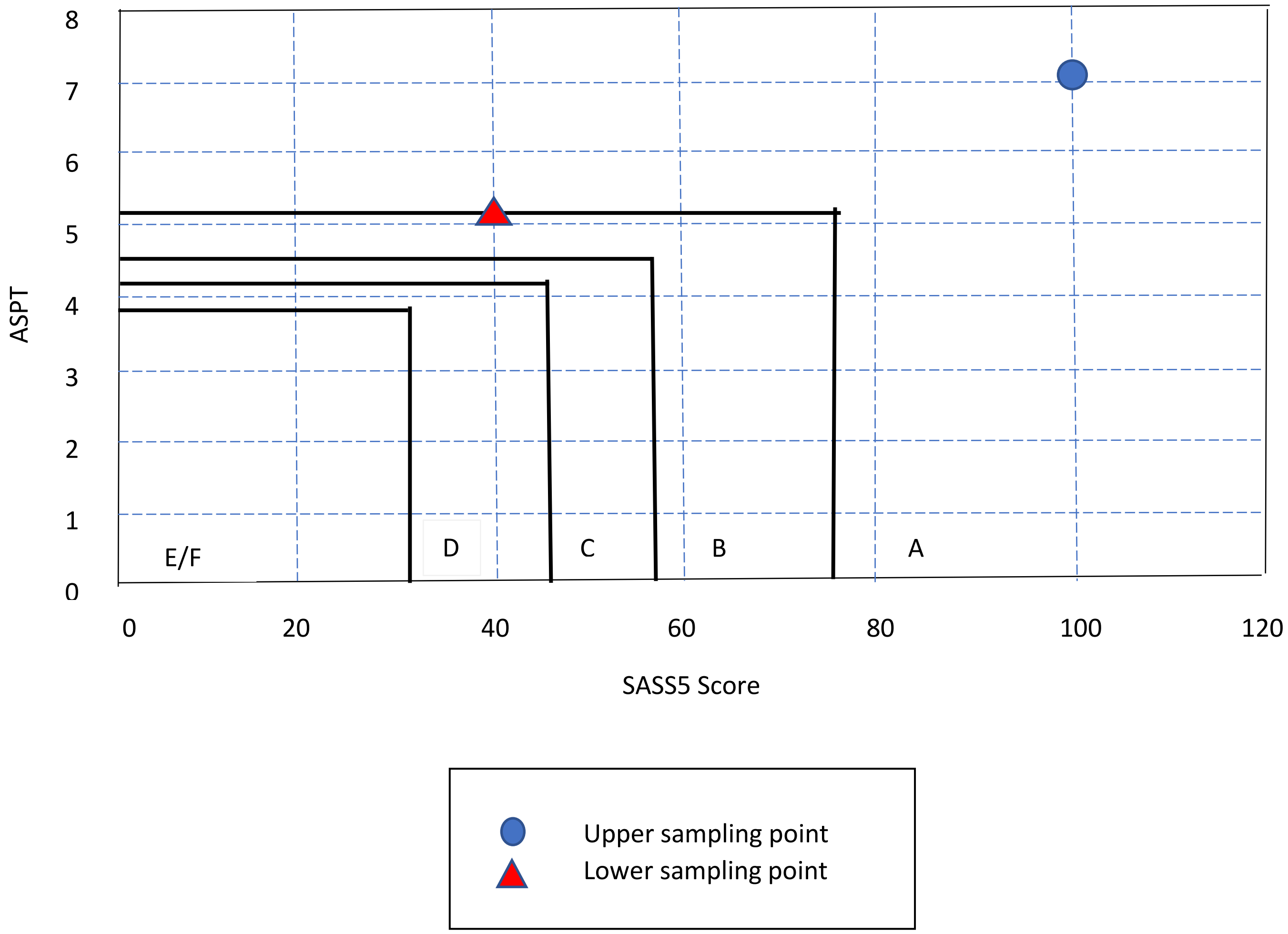
Parameter	Upper	Lower
SASS5 Score	100	40
Number of Taxa	14	7
ASPT	7.1	5.7

At the upper sampling point the Snel River is a small mountain stream that lacks the wide variety of habitats of a larger stream in similar environments where biomonitoring scores can be very high. Hence the score of 100 indicated a healthy aquatic environment with an excellent biodiversity for such a small stream. At the upper sampling point was already some human impact, with a house higher up the mountain and more water take-off points. According the high SAS5 score this impact was limited.

There is a marked drop in the SASS5 score as well as in the ASPT from the upper to the lower sampling station. This is despite the lower sampling station having a good flow of water and a wider variety of habitat during the site visit.

According to Figure 1 the biodiversity at the upper sampling station is excellent with little if any human impact (class A). The biodiversity at the lower sampling station is good, but with some impact (class B). Without agriculture it would most likely be excellent as well at the lower sampling point.

The very lower sampling point was a dry cobble bed devoid of aquatic macroinvertebrates and no SASS5 score at all, as the available water was abstracted for irrigation and none was left for the river.



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 13 Biomonitoring Results

At the upper sampling point the Snel River is a small mountain stream that lacks the wide variety of habitats of a larger stream in similar environments where biomonitoring scores can be very high. Hence the score of 100 indicated a healthy aquatic environment with an excellent biodiversity for such a small stream. At the upper sampling point was already some human impact, with a house higher up the mountain and more water take-off points. According the high SAS5 score this impact was limited.

There is a marked drop in the SASS5 score as well as in the ASPT from the upper to the lower sampling station. This is despite the lower sampling station having a good flow of water and a wider variety of habitat during the site visit.

According to Figure 1 the biodiversity at the upper sampling station is excellent with little if any human impact (class A). The biodiversity at the lower sampling station is good, but with some impact (class B). Without agriculture it would most likely be excellent as well at the lower sampling point.

The very lower sampling point was a dry cobble bed devoid of aquatic macroinvertebrates and no SASS5 score at all, as the available water was abstracted for irrigation and none was left for the river.

13 Water Quality

Table 3 Water Quality

Parameter		Upper Sampling Point	Lower Sampling Point
Temperature	°C	13.9	14.6
Oxygen	mg/l	9.3	9.4
pH		7.2	7.9
Electrical conductivity	mS/m	16	51
Ammonia	mg/l	0.3	0.3
Nitrite	mg/l	0.01	0.01
Nitrate	mg/l	>0.36	>0.36
Total Nitrogen	mg/l	13	10
Total Phosphorus	mg/l	<0.01	<0.01

The ammonia concentration (Table 3) was low at both upper and lower sampling stations. Evidently the input of animal excrement and fertiliser remnants as ammonia was insignificant. If any ammonia entered the system, it was quickly broken down by the processes of nitrification and denitrification.

However, the total nitrogen concentration was very high at both sampling stations. This was most likely because of agricultural return flow. It is difficult to tell how much of this was the end-product of the denitrification process. The nitrogen concentration was already happening at the upper sampling station, even though there were many more hectares of fruit trees and vineyards further down the valley.

Phosphorus binds to the soils and is not easily leached out. Hence very little was detected in the water at both sampling stations. This corresponds the farming practice that a huge dose of phosphorus is added to the soil when trees are planted, but thereafter very little is added.

The finger print of a high nitrogen concentration and a low phosphorus concentration has been encountered at many streams that WATSAN investigated. This is typical for streams in agricultural areas.

The overall water quality was good. It did not explain the lowering of the SASS5 score at the lower sampling station. The presence of insecticide in the water might have been the reason. This is an expensive laboratory analysis, for which was not budgeted for during the planning of the project.

14 Present Ecological State

The PES is a protocol that have been produced by Dr Neels Kleynhans 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.

Table 4 Upper sampling point habitat integrity

Instream	**score**	**weight**	**Product**
Water Abstraction	23	14	322
Flow modification	23	13	322
Bed modification	24	13	312
Channel modification	24	13	312
Water quality	23	14	322
Inundation	23	10	230
Exotic macrophytes	24	9	216
Exotic fauna	25	8	200
Solid waste disposal	24	6	144
max score		100	2380
% of total			95.20
Class			**A**

Riperian Zone			
Water abstraction	23	13	322
Inundation	22	11	242
Flow modification	21	12	252
Water quality	24	13	312
Indigenous vegetation removal	2	13	26
Exotic vegetation encroachment	1	12	12
Bank erosion	15	14	210
Channel modification	10	12	120
		100	1496
% of total			59.8
Class			**D**

Table 5 Lower Sampling Point Habitat Integrity

Instream	**score**	**weight**	**Product**
Water Abstraction	12	14	168
Flow modification	12	13	156
Bed modification	10	13	130
Channel modification	8	13	104
Water quality	15	14	225
Inundation	15	10	150
Exotic macrophytes	10	9	90
Exotic fauna	25	8	200
Solid waste disposal	18	6	108
max score		100	1331
% of total			53.2
Class			**D**
Riperian Zone			
Water abstraction	12	13	156
Inundation	12	11	132
Flow modification	10	12	120
Water quality	15	13	195
Indigenous vegetation removal	2	13	26
Exotic vegetation encroachment	1	12	12
Bank erosion	15	14	210
Channel modification	1	12	12
		100	773
% of total			30.9
Class			**E**

Table 6 Cobble Bed Sampling Point Habitat Integrity

Instream	**score**	**weight**	**Product**
Water Abstraction	1	14	14
Flow modification	1	13	13
Bed modification	10	13	130
Channel modification	8	13	104
Water quality	1	14	14
Inundation	1	10	10
Exotic macrophytes	5	9	216
Exotic fauna	25	8	200
Solid waste disposal	18	6	108
max score		100	809
% of total			32.4
Class			**E**

Riperian Zone			
Water abstraction	1	13	13
Inundation	1	11	1
Flow modification	1	12	12
Water quality	1	13	13
Indigenous vegetation removal	2	13	26
Exotic vegetation encroachment	1	12	12
Bank erosion	10	14	140
Channel modification	5	12	60
		100	277
% of total			11.1
Class			**F**

Table 7 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

Table 9 Summary of Habitat Assessment

Sampling Station	Instream	Riparian
Upper Lower Cobble Bed	A Near Pristine D Largely Modified E Extensively Modified	D Largely Modified D Largely Modified F Critically Modified

The habitat assessment paints a different picture as that of the DWS of 2009. (Appendix). The entire river from top to bottom is assigned a D rating, according to DWS. According to the current instream assessment the mountain stream high against the incline is still near-pristine. From there, downhill, as water abstraction and

Table 9 Scores for ecological conditions and habitat descriptions (Louw & Kleynhans, 2007, from Ann. 2012)

Ecological Category	Ecological Condition % score	Description of the habitat
A A/B	92 - 100 87 - 92	Still in a reference condition
B B/C	82 - 87 77 - 82	Slightly modified from a reference condition. A small change in natural habitats and biota has taken place but the basic ecosystem function is essentially unchanged
C C/D	62 - 77 57 - 62	Moderately modified from the reference condition. Loss of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged
D D/E	42 - 57 37 - 42	Largely modified from the reference condition. A large loss natural habitat, biota and basic ecosystem function has occurred.
E E/F	22 - 37 17 - 22	Seriously modified from the reference condition. The loss of natural habitat, biota and basic ecosystem function is extensive.
F	0 - 17	Critically / Extremely modified from the reference condition. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances basic ecosystem functions have been destroyed and the changes are irreversible.

agricultural return flow impacts on the stream, the rating quickly declines to a D. Further downhill, where all water has been abstracted, the rating drops to E.

This picture presents itself along other tributaries of the Breede River as well. An example is the Jan du Toits River, on which WATSAN Africa has done field work as well.

The upper riparian zone is heavily overgrown with black wattle and blue gum trees, with only a few indigenous bushes left, hence the D rating. This situation continues down the river end then deteriorates in the lower reaches as the absence of water drives the rating down to E.

The question now arises how these findings compare to those of previous investigations.

According to the DWS (Ann. 2012), the PES of the Wabooms River was D/E at the time. The officially recommended ecological category for the Wabooms River is D as well.

Evidently most tributaries of the Breede River have been assigned a D (Ann., 2012).

These ratings were arrived at using the demarcation of Table 9.

The findings of the current investigation are similar to those of previous investigations.

15 Ecological Importance

The concept was developed by Dr Neels Kleynhans of the DWS.

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

"Ecological Importance (EI) refers to the diversity, rarity, uniqueness of habitats and biota and it reflects the importance of protecting these ecological attributes from a local, regional and international perspective."

Table 10. 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)

According to Dr Martine Jordaan of Cape Nature the indigenous species of fish that can potentially be present are the following:

Sandelia capensis
Galaxias zebratus
Pseudobarbus burchelli

P burchelli is a red data species and is endemic in only certain rivers of the Western Cape. It is endangered on a national and even international scale. This leaves the Waboom River as most important, where the highest form of protection should be applied.

This rebels against previous findings where the EI of the Waboom River has been rated as "Low".

G. zebratus is widely distributed throughout the province but is characterized with localised populations with unique genotypes. As many of these fish have been recorded during site visits, probably with such a unique genotype, the Waboom River must be nothing but important.

S. capensis is widely distributed as well.

16 Ecological Sensitivity

"Ecological Sensitivity (ES) refers to the ability of an ecosystem to tolerate disturbances and to recover from impacts. The more sensitive a system is, the lower the tolerance will be to various forms of alterations and disturbances. This serves as a valuable indicator of the degree to which a water resource can be utilised without putting its ecological sustainability at risk and the level of protection the system requires."

The Ecological Sensitivity (ES) refers to the potential of the river to bounce back to an ecological condition closer to the situation prior to human impact. The upper reaches of the catchment are near-pristine, but the lower part is heavily impacted upon. Yet, if the river is left to its own devises, it would probably recover, as many rivers have shown to be able to recover.

When the river is dry, either because of the natural fluctuation is seasonal rainfall or the abstraction of water for agricultural purposes, fish and macroinvertebrates disappear. The SASS5 score will drop as the flow decreases and eventually go to zero when the river dries up.

However, fish re-appears and macroinvertebrates in the freshly flooded river following heavy rainfall in the mountains as recruitment takes place from the upper river reaches. Recruitment of macroinvertebrates occurs as flying insects colonise the newly available habitat. This phenomenon has been recorded in other similar rivers as the Snel River, such as the Jan du Toit River (Van Driel, 2017).

In conclusion, the Snel River is not sensitive to dry conditions and will predictably recover as the flow of water returns. If an adequate volume of water is allowed to flow down the river, this would happen all the way to the confluence.

The ES has previously been rated as “Moderate”.

The instream biodiversity would benefit if agricultural return flow is better controlled. Recovery would probably be slow, as agrochemicals are leached out of the system.

The area carries a vested agricultural industry that in effect destroyed most of the riparian zone. It does not seem realistic to expect that the berms will ever be removed, the river be allowed to naturally meander and that the natural vegetation will be re-planted. The almost non-existent riparian zone can nevertheless be categorised as most sensitive. It will not easily return to its former state, even if aided by a major rehabilitation program.

17 Resource Economics

Table 11. Goods and Services

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	5
Natural resources	2
Cultivated food	5
Cultural significance	3
Tourism and recreation	4
Education and research	3

0	Low
5	High

The goods and services delivered by the environment, in this case the Waboom River, 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 Waboom River the goods and services delivered are particularly applicable and important, hence it was decided to include it in the report.

The diagram (Figure 14) is an accepted manner to visually illustrate the resource economic footprint the river.

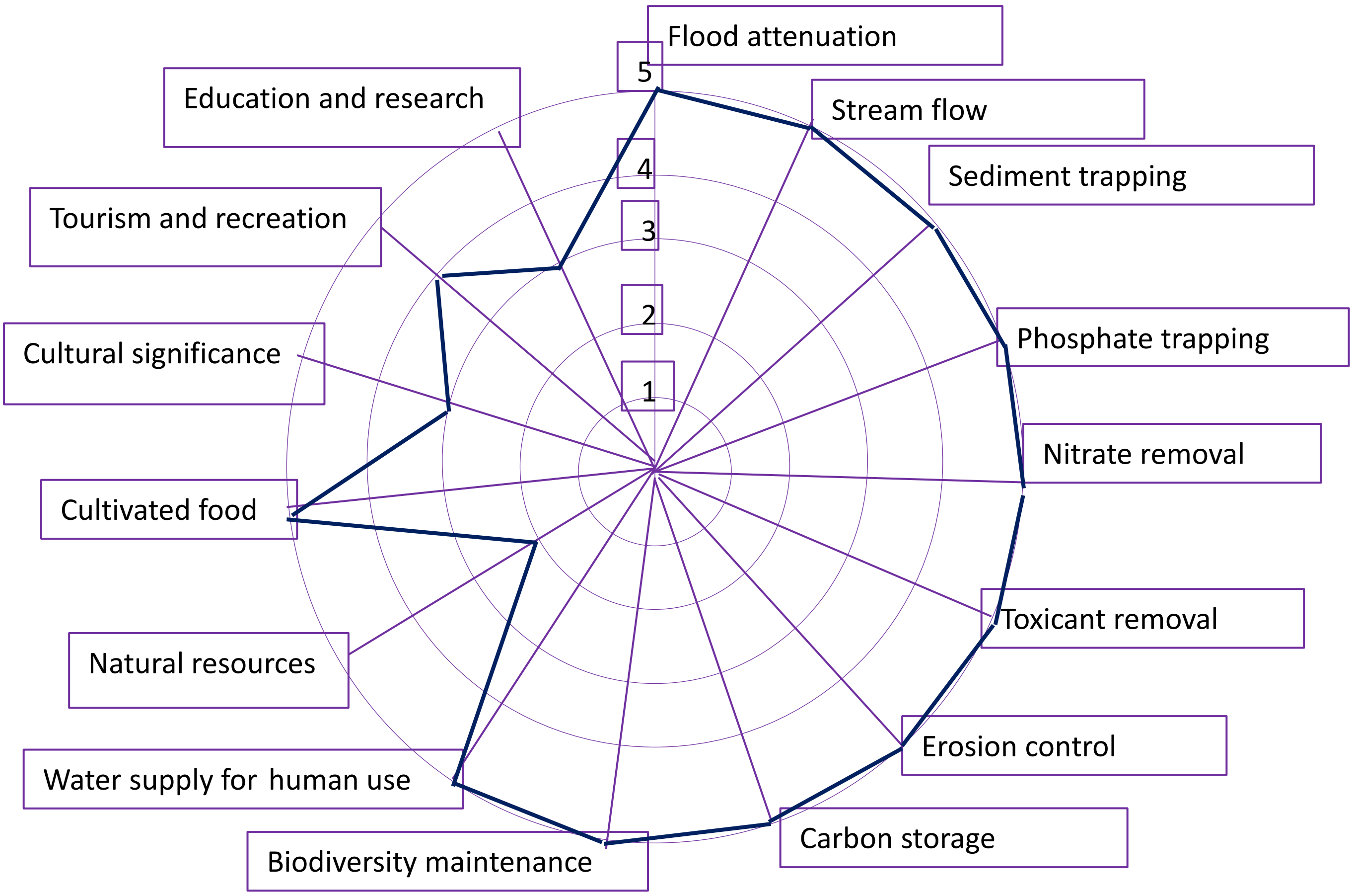


Figure 14. Resource Economics Footprint of the Waboom River

The star shape of Figure 14 is large and will probably catch the eyes of the decision-makers. The aspects on the right-hand side of the star get full marks. The reason that the left-hand side has been somewhat marked down is that a small river up against a mountain side is probably of less importance to the tourism and recreation industry than the major attractions in the Western Cape.

18 The New Weir

The envisaged weir is located at the very same place as the upstream sampling point, adjacent and upstream of the bridge.

The proposed structure is depicted in the Figure 16. The engineering drawings indicate a flow diversion structure across the Snel River, with a division box on the river's bank to distribute the water for irrigation to downstream users. The high flow will pass over the weir, over a concrete flume and then over a Reno Mattress down the river. Diverted water not destined for irrigation will be let back into the river through a pipe.

From the drawings is can be deducted that water destined for irrigation will be measured and taken from the stream through a set of calibrated V-notches, or a similar arrangement.

During the construction, a temporary weir will divert the flow of the river around the construction site. The flow will be directed into a channel to a point downstream of the construction site. This weir and channel will be removed and the site rehabilitated once the construction has been completed.

Another temporary weir adjacent to the flow diversion-weir will be constructed to direct water down a pipe into the current irrigation provisioning pipeline. Water from a spring higher up and next to the river is currently collected and carried down a pipe to a man hole, from where the pipeline starts. The manhole is the point to which this temporary pipe will connect to the existing system. Once the division box is functional, this temporary pipe will become superfluous.

A storm water diversion berm will be constructed uphill from the new construction on the bank of the river. This berm will remain as a permanent structure.

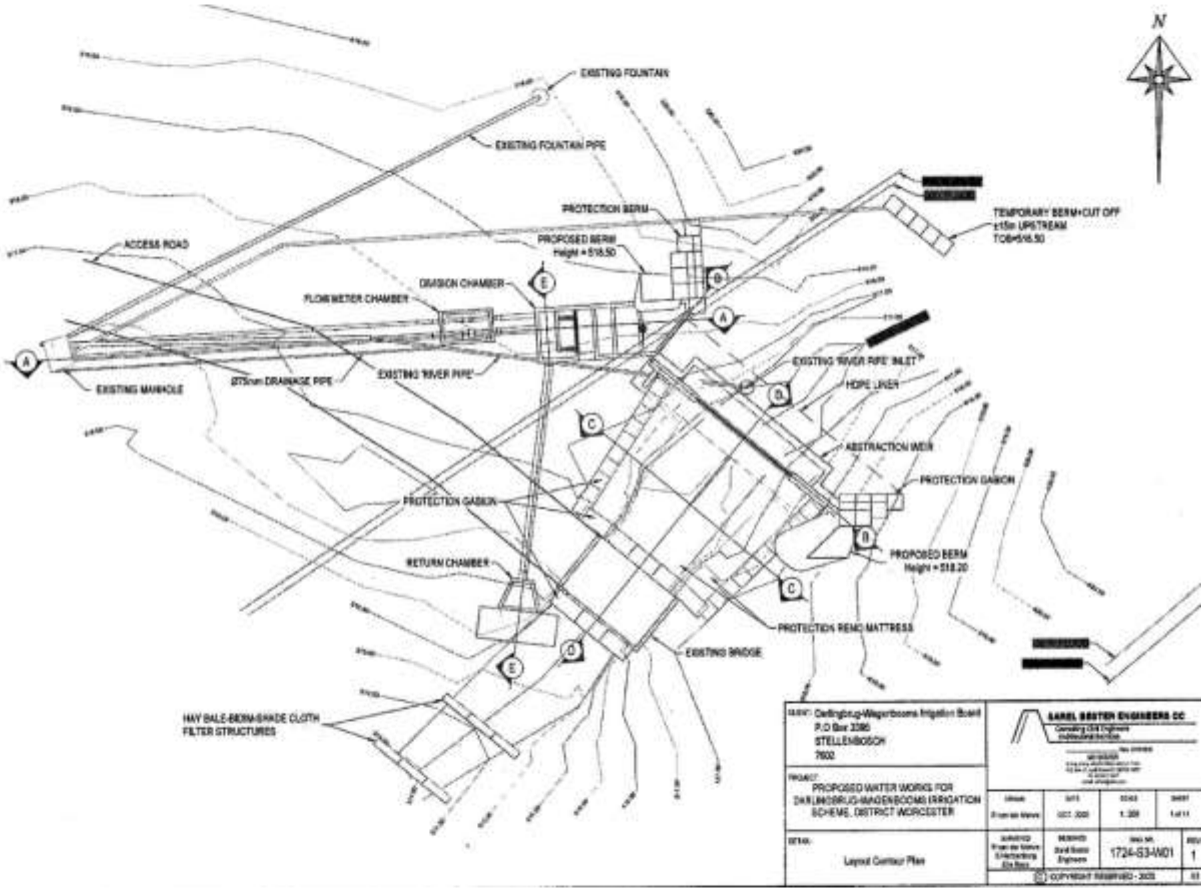


Figure 15 New Weir engineering drawing

19 The Pipe

A pipe will convey the water from the weir downhill to another instream division structure (Figure 17). It follows the northern bank of the river. Halfway down it crosses over to the southern bank.

The division structure is located just downstream of the lower sampling station.

The distance from the proposed weir to the water divide is 2.6 km as the crow flies and some 3km following the river's meander.

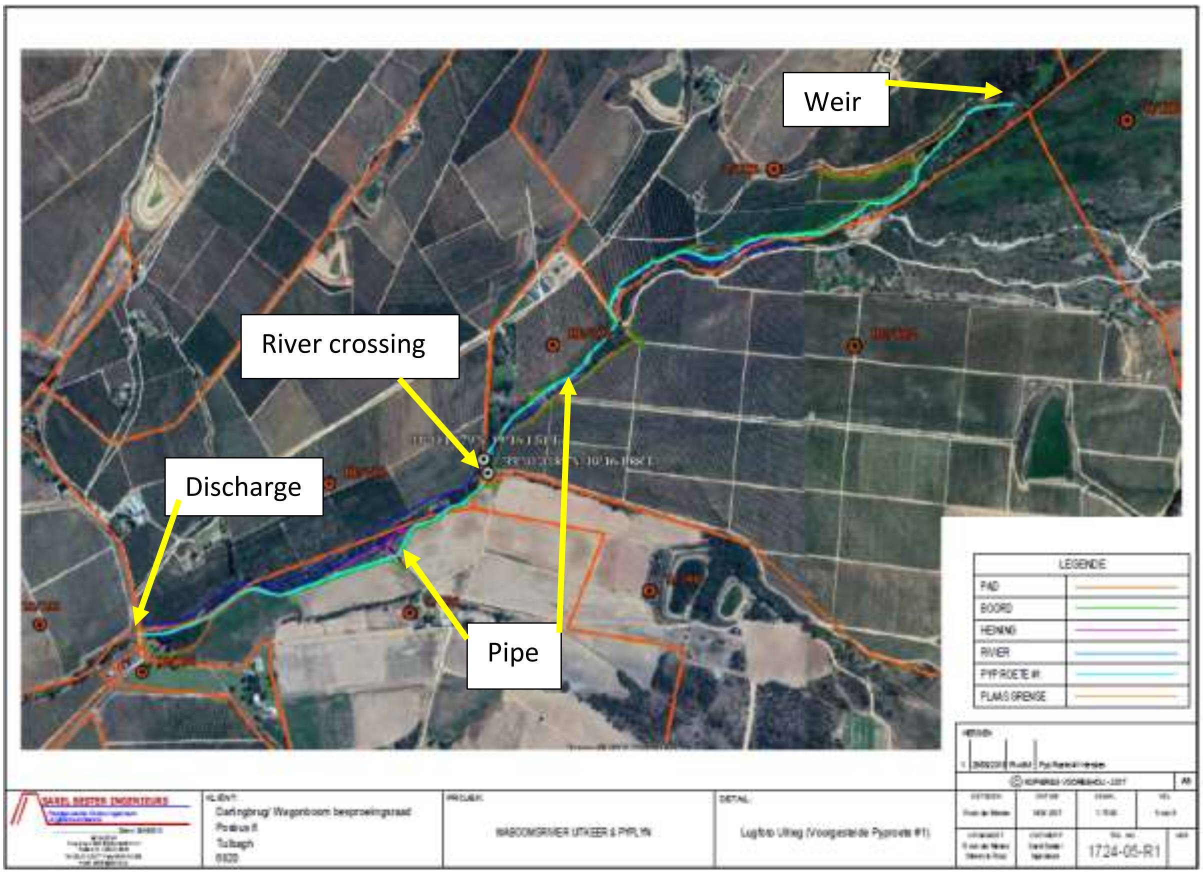


Figure 16 Pipe

Figure 17 Dividing Structure (Image Steven le Roux)

20 Water Divides

There is an existing pipe at the upper sampling station. This water off-take now is an existing legitimate water use. This pipe will be replaced by the smaller pipe in the dividing box at the envisaged weir (Figure 18 and 19, Appendix).

The bigger pipe in the proposed weir is the one that will go down all the way to the existing downstream water divide.

Twenty percent of the take-off from the upper weir will go into the smaller pipe (Figure 18). From there it will piped into an existing man hole, together with the water from a spring that decants next to river just upstream from the proposed weir site.

Eighty percent of the water will be piped with the larger of the pipes (Figure 18) to the lower water divide.

At the lower water divide the available water will by further divided in a 40 / 60 ratio to be distributed among the two irrigation boards.

There are a number of existing water users along the Waboom River with water off-takes in the river. The proposed weir and the associated pipeline are supposed to integrate these into a single water provision system, with these off-takes eliminated.

21 Potential Impacts

The question now rises what impact must be addressed in the Risk Matrix.

If the water level drops because of abstraction in the upper reached of the Waboom River and its tributaries, it can be expected that the dry period lower down the river would be extended. Putting it is technical terms, the hydroperiod would be shortened.

Moreover, the dry zone will predictably creep higher up the river as abstraction increases.

This is not unlike the current situation. While there was a strong flow during the site visit at the upper sampling site, at the location where the weir is to be built, there was no flow lower down, with the cobble bed completely exposed downstream of the lower water divide.

The instream classification depends very much on the presence or absence of water in the river. At the upper sampling point the classification was A (Table 1, near natural), the lower sampling point yielded a D (largely modified) and the cobble bed was given a F (critically modified). With no water at the lower sampling point, the classification would predictably be lowered to F as well.

The theory is now put forward that the more water is abstracted, the higher the F classification would creep up the river.

This allows for the environmental risk to be determined. What is the environmental risk to the Waboom River upstream of the lower sampling point if more water is abstracted?

The paradigm is complicated by seasonality. During the dry season the river can be naturally dry much higher up the river than the lower sampling point. At many other tributaries of the Breede River the tributaries only flow during and shortly after heavy rain. In these rivers the hydroperiod is rudimentary of what it was prior to abstraction. One such example is the Jan du Toit River. What is the risk that such a situation can develop in the Snel and Waboom River because of increased abstraction?

The impact of abstraction can be better assessed following hydrological modelling (Hughes et al). However, this is another project with a separate and substantial budget. The Risk Matrix will have to be completed with what Dr Neels Kleynhans and his so-workers left us to work with.

The Risk Matrix is completed under the assumption that the new draw-down of water from the envisaged weir at the upper sampling point would be to the level of the Ecological Reserve.

22 Mitigation Measures

1. The clearing of the construction site involves the removal of the riparian vegetation and the loose rocks in the stream to expose the bedrock. This can be done minimally, as little as possible, without excessive impact. There will be a permanent instream impact, but it can be limited to an area as small as possible.

2. Likewise, as little as possible building material can be stockpiled on the building site, with no more than is immediately required. Care should be taken that sand and other debris do not get washed into the river along with storm water.

3. If the actual construction of the weir is carried out with due consideration for the riparian and instream environment, the impact can be limited to the building site and prevented from having an impact further down the stream. The single most significant mitigation measure in this respect is the timing of the construction phase. It should be done during the dry season, February and March, when water levels in the Snel River are low.

4. The long-term abstraction of water will predictably have an impact that can only be mitigated to limited extent. Mitigation includes the omission of water offtakes along the river apart from the formal ones at the two dividing structures. All existing offtakes upstream of the end of the envisaged pipe should be

incorporated into the proposed weir. This would be predictably met with fierce resistance from those with vested interest.

5. The draw down could be less than to the level of the Ecological Reserve. In this event the creep of dry conditions up the river would be less. The hydroperiod would not be shortened as much. Exactly to what extent the creep and hydroperiod would be affected can be predicted by hydrological modelling. However, this is another project with a separate budget.

6. The clearing of the site following the construction phase can be done with due care and without letting any loose material into and down the river.

7. Erosion control measures should be implemented. Suitable vegetation should be planted upon completion of the project.

8. Finally, and most importantly, if the flow at the site of the proposed weir is 50 litres per second or more, there should be at least 2 of 3 litres per second flowing from the Waboom River into the Breede River. This would keep a currently highly compromised river alive. It should not be allowed that all the water is taken. These figures are only meant to serve as an example. Observation and adjustment of the operational rules are necessary to sustain ecological responsibility.

9. A permanent river warden could be appointed to regularly inspect the water provision system and to enforce agreed upon operational rules. Such a person would probably be employed by the irrigation boards.

10. A measure that became evident during the planning process pertains to the placement of hay bales covered with geofabric in the river downstream of the construction site. This would reduce the quantity of slit and disturbed sediments to wash down the river during the construction phase.

23 Impact Assessment

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

The main benefit of this exercise is that it allows for the evaluation of mitigation measures.

The very nature of the project, the construction of a weir in the river's bed, leaves behind a footprint. A stretch of aquatic habitat upstream of the bridge, albeit a short section, will be replaced with a concrete structure. No mitigating measures can change this. This structure will be a permanent feature and the ecological outcomes were considered to be irreversible and irreplaceable.

Likewise, water abstraction is unlikely to cease. However, aquatic habitat is resilient and aquatic ecology will to a great measure restore itself of even the abstraction is curtailed or stopped. Hence for this aspect the ecological outcomes were considered to be replaceable and reversible. It is unlikely that the current abstraction status will change in the Wabooms River.

Table 12 Impact Assessment

Description of impact: Weir Construction Phase Clearing of the weir site Stockpiling of building material Construction of the weir Construction of by-pass channel Destruction of riparian and instream habitat **Mitigation measures** Construction only during the dry season, limit the foot print, placement of hay bales								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Short term	High	Probable	Certain	Irreversible	Irreplaceable
With mitigation measures								
Direct	Local	Medium	Short term	Medium	Probable	Sure	Irreversible	Irreplaceable

Description of impact: Pipeline Construction Phase Clearing of the site Digging the trench Laying of the pipeline Construction of pedestals at crossing Destruction of riparian habitat **Mitigation measures** Limit the foot print,								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Short term	High	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Direct	Local	Medium	Short term	Low	Unlikely	Sure	Reversible	Replaceable

Description of impact: Rehabilitation of the construction site Removal of the by-pass channel and temporary weirs Levelling and landscaping Re-planting of vegetation More sediments washed down the river **Mitigation measures** Limit the foot print, prevent erosion								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Short term	Medium	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Direct	Local	Medium	Short term	Low	Unlikely	Sure	Reversible	Replaceable

Description of impact: Operational Phase Long-term water abstraction Further limit hydroperiod Dry zone creeping up the sub-catchment Mitigation measures Maintain ecological reserve								
Type Nature	Spatial Extent	Severity	Duration	Significance	Probability	Confidence	Reversibility	Irreplaceability
Without mitigation								
Direct	Regional	High	Long term	High	Probable	Certain	Reversible	Replaceable
With mitigation measures								
Direct	Local	Medium	Long term	Medium	Unlikely	Sure	Reversible	Replaceable

24 Significance

Decision-makers often press on a numerical score for Significance**.** The score takes into consideration both the environmental value of the site and the degree of impact. **(**Table 32.6, p61, Appendix) provides a system for allocation values for each of the parameters Conservation Value, Extent, Duration, Severity and Likelihood with regard to possible impacts on the Waboom River estuary. These values are then entered into the equation on p61 to derive at a value for Significance. The value for Significance can subsequently be evaluated according to Table 32.6.

Table 32.6 provides a yardstick for decision-making with regard to allow or disallow a development with its concomitant impact on the botanical environment.

The scores that were given are entirely those of the specialist, based on his or her knowledge and experience. These scores form a bases for debate and consensus, should contemporaries and decision-makers wish to add to the process.

The scores apply under the assumption that mitigation measures will be in place.

The scores given were as follows:

Table 13 Significance Score

Parameter	Score
Conservation value Likelihood Duration Extent Severity Significance	4 5 5 4 4 72

The significance came out as high, despite of mitigation measure being in place. The construction of a weir and subsequent abstraction od water in a small tributary of the Breede River with a high conservation value cannot yield a lesser rating for Significance that “High”.

25 Risk Matrix

The assessment was carried out according to the interactive Excel table that is available on the DWS webpage. The Risk Matrix methodology is tabled in the Appendix. Table 14 is a replica of the Excel spreadsheet that has been adapted to fit the format of this report. The numbers in Table 14 (continued) represent the same activities as in Table 14.

The Risk Matrix was specifically designed to aid official decision-making pertaining to the appropriate level of authorization. Levels of authorization include a letter of consent, a General Authorization or a License. If the risks to the aquatic environmental are high, a License is appropriate.

Table 14 Risk Matrix

No.	Activity	Aspect	Impact	Significance	Risk Rating
1.1	Clearing of the weir site	Removal of vegetation, loose rocks, soil	Destruction of riparian vegetation and aquatic habitat	56	Moderate
1.2			Downstream accumulation of sediments	46	Low
2	Stockpiling of building material	Material in riparian and aquatic habitat	Disturbance of habitat	38	Low
3	Construction of weir	Placing of concrete and reno matrass	Instream habitat destruction	152	Moderate
4.1	Abstraction of water	Lowering of water level	Reduce aquatic biodiversity	175	High
4.2		Shorten hydroperiod	Reduce biodiversity	171.5	High
4.3		Upstream creep of dry river bed	Absence of macroinvertebrates	175.5	High
5	Clearing of building site	Rehabilitation	More sand and material in aquatic habitat	26	Low
6.1	Pipeline	Construction	Riparian zone	62	Moderate
6.2			Instream habitat	64	Moderate
6.3		Operational Phase	Riparian zone	112	Moderate
6.4			Instream habitat	124	Moderate

Table 14 Continued Risk Rating

No	Flow	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Conse-quence
1.1	2	2	4	4	3	1	3	7
1.2	1	2	2	2	1.75	3	1	5.75
2	1	2	5	2	1.75	1	2	4.75
3	4	1	4	4	3.5	1	5	9.5
4.1	5	1	3	4	3.5	4	5	12.5
4.2	5	1	1	4	3.25	4	5	12.25
4.3	5	1	3	4	3.25	4	5	12.25
5	1	2	1	2	1.25	1	1	3.25
6.1	1	1	3	2	1.75	1	5	7.75
6.2	2	1	3	2	2	1	5	8
6.3	1	1	1	1	1	1	5	7
6.4	2	1	2	2	1.75	1	5	7.75

No	Frequency of activity	Frequency of impact	Legal issues	Detection	Likelihood	Significan-ce	Risk Rating
1.1	1	1	5	1	8	56	Moderate
1.2	1	1	5	1	8	46	Low
2	1	1	5	1	8	38	Low
3	5	5	5	1	16	152	Moderate
4.1	4	4	5	1	14	175	High
4.2	4	4	5	1	14	171.5	High
4.3	4	4	5	1	14	171.5	High
5	1	1	5	1	6	26	Low
6.1	1	1	5	1	8	62	Moderate
6.2	1	1	5	1	8	64	Moderate
6.3	5	5	5	1	16	112	Moderate
6.4	5	5	5	1	16	124	Moderate

The risk assessment is a requirement of Government Notice 1180 of 2002 in terms of the National Water Act (36 of 1998).

The scores that were given are solely that of the assessor, according to the guidelines on the DWS webpage.

If additional water is abstracted from the Snel River at the envisaged weir to the level of the Ecological Reserve, there is a high risk that more exposed cobble bed without any flow of water will creep up the river, that the hydroperiod would be significantly shortened and that aquatic biodiversity would be deleteriously affected.

There will be a moderate risk when the riparian vegetation and the loose rocks in the stream are going to be removed of damage to the habitat. This damage will be localised to the construction area. The risk to the downstream habitat is low.

During the construction phase instream habitat right at the construction site will be destroyed, with no downstream destruction, leaving the construction phase of the project with an overall moderate risk.

The risks attached to the construction and operation of the pipeline are moderate in all events, taking into consideration that a part of the pipeline will be located on the bed of the river and that the riparian zone is already denaturalised.

For high risk projects such as the envisaged Waboom River weir, the DWS is obliged under current legislation to issue a license with strict conditions. The absence of such a licence would constitute an illegal activity.

26 Offset

The concept of an offset has been introduced in current environmental practice when the National Environmental Management Act (NEMA) has been promulgated in 1998. According to the concept land that is sacrificed for development is replaced by land elsewhere to make up for the loss of ecosystem services.

The loss of ecosystem services as a result of current abstraction from the Waboom River is inevitable and is set to continue and even increase when the new weir has been constructed. For this loss it is difficult to see than any land will ever be acquired according to the offset principle, but perhaps another form of offset could be contemplated.

There are a number of tributaries in the upper catchment of the Breede River that are still relatively unimpacted and with a high conservation value. Some of these are densely overgrown with alien vegetation.

It is suggested that the concerned irrigation boards are levied with a small amount, as an offset. This money can be ringfenced for conservation purposes, such as the control of alien vegetation in upper catchments. Moreover, irrigation boards could “adopt” such a sub-catchment, in a self-regulatory manner, without any administrative support from the authorities, apart from regular monitoring and oversight.

Such an approach would greatly enhance the changes for a successful Water Use License Application for the construction and operation of the envisaged weir.

27 Waboom Mountain Catchment

The high ground up the mountains with its very high seasonal rainfall is the life blood of the farming activities in the valley below and hence deserve special consideration.

The upper catchment is overgrown in places with exotic and invasive eucalypt trees. These mature blue gum trees evapotranspirate a substantial volume of water, water that could have flowed down the Waboom River. This water was bound to decant into the river downstream, instead of dissipating into the atmosphere. It could have benefitted the aquatic ecosystem and be used for irrigation.

It only makes economic sense to the farming community to eradicate these blue gum trees, as it is sensible to get rid of the black wattle and Port Jackson trees and other alien vegetation.

If the applicants show commitment to control invasive trees in the mountain catchment and elsewhere along the Waboom River, the BGCMA is more likely to consider the WULA favourably.

28 Conclusions

Figure 18 has been adapted from one of the most recent DWS policy documents.

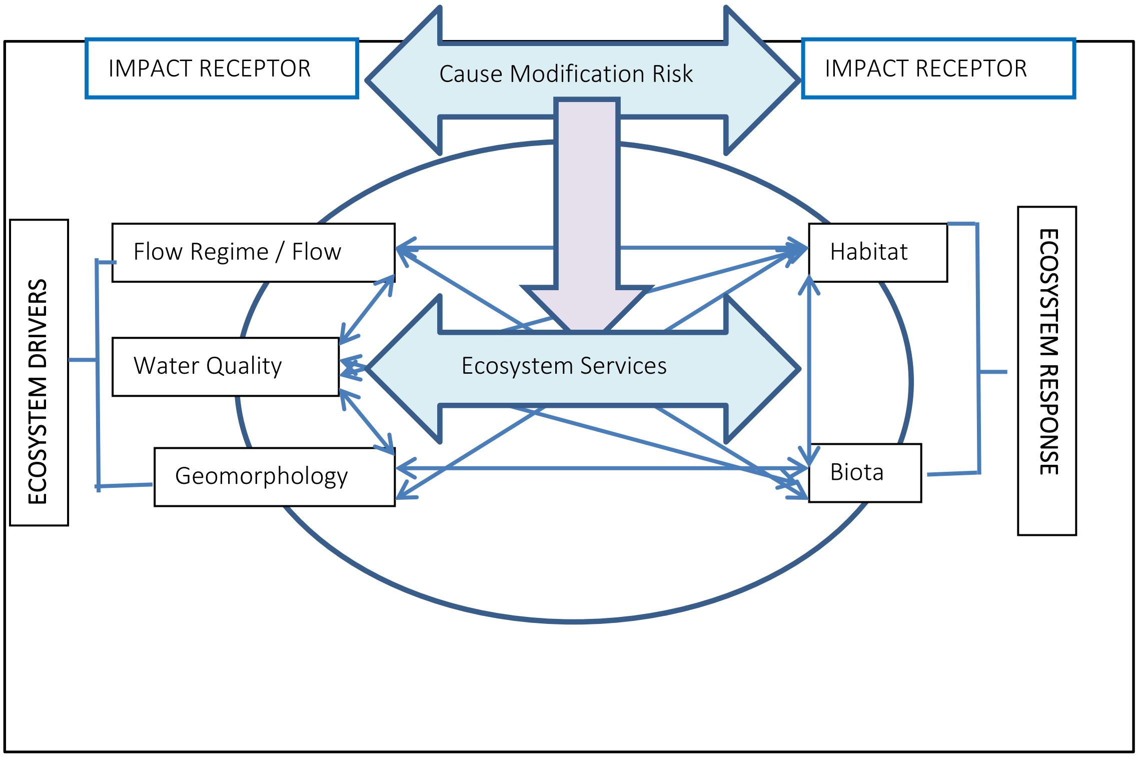


Figure 18 Minimum Requirements for a S21(c) and (i) Application.

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

The conclusions can be structured along the outline that is provided by Figure 17.

The main driver of the Snel River ecosystem is the water that comes down the river from the high ground up the Waaihoek Mountains. This is countered by the large-scale water abstraction for extensive farming. The main impacts are the limiting of the hydroperiod, lowering of water levels and the creep of dry conditions up the river. The agricultural return flow impacts on the water quality.

The geomorphology of the river has been substantially modified.

The connectivity of the river with its riparian zone has been seriously compromised.

Despite of the substantial aquatic habitat availability, biodiversity has been deleteriously impacted upon, as indicated by the SASS5 score. There is a real risk that this tendency will continue as more water is abstracted from the envisaged weir in the upper reaches of the Waboom River.

The real loss of ecosystem services is felt lower down the Breede River. Most of the tributaries have been extensively modified over millennia of intensive farming. The river is reduced to a “saline trickle” during the dry season (quote from a well-known environmentalist).

The current abstraction from the Waboom River probably already is on the level of the Ecological Reserve, perhaps even lower. The construction of the envisaged weir would at least formalise current abstractions and allow for better control by the authorities.

There is little doubt that a license is required for the envisaged project, according to the Risk Assessment, and that lesser forms of approval such a letter of consent or a General Authorisation are entirely inappropriate.

29 References

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30 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

Name of the company: Watsan Africa Date: 5 November 2020

31 Résumé

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Water Scientist

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Experience

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

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

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

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

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

University of Western Cape and Stellenbosch University 1994- 1998 part-time
- Lectured post-graduate courses in Water Management and Environmental Management to under-graduate civil engineering students
- Served as external dissertation and thesis examiner

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

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

Reports

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

- Fresh Water Report Calvinia Sports Grounds Irrigation
- Fresh Water Report CA Bruwer Agricultural Development Kakamas
- Fresh Water Report Zwartfontein Farm Dam, Hermon
- Statement Delsma Farm Wetland, Hermon
- Fresh Water Report Lemoenshoek Farms Pipelines Bonnyvale
- Fresh Water Report Water Provision Pipeline Brandvlei
- Fresh Water Report Erf 19992 Upington
- Botanical Report Zwartejongensfontein Sand Mine, Stilbaai
- Fresh Water Report CA Bruwer Feldspath Mine, Kakamas
- Sediment Yield Calculation, Kenhardt Sand Mine
- Wetland Demarcation, Grabouw Traffic Center
- Fresh Water Report, Osdrift Sand Mine, Worcester
- Fresh Water Report, Muggievlak Storm Water Canal, Vredenburg
- Fresh Water Report, Marksman's Nest Rifle Range, Malmesbury
- Biodiversity Report, Muggievlak Storm Water Canal, Vredenburg
- Strategic Planning Report, Sanitation, Afghanistan Government, New Delhi, India
- Fresh Water Report, Potable Water Pipeline, Komaggas
- Fresh Water Report, Wastewater Treatment Works, Kamieskroon
- Fresh Water Report, Turksvy Farm Dam, Upington
- Fresh Water Report, Groblershoop Urban Development, IKheis Municipality
- Fresh Water Report, Boegoeberg Urban Development, IKheis Municipality
- Fresh Water Report, Opwag Urban Development, IKheis Municipality
- Fresh Water Report, Wegdraai Urban Development, IKheis Municipality
- Fresh Water Report, Topline Urban Development, IKheis Municipality
- Fresh Water Report, Grootdrink Urban Development, IKheis Municipality
- Fresh Water Report, Gariep Urban Development, IKheis Municipality
- Fresh Water Report, Bonathaba Farm Dam, Hermon
- Botanical Report, Sand Mine Greystone Trading, Vredendal
- Botanical Report Namakwa Klei Stene, Klawer
- Fresh Water Report Buffelsdrift Quarry, George
- Fresh Water Report Styerkraal Agricultural Development, Onseepkans.
- Technical Report Arabella Country Estate Wastewater Treatment Works, Kleinmond

32 Appendix

32.1 Biomonitoring Results

SASS5 Score Sheet										
Date	20 Oct 17	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**
Locality	Waboomsrivier	Porifera	5		**Hemiptera**			**Diptera**		
	Upper Sampling Point	Coelenterata	1		Belostomatidae	3		Athericidae	10	
		Turbellaria	3		Corixidae	3		Blepharoceridae	15	
		Oligochaeta	1		Gerridae	5		Ceratopogonidae	5	5
Coordinates	33°29' 52.46"	Huridinea	3		Hydrometridae	6		Chironomidae	2	2
	19°16'48.18"	**Crustacea**			Naucoridae	7		Culicidae	1	
		Amphipodae	13		Nepidae	3		Dixidae	10	10
DO mg/l	9.3	Potamonautidae	3		Notonectidae	3		Empididae	6	
Temperature °C	13.9	Atyidae	8		Pleidae	4		Ephydridae	3	
pH	7.15	Palaemonidae	10		Veliidae	5		Muscidae	1	
EC mS/m	16	Hydracarina	8		**Megaloptera**			Psychodidae	1	
		Plecoptera			Corydalidae	10		Simuliidae	5	5
SASS5 Score	100	Notonemouridae	14		Sialidae	8		Syrphidae	1	
Number of Taxa	14	Perlidae	12	12	**Trichoptera**			Tabanidae	5	
ASPT	7,1	**Ephemeroptera**			Dipseudopsidae	10		Tipulidae	5	5
		Baetidae 1 sp	4		Ecnomidae	8	8	**Gastropoda**		
Other Biota	Galaxias	Baetidae 2 sp	6	6	Hydropsychidae 1 sp	4		Ancylidae	6	
	Tadpoles	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	9	Psychomyidae	8	8	Planorbidae	3	
		Oligoneuridae	15		**Cased Caddis**			Thiaridae	3	
Comments		Polymitarcyidae	10		Barbarochthonidae	13	13	Viviparidae	5	
		Prosopistomatida	15		Calamoceratidae	11		**Pelecipoda**		
		Teloganodiadae	12		Glossostomatidae	11	11	Corbiculidae	5	
		Trichorythidae	9		Hydroptilidae	6		Sphariidae	3	
		Odonata			Hydrosalpingidae	15		Unionidae	6	
		Calopterygidae	10		Leptostomatidae	10				
		Clorocyphidae	10		Leptoceridae	6	6			
		Chorolestidae	8		Petrothrincidae	11				
		Coenagrionidae	4		Pisulidae	10				
		Lestidae	8		Sericostomatidae	13				
		Platycnemidae	10		**Coleoptera**					
		Protoneuridae	8		Dyticidae	5				
		Aesthnidae	8		Elmidae Dryopidae	8				
		Corduliidae	8		Gyrinidae	5				
		Gomphidae	6		Haliplidae	5				
		Libellulidae	4		Helodidae	12				
		Lepidoptera			Hydraenidae	8				
		Pyralidae	12		Hydrophilidae	5				
					Limnichidae	10				
					Psephenidae	10				
Score				27			46			27

SASS5 Score										
Date	20 Oct 17	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**	**Taxon**	**Weight**	**Score**
Locality	Waboomsrivier	Porifera	5		**Hemiptera**			**Diptera**		
	Lower Sampling Point	Coelenterata	1		Belostomatidae	3		Athericidae	10	
		Turbellaria	3		Corixidae	3		Blepharoceridae	15	
		Oligochaeta	1	1	Gerridae	5		Ceratopogonidae	5	
Coordinates	33°30' 34.03"	Huridinea	3		Hydrometridae	6		Chironomidae	2	2
	19°15'27.40"	**Crustacea**			Naucoridae	7		Culicidae	1	
		Amphipodae	13		Nepidae	3		Dixidae	10	
DO mg/l	9.4	Potamonautidae	3		Notonectidae	3		Empididae	6	
Temperature °C	14.0	Atyidae	8		Pleidae	4		Ephydridae	3	
pH	7.93	Palaemonidae	10		Veliidae	5		Muscidae	1	
EC mS/m	51	Hydracarina	8	8	**Megaloptera**			Psychodidae	1	
		Plecoptera			Corydalidae	10		Simuliidae	5	5
SASS5 Score	40	Notonemouridae	14		Sialidae	8		Syrphidae	1	
Number of Taxa	7	Perlidae	12		**Trichoptera**			Tabanidae	5	
ASPT	5,7	**Ephemeroptera**			Dipseudopsidae	10		Tipulidae	5	
		Baetidae 1 sp	4		Ecnomidae	8		**Gastropoda**		
Other Biota	Galaxias	Baetidae 2 sp	6	6	Hydropsychidae 1 sp	4		Ancylidae	6	
	Tadpoles	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	12	Glossostomatidae	11		Corbiculidae	5	
		Trichorythidae	9		Hydroptilidae	6		Sphariidae	3	
		Odonata			Hydrosalpingidae	15		Unionidae	6	
		Calopterygidae	10		Leptostomatidae	10				
		Clorocyphidae	10		Leptoceridae	6				
		Chorolestidae	8		Petrothrincidae	11				
		Coenagrionidae	4		Pisulidae	10				
		Lestidae	8		Sericostomatidae	13				
		Platycnemidae	10		**Coleoptera**					
		Protoneuridae	8		Dyticidae	5				
		Aesthnidae	8		Elmidae Dryopidae	8				
		Corduliidae	8		Gyrinidae	5				
		Gomphidae	6	6	Haliplidae	5				
		Libellulidae	4		Helodidae	12				
		Lepidoptera			Hydraenidae	8				
		Pyralidae	12		Hydrophilidae	5				
					Limnichidae	10				
					Psephenidae	10				
Score				33			0			7

32.2 Hydrology Wabooms River

Table A3 3: EWR summary Table for the Wabooms River at node Niv6 in Quaternary Catchment H10F

Desktop Version 2, Generated on 21/08/2009
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff : Niv6.

Annual Flows (Mill. cu. m or index values):

MAR	=	8.362
S.Dev.	=	6.380
CV	=	0.763
Q75	=	0.000
Q75/MMF	=	0.000
BFI Index	=	0.243
CV(JJA+JFM) Index	=	8.094

Ecological Category = D

Total EWR	=	1.464 (17.51 %MAR)
Maint. Lowflow	=	0.861 (10.29 %MAR)
Drought Lowflow	=	0.861 (10.29 %MAR)
Maint. Highflow	=	0.604 (7.22 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (EWR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.209	0.433	2.071	0.085	0.085	0.037	0.122
Nov	0.061	0.163	2.683	0.058	0.058	0.000	0.058
Dec	0.006	0.025	4.306	0.054	0.054	0.000	0.054
Jan	0.080	0.631	7.921	0.043	0.043	0.000	0.043
Feb	0.011	0.069	6.185	0.038	0.038	0.000	0.038
Mar	0.026	0.175	6.756	0.040	0.040	0.000	0.040
Apr	0.025	0.110	4.330	0.041	0.041	0.037	0.078
May	0.575	1.236	2.148	0.062	0.062	0.037	0.099
Jun	1.517	1.836	1.211	0.089	0.089	0.037	0.126
Jul	2.295	2.211	0.963	0.113	0.113	0.275	0.389
Aug	2.650	3.302	1.246	0.122	0.122	0.143	0.265
Sep	0.908	1.181	1.301	0.115	0.115	0.037	0.152

32.3 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 32.3.1 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 32.3.2 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 32.3.3 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 32.3.4 Probability, confidence, reversibility and irreplaceability

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

Table 32.5 Conservation Value

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

Table 32.6 Significance

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

Table 32.7 Scoring system

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

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

32.8 Risk Matrix Methodology

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

Negative Rating

TABLE 1- SEVERITY

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

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

TABLE 2 – SPATIAL SCALE

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

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

TABLE 3 – DURATION

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

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

TABLE 4 – FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

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

TABLE 5 – FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

TABLE 6 – LEGAL ISSUES

How is the activity governed by legislation?

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

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

TABLE 8: RATING CLASSES

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

A low risk class must be obtained for all activities to be considered for a GA

TABLE 9: CALCULATIONS

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