# Aquatic assessment in terms of Section 24G of NEMA application for construction of a dam on Portion 3, Farm 36, Buffelsfontein near Ladismith, Western Cape.

**Prepared by: Dr. Jackie Dabrowski, Confluent Environmental (Pty) Ltd**

**For: Cape EAPrac**

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## DECLARATION OF CONSULTANTS INDEPENDANCE

This report was compiled by Jacqueline (Jackie) Dabrowski, the Director of Confluent Environmental (Pty) Ltd. Jackie holds a Ph.D. in Veterinary Science and her post-graduate studies were in the field of freshwater ecology. She has conducted research and published scientific articles on a range of topics including aquatic food webs, fish health, and trends in water quality, branchiopod diversity, and land-use impacts on water quality. Her consulting work has focussed on a range of environmental assessments of dams, rivers, ephemeral watercourses and wetlands at various locations in South Africa. Jackie has conducted several assessments of non-perennial drainage lines impacted by a variety of land-uses.

At the time of conducting the study and compiling this report Jackie did not have any interest, hidden or otherwise, in the proposed development that this study has reference to. Work performed for this study was done in an objective manner with the aim to present facts, findings and recommendations based on relevant professional experience and scientific data.

Jackie Dabrowski (Ph.D., Pr.Sci.Nat. *Aquatic Science*)
SACNASP Registration Number 115166

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# 1. INTRODUCTION

## 1.1 Background

Confluent Environmental (Pty) Ltd. were appointed by Cape EAPrac to provide an aquatic specialist study in terms of Section 24G of the National Environmental Management Act (NEMA; Act No. 107 of 1998) on behalf of the land owners of Portion 3 of Farm 36, Buffelsfontein, near Ladismith. The land owner commenced construction of an instream dam (> 100 $m^2$ surface area) on a network of unnamed non-perennial drainage lines in order to store water for livestock watering and irrigation. Part of the dam wall and basin crosses the cadastral boundary to the east onto Portion 66 of Farm 42. Approximately 2.1 hectares of vegetation was cleared for construction of the dam basin and wall. These activities trigger the requirement for assessment and authorisation in terms of the NEMA, and should have been considered in an Environmental Impact Assessment. Authorisation in terms of NEMA should have been obtained prior to commencement of these activities. Failure to obtain the necessary authorisations means these activities are considered unlawful in terms of the NEMA.

## 1.2 Scope of work

The scope of work covers the following aspects:

- Characterise the affected aquatic ecosystem in relation to its current and reference condition using tools to determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS);
- Consider construction of the dam within the broader regional context;
- Identify and assess the mitigated and unmitigated environmental impacts resulting from construction and future operation of the dam;
- Provide recommendations.

## 1.3 Legislation and definitions

Any reference to a watercourse in this report is based on the definition in the National Water Act (NWA; Act 36 of 1998) which defines a watercourse as:

(a) a river or spring;
(b) **a natural channel in which water flows regularly or intermittently;**
(c) a wetland, lake or dam into which, or from which, water flows ; and
(d) any collection of water which the Minister may, by notice or Gazette, declare to be a watercourse.

Definition (b) is highlighted in bold as it provides the best description of the affected watercourse(s) at the site.

### 1.4 Assumptions and limitations

- As no water was flowing in the watercourse at the time of the assessment, it was not possible to make direct observations of any aquatic biota that may be associated with the aquatic ecosystem, or pinpoint areas of active erosion;
- The area has received below average rainfall for several years and the vegetation on site reflects the drought conditions. Therefore vegetation could not be extensively described in the riparian zone;
- The retrospective nature inherent in Section 24G applications means the assessment is dependent on comparison of the impacted site to suitable reference conditions. In this case the impacted site was compared to sites upstream and downstream of the area. The assumption was made that these sites provide a suitable comparison.
- This assessment is based on the findings of visual assessment of the site combined with available desktop resources. This study was not informed by detailed hydraulic, hydrological, faunal or floral assessments.

## 2. DESCRIPTION OF THE UNAUTHORISED ACTIVITY

Construction of the dam commenced in May 2018, and took place within the watercourse bed, banks and adjacent areas. In order to construct the dam, vegetation was cleared and soil was excavated to form the dam basin (Figure 1). Excavated soil was used to build the embankment which is approximately 208 m in length and measures 10.7 m above the lowest contour in the dam basin at 386 m.a.m.s.l. The dam spillway is located to the west of the wall at 394 m.a.m.s.l. The original path of the watercourse was to the east of the dam wall where it was channelled between orchards to connect with the Groot River. It is *unclear how the spillway will connect to the original watercourse* (Figure 2). There is a piped outlet midway across the embankment at the base of the dam wall. This leads to a channel which measures approximately 210 m in length, and has been excavated to a point where the water will be used to irrigate orchards. No foreign material appears to have been brought onto the site for the purpose of construction. The Full Supply Volume of the dam would be 149 621.62 $m^3$ with a Full Supply Area of 3.1 hectares. The area currently cleared measures approximately 2.5 ha, and *further clearing of vegetation is required* (Figure 2).

Prior to construction of the dam there was a much smaller impoundment further downstream which, according to the land-owner, was repeatedly damaged during floods. Remnant parts of the structure (concrete) are still present in the channel, which his highly eroded. The riparian vegetation along both banks of the channel leading from the original dam area to the Groot River between orchards was removed sometime in 2018, leaving the channel exposed. It is not known whether this activity was somehow related to the dam construction.

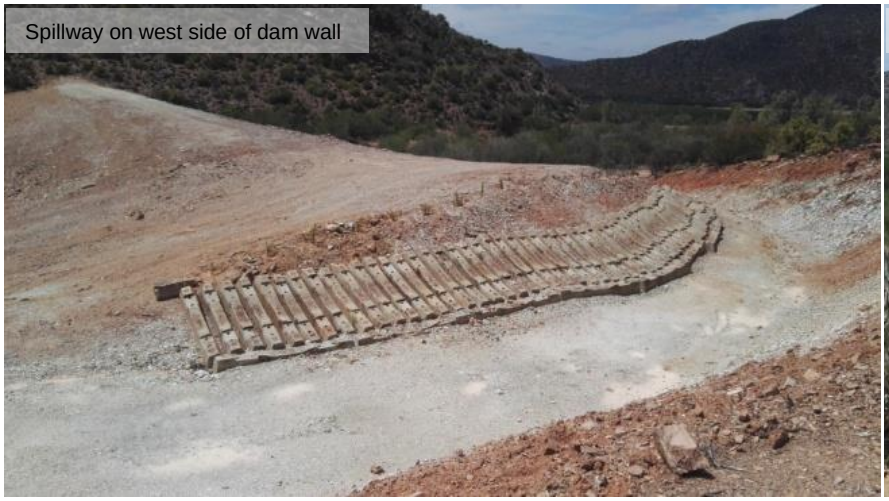
### 2.1 Operating rules

Storage in the dam is currently limited to 23 800 $m^3$ according to Section 32 of the National Water Act (Existing Lawful Use). Given the small outlet pipe at the base of the dam wall, it is expected that floodwaters will fill the dam above this volume. However, the water user is required to leave the valve open in order to drain the water to the lawful level until a Section 53 directive has been issued. Only if the water user has received authorisation in terms of Section 40 may they store water to the full capacity of the dam. Further than this, the

operating rules are unknown, particularly with regard to maintenance of ecological flows in the Groot River.


Construction in progress, May 2018


Dam basin from dam wall, Feb 2019


Spillway on west side of dam wall


Channel from dam wall to orchards


**Figure 1**. Photos showing construction of the new dam in progress and the finished dam as well as the spillway and channel constructed from the dam wall to orchards for irrigation. The old dam was washed away in floods with associated debris and erosion damage still visible in the basin downstream of the new dam.

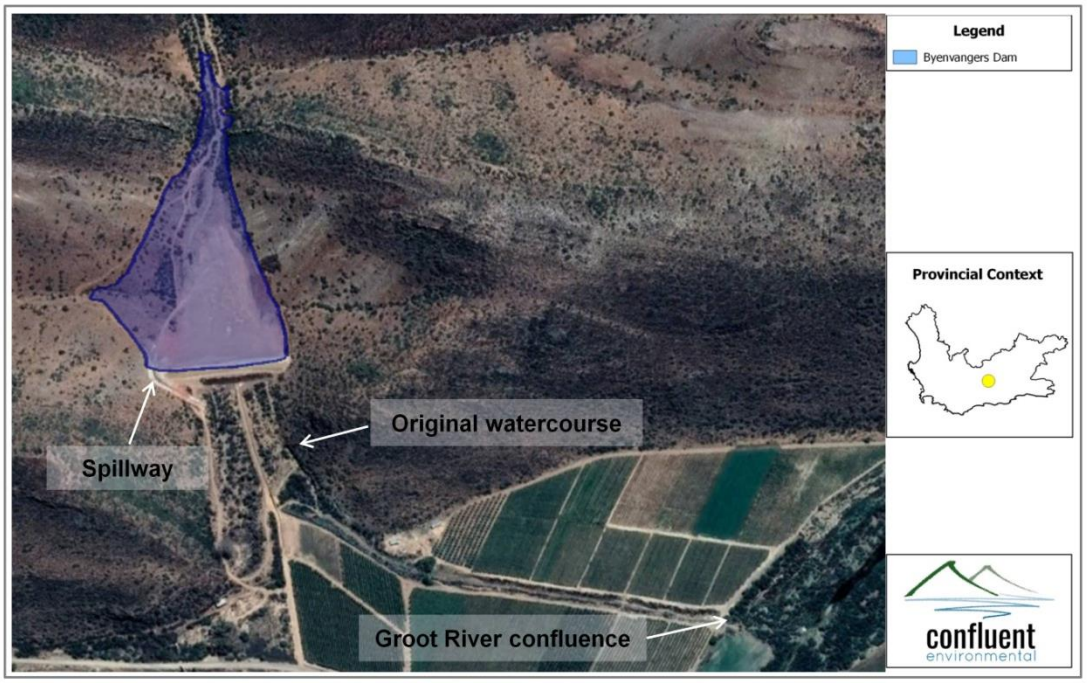



**Figure 2**. Overview of the newly constructed dam showing uncleared vegetation remaining in the dam basin, as well as the location of the spillway, original path of the watercourse, and confluence with the Groot River.

## 3. ATTRIBUTES OF THE AFFECTED AQUATIC ECOSYSTEM

### 3.1 Catchment context

The site is located in the Breede-Gouritz Water Management Area 8 (Quaternary catchment J11J). The dam is located on an unnamed ephemeral stream which arises as a network of ephemeral streams draining Byenvangerskloof in the Klein Swartberg mountains and foothills, before flowing into the Groot River. The Groot River is a major tributary of the Gouritz River. The total area of the Sub-Quaternary Reach is 29 921 ha and the delineated catchment for the dam measures 575 ha which is equivalent to 1.9% of the catchment area (Figure 3). Apart from the Groot River and the Huis River, the vast majority of rivers and streams in the sub-quaternary are classified as intermittent, non-perennial streams. Intermittent streams are important conduits for water, energy, material and biota even when surface water is not present. Shallow subsurface flows may connect dry parts of streams to downstream sections with permanent flows. *These may be critical for the maintenance of base flows in mainstem rivers*.

Land-use in the catchment of the Byevangers Dam is mostly for grazing livestock, although it hasn't been used as such for the previous 5 years due to the drought.

The dam would receive water from a large network of drainage lines during high flow events. To the west and east of the basin, two drainage lines flow directly into the dam. In the source zone there are two main drainage lines arising in the mountains which form a confluence in the foothills. A complex network of streams drain the foothills and join the main stream.

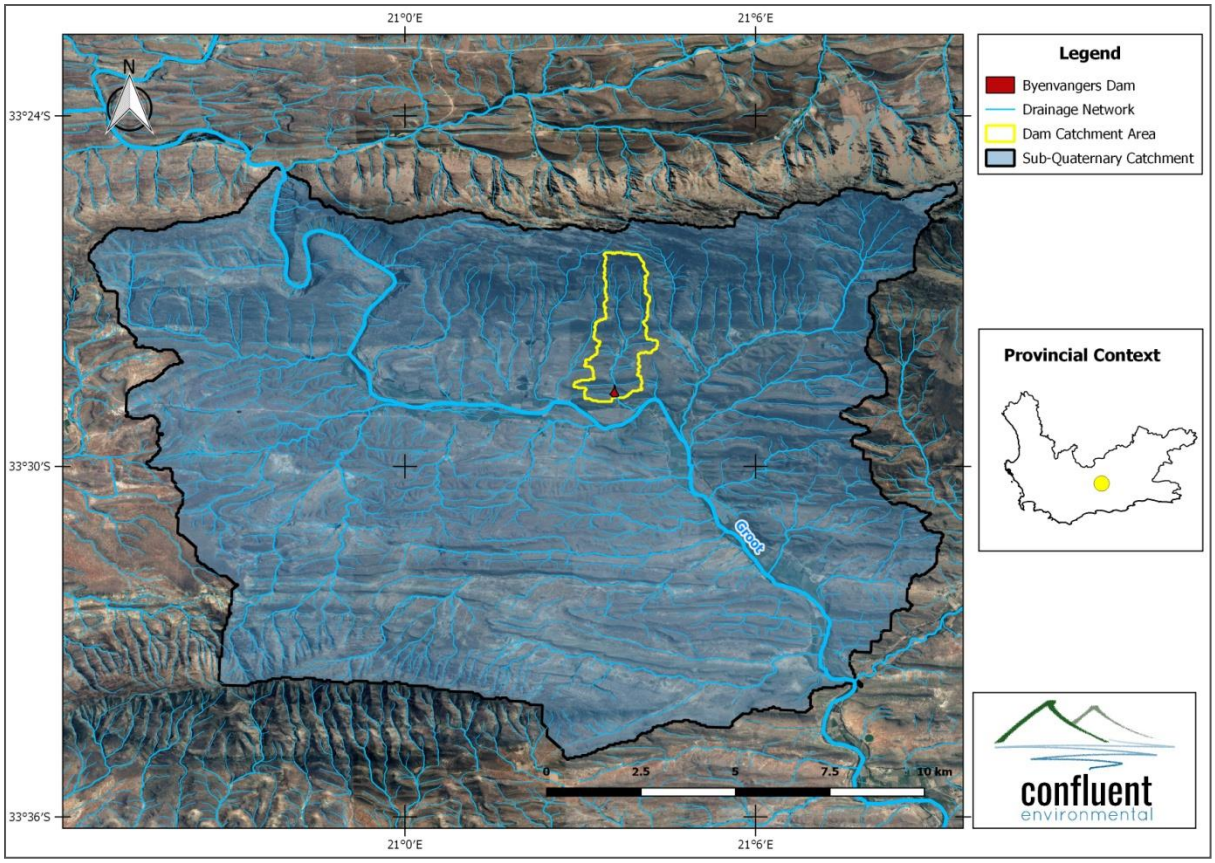



**Figure 3**. Delineated catchment for the illegal dam within the sub-quaternary reach.

### *3.1.1 Ecoregion & Vegetation*

The study area occurs within the **Southern Folded Mountains** (Ecoregion level 2: 19.01). The terrain is described as lowlands, hills and mountains with parallel hills and moderate to high relief. Altitude ranges from 100 – 1 300 m.a.m.s.l. Mean Annual Precipitation ranges from 0 – 400 mm and can fall all year round, but predominantly in winter.

Vegetation at the site of the dam basin is classified as **Western Gwarrieveld** (SKv9) according to Mucina and Rutherford (2006), although the mapped boundary of **Matjiesfontein Quartzite Fynbos** (type FFq3) surrounds the dam to the north, east and south, and includes part of the catchment. The conservation status of both vegetation types is 'Least Threatened'. The vegetation in this area could therefore be considered transitional between Succulent Karoo and Midland and Mountain Fynbos Ecosystems.

### *3.1.2 Watercourse Classification*

The method of classification for wetlands and other ecosystems was used to classify the watercourse immediately upstream of the disturbed area of the dam according to Ollis *et al*. (2013; Table 1). The dam is located in *very close proximity to the floodplain of the Groot River*.

**Table 1.** Classification of the watercourse at the site of unauthorised dam construction

| Level 1 | Level 2 | | Level 3 | Level 4: HGM Unit | | Level 5 |
|---|---|---|---|---|---|---|
| System | DWS Ecoregion | Vegetation | Landscape unit | 4A | 4B | Hydrological Regime |
| **Inland** (high) | Level 2 ecoregion 19.01. **Southern Folded Mountains** | NFEPA WetVeg: **Rainshadow Valley Karoo** and **Western Fynbos Renosterveld**<br><br>SA Veg: **Western Gwarrieveld** and **Matjiesfontein Quartzite Fynbos** | **Valley floor** Situated between two distinct valley side-slopes | **River** Linear, with discernable bed and banks, which periodically carries a concentrated flow of water | **Lower foothills** geozone E Gradient class (0.003) falls within the category (0.001-0.005) | **Non-perennial, Intermittent** Does not flow continuously through the year; water flows at intervals varying from < 1 year to several years |

### *3.1.3 Socio-economic considerations*

Within the Breede-Gouritz Water Management Area (BGCMA), the agriculture and processing sector is the largest, contributing > 23% to the Gross Geographic Product (GGP) and providing > 58% of employment. This excludes other sectors such as manufacturing, construction and services which are partially dependent on the agricultural sector for support.

The purpose of the dam is to supply irrigation water for the deveopment of 40ha of plum orchards. If fully developed, this would provide 80 permanent jobs and an additional 41 temporary seasonal jobs for approximately 4 months of the year.

## 3.2 Historical context

Historical aerial images were available from surveys in 1956, 1968, 1974 and 1991. In 1956 the upper reaches of the stream displayed a narrow, well defined riparian zone along the banks. The riparian zone was broadest in the current dam basin. The river channel was increasingly braided from the upper reaches towards the dam. In this sense, the area occupied by the dam was almost an extension of the Groot River floodplain.

A small dam on the west bank of the river is visible downstream of the current dam, and was labelled on historic 1:50 000 topographic map (1968) as Rooikrans. This appeared to be an offstream dam because the main channel connecting the watercourse to the Groot River was located to the east of this dam.

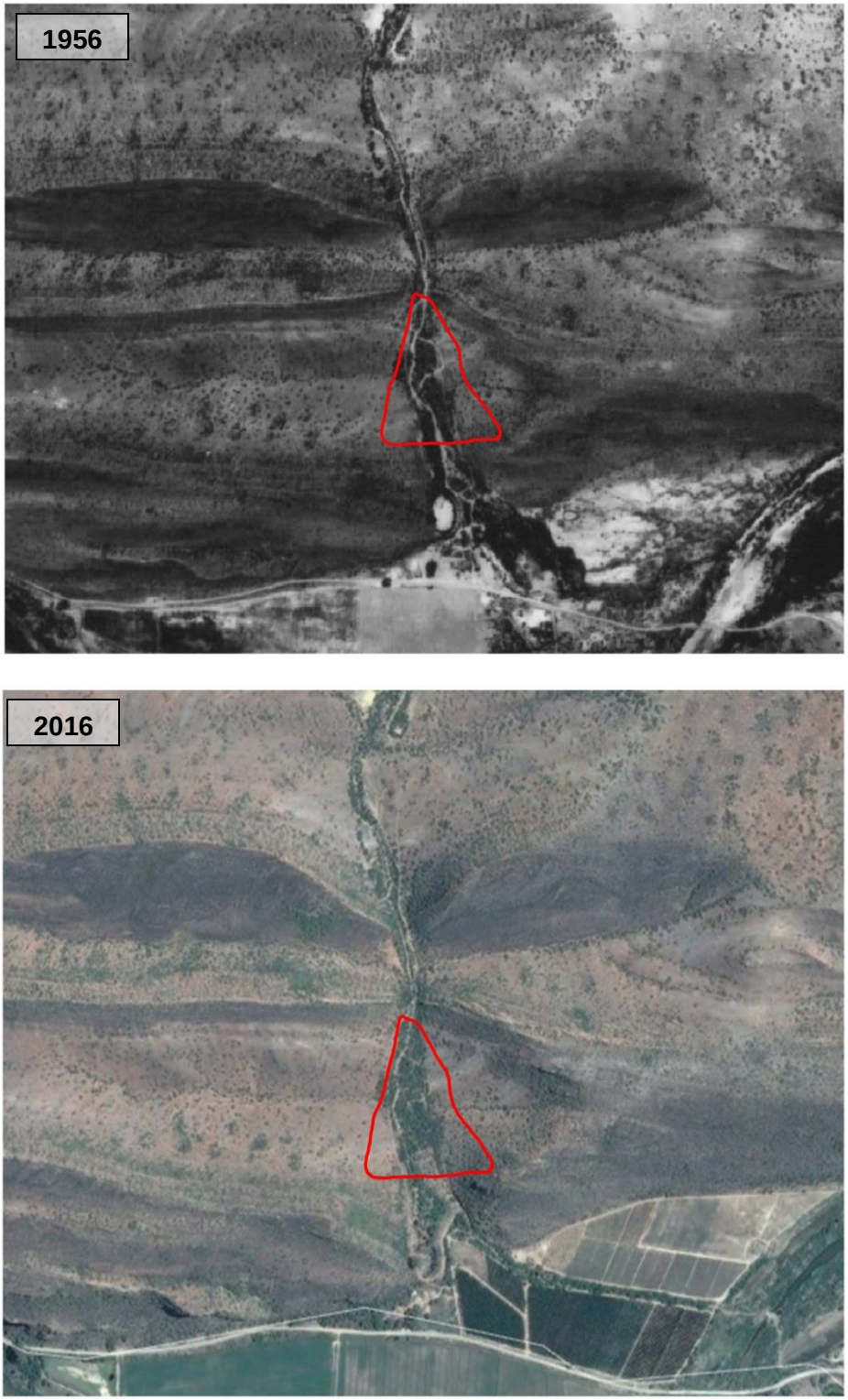
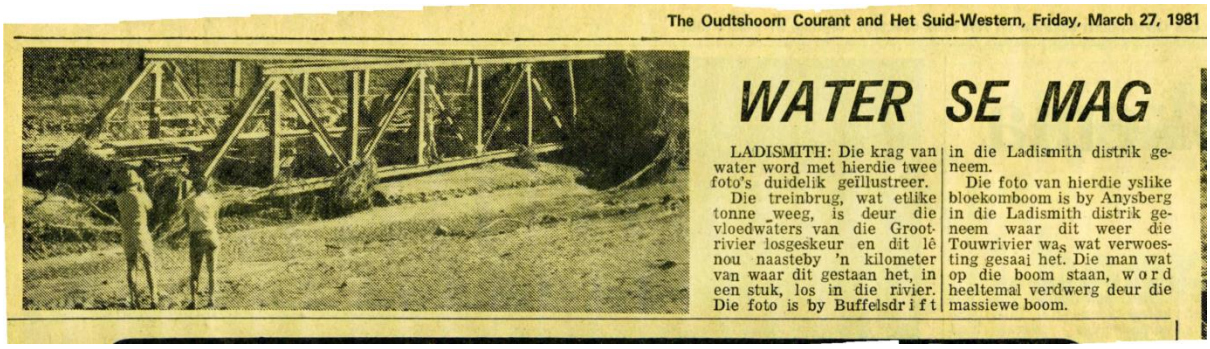



**Figure 4**. Historic (1956 and 2016) aerial pictures of the watercourse showing the approximate outline of the dam area in red.

Floods in the Groot River during heavy rainfall events can be severe as depicted by the newspaper clipping in Figure 5.



The Oudtshoorn Courant and Het Suid-Western, Friday, March 27, 1981

# WATER SE MAG

LADISMITH: Die krag van water word met hierdie twee foto's duidelik geïllustreer.

Die treinbrug, wat etlike tonne weeg, is deur die vloedwaters van die Grootrivier losgeskeur en dit lê nou naasteby 'n kilometer van waar dit gestaan het, in een stuk, los in die rivier. Die foto is by Buffelsdrift in die Ladismith distrik geneem.

Die foto van hierdie yslike bloekomboom is by Anysberg in die Ladismith distrik geneem waar dit weer die Touwrivier was wat verwoesting gesaai het. Die man wat op die boom staan, word heeltemal verdwerg deur die massiewe boom.

**Figure 5**. Newspaper clipping from the Oudtshoorn Courant in 1981 describing how severe flooding of the Groot River washed an entire steel train bridge more than 1 km downstream.

## 3.3 National Freshwater Ecosystem Priority Areas (NFEPA)

The dam has been constructed on a network of watercourses that flow into the Groot River within NFEPA area (sub-quaternary reach) 8686, which is categorised as a **Fish Corridor**. This category is explained according to Nel *et al*., (2011) as follows:

*"These areas cater for large migratory threatened and near threatened fish species that require connectivity between habitats, usually between the mainstem and tributary habitats."*

The only fish species listed as occurring in the Groot River near this site is *Enteromius anoplus* (Chubbyhead barb) which is a widespread species across South Africa and according to the Red List is categorised as 'Least Concern'. However fish of conservation concern that were once abundant in areas of the Gouritz catchment include the small-scale redfin (*Pseudobarbus asper*; Endangered) which are known to colonise ephemeral rivers following rainfall events and occur alongside Chubbyhead barbs. The Slender redfin (*Pseudobarbus tenuis*; Near Threatened) is endemic to the Gouritz River system, and is an important part of the fish assemblages with Cape kurper, Cape galaxias and eels. Introduced fish, water abstractiona nd habitat alteration are the major impacts affecting the distribution of these species (Garrow and Marr, 2012).

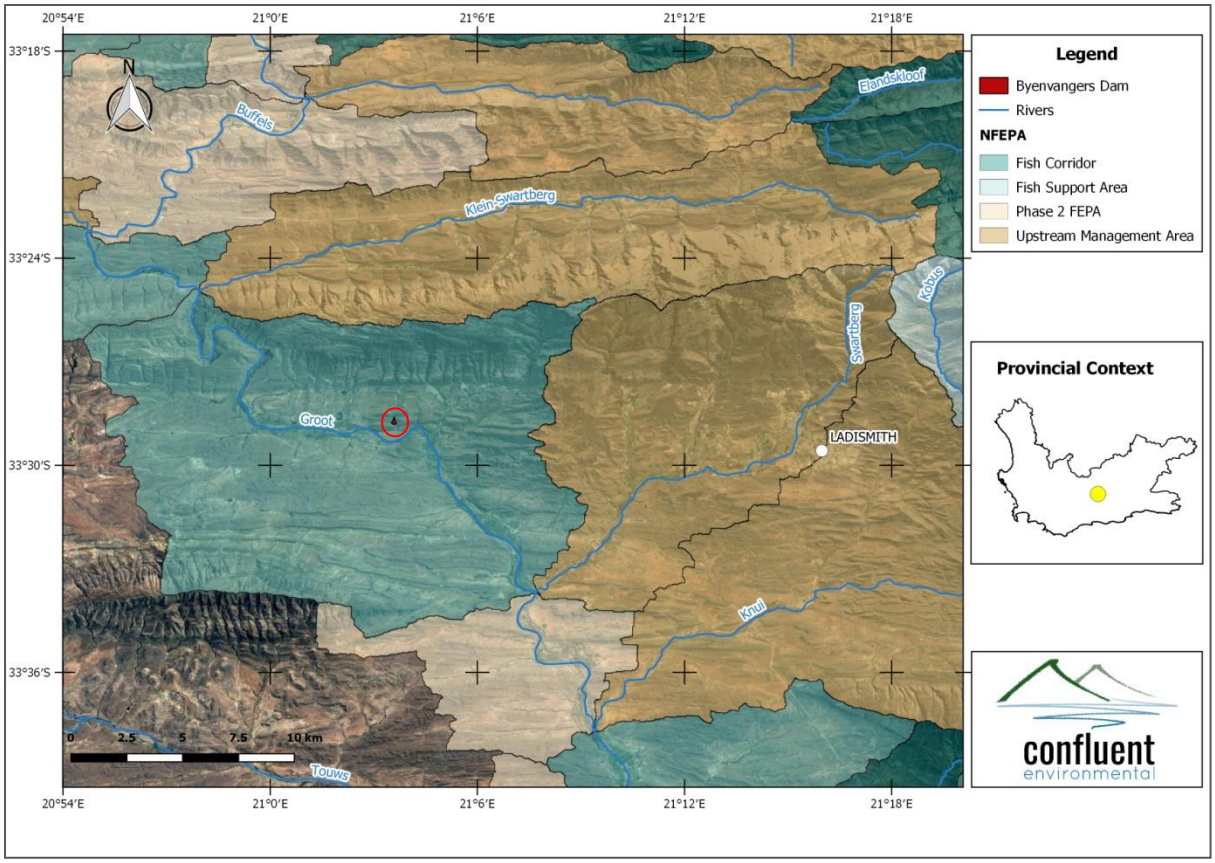



**Figure 6.** Map showing the illegally constructed dam (circled) within the context of the NFEPA atlas and in relation to nearby rivers and towns.

## 3.4 Conservation Status

The Western Cape Biodiversity Spatial Plan (WCBSP; 2017) covers both terrestrial and freshwater habitats. According to the plan, the unnamed watercourse and associated tributaries are classified as an Ecological Support Area (ESA) Aquatic: Watercourse on site. The WCBSP defines systems in this category as:

"*Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.*"

The management objective for systems in this category is to:

*"Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised."*

The land adjacent to the watercourse is defined as 'Other Natural Area'. According to the WCBSP the desired management objective for systems in this category is to:

*"Minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. Offers flexibility in permissible land uses, but some authorisation may still be required for high-impact land uses."*

The middle reaches of the dam catchment are classified as Critical Biodiversity Areas (CBA1) and the upper reaches in the Klein Swartvlei Mountains are Protected Areas. The Groot River downstream of the confluence with the drainage line is categorised as an ESA2.

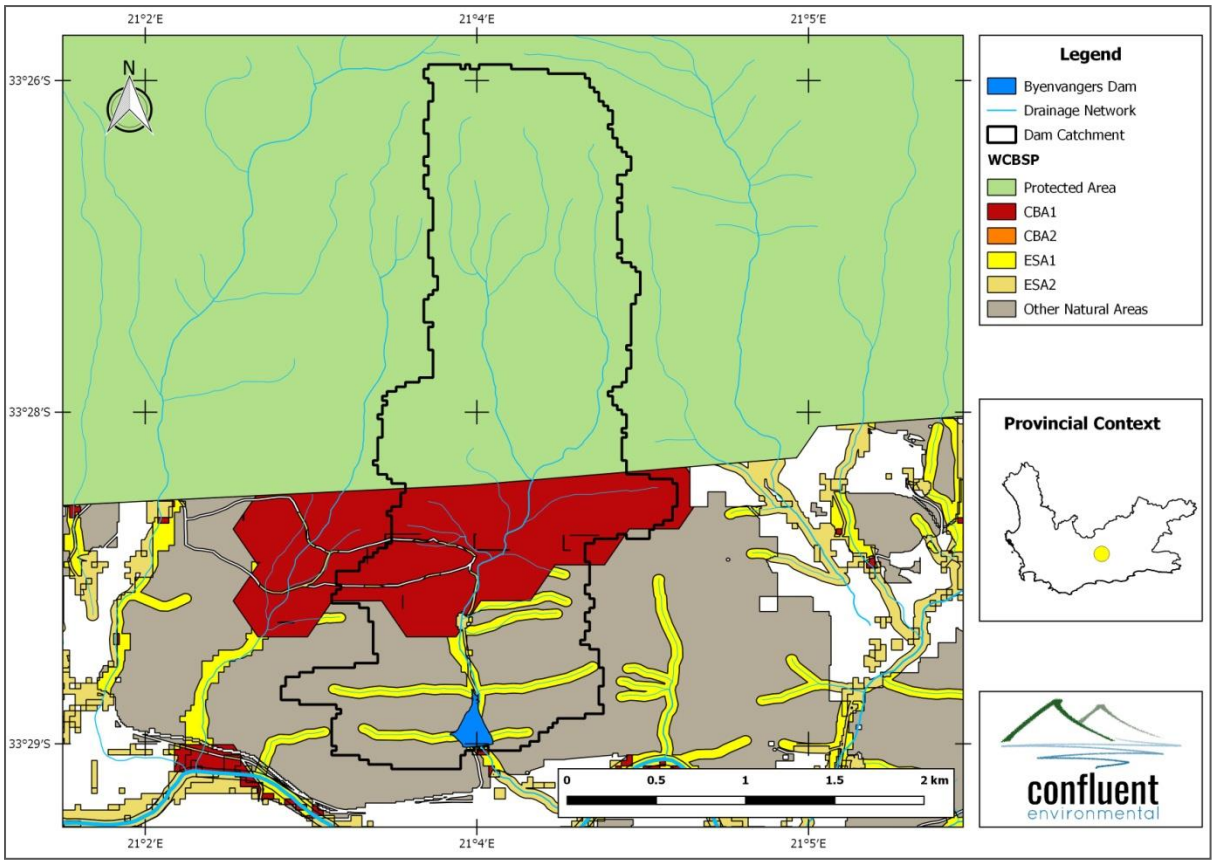



**Figure 7**. Map depicting the location of the illegal dam, associated watercourses and delineated catchment in relation to areas identified by the Western Cape Biodiversity and Spatial Plan (2017).

## 3.5 Desktop Present Ecological State and Ecological Importance (PES & EIS)

The Present Ecological State of the Groot River in the Sub-Quaternary Reach (SQR) where the dam is located is categorised as **D, Largely Modified** (DWS, 2014). The desktop PES is determined per SQR, which means that it incorporates impacts at a wider scale than a single watercourse. Therefore the PES largely reflects impacts affecting the floodplain of the Groot River such as clearing vegetation, degraded water quality and levelling for agriculture.

The Ecological Importance (EI) of the SQR is listed as Moderate as fish representivity and rarity per secondary catchment is low, but invertebrate representivity and rarity are Very High. The Ecological Sensitivity (ES) is rated as Moderate for fish, and Very High for macroinvertebrates because of invertebrate sensitivity to alterations in flow velocity and changes in water chemistry. Overall the **EI is Moderate and the ES is High**.

## 3.6 Resource Quality Objectives (RQOs)

The recently determined Resource Quality Objectives (RQOs) for the Groot River at this point (Node gv6) are related to the maintenance of high and low river flows (DWS, 2018). In terms of quantity, the RQO states that "*flows shall be sufficient to maintain the Groot River in*

*an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category D).*"

The monthly maintenance low and high flows (in million cubic metres) are presented in the RQOs for the Groot River at this node (DWS, 2018; Table 2). The volume of the dam at Full Supply Level is approximately 0.149 million $m^3$.

**Table 2.** Monthly maintenance flow volumes for the Groot River at node gv6.

| Month | Maintenance low flow (million $m^3$) | Maintenance high flow (million $m^3$) |
|---|---|---|
| Oct | 0.016 | 0.559 |
| Nov | 0.018 | 1.719 |
| Dec | 0.019 | 0.559 |
| Jan | 0.016 | 1.719 |
| Feb | 0.015 | 0 |
| Mar | 0.022 | 0 |
| Apr | 0.024 | 0 |
| May | 0.027 | 0 |
| Jun | 0.029 | 0 |
| Jul | 0.027 | 0 |
| Aug | 0.027 | 0 |
| Sep | 0.018 | 0 |

Water quality is also identified as an important consideration and the RQO stipulates that various parameters (phosphate, total inorganic nitrogen, salts, pH, dissolved oxygen, and atrazine) should be maintained at present day levels. Atrazine should not be present at toxic levels that pose a threat to aquatic ecosystem health.

# 4. METHODS

## 4.1 Site selection

The field assessment aimed to determine the baseline characteristics (Present Ecological State) of the affected aquatic ecosystem, as well as how construction of the dam has altered this condition. Therefore the entire dam area (basin and wall) was assessed, along with the watercourse upstream and downstream of the dam. The length of the watercourse was walked upstream for approximately 1 km and the area downstream between the dam wall and orchards was assessed. The watercourse upstream and downstream of the dam were considered representative of reference conditions, although upstream was a lot less impacted than downstream.

## 4.2 Watercourse habitat assessment

The availability and diversity of habitats are major determinants of aquatic biota. The Index of Habitat Integrity (IHI; Kleynhans, 1996) measures the impact of human disturbance on riparian and instream habitats. The IHI is a rapid assessment of the severity of impacts affecting habitat integrity within a river reach. It can be applied to both perennial and non-perennial watercourses. The instream impacts considered were: water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; and rubbish dumping. The riparian impacts assessed were:

vegetation removal; exotic vegetation; bank erosion; channel modification; water abstraction; inundation; flow modification; physico-chemistry. Each of the impacts were given a score based on their degree of modification (1-25; Table 3), along with a confidence rating based on the level of confidence in the score.

**Table 3**. Descriptive classes for the assessment of habitat modifications (Kleynhans, 1996)

| Impact Class | Description | Score |
|---|---|---|
| None | No discernible impact or the modification is located in a way that has no impact on habitat quality, diversity, size and variability. | 0 |
| Small | The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small. | 1-5 |
| Moderate | The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is limited. | 6-10 |
| Large | The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced. | 11-15 |
| Serious | The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not affected. | 16-20 |
| Critical | The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally. | 21-25 |

An IHI class is then determined based on the resulting score (Table 4). These results provide an indication of the present ecological state (PES) as observed at the site compared to that determined in the desktop PESEIS (DWS, 2014).

**Table 4**. Index of habitat integrity (IHI) classes and descriptions.

| Integrity Class | Description | IHI Score (%) |
|---|---|---|
| **A** | Natural | > 90 |
| **B** | Largely Natural | 80 – 90 |
| **C** | Moderately Modified | 60 – 79 |
| **D** | Largely Modified | 40 – 59 |
| **E** | Seriously Modified | 20 – 39 |
| **F** | Critically Modified | 0 – 19 |

## 4.3 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) was derived using the methods developed by Department of Water Affairs and Forestry (DWAF; 1999). Ecological Importance of a system is defined as the expression of its importance to the maintenance of ecological diversity and functioning on local as well as broader scales. Ecological sensitivity relates to the system's resilience to disturbance, or its ability to recover from disturbance that has occurred. The EIS rating does not incorporate the PES and therefore indicates the potential importance or sensitivity of a system as it could be expected under unimpaired conditions. For the EIS assessment both biotic and abiotic factors are considered as follows:

- The presence of rare, endangered or unique aquatic species. This includes species of conservation concern, endemic or isolated species populations, intolerant species and overall species richness;
- Diversity and refuge value of habitat types;

- Sensitivity of the system to changes in flow and related water quality changes;
- Importance of providing functional connectivity between related systems;
- Biological connectivity in the form of migration routes / corridors instream and along riparian zones;
- Protection level of the area where the system is located (e.g. National Park).

These parameters are scored individually and the median score of all variables is calculated to derive an EI and ES category which are defined in (**Table 5**).

**Table 5**. Ecological Importance and Sensitivity Categories

| Ecological Importance & Sensitivity Categories | General Description |
|---|---|
| Very high | Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use. |
| High | Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use. |
| Moderate | Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use. |
| Low/marginal | Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use. |

# 5. RESULTS

## 5.1 Site Conditions

On the day of the site visit (20 February 2019) there was zero flow observed in any of the drainage lines, and no water in the dam basin. Weather conditions were overcast and mild. Construction work had been halted at the dam, and there was no indication that further work was in progress.

## 5.2 Index of Habitat Integrity

The habitat integrity of the watercourse(s) was determined with and without the dam. For the assessment without the dam, areas both upstream and downstream were considered in combination to provide a more accurate picture of the pre-existing impacts within the river reach. Photos of several impacts discussed are presented in Figure 8.

The Present Ecological State (PES) of the watercourse prior to the dam construction was classified as **C, Moderately Modified**. This was largely due to the pre-existing impacts associated with the dam that washed away in floods. Impacts from that dam are present in the area below the current dam wall and include high rates of sediment accumulation, areas of severe erosion and alien trees. There is also fairly extensive erosion in the upper foothills of the watercourse which is due to historic overgrazing. At a road crossing in the upper foothills, extensive sedimentation is evident in the river channel as a result of erosion in the area. A well developed riparian zone exists either side of the channel upstream of the dam. Some of the plants were identified in this zone which include (but are not limited to) those presented in Table 6.

**Table 6.** Indigenous plants identified in the riparian zone of the watercourse upstream of the dam

| Scientific name | Common name |
|---|---|
| *Carissa haematocarpa* | Karoo num-num |
| *Portulacaria afra* | Spekboom |
| *Euphorbia stolonifera* | Rankmelkbos |
| *Crassula capitella* | |
| *Solanum tomentosum* | Slangappel |
| *Salsola aphylla* | Saltbush, Gannabos |
| *Vachellia karroo* | Sweet thorn |
| *Olea euopaea* | Olienhout, Wild Olive |

The PES of the watercourse with the newly constructed dam was classified as **D, Largely Modified**. This is due to increased impacts associated with vegetation clearance and habitat modification of the bed, channel and riparian zone. Given the intermittent hydrological regime of the system, the increased impact associated with water abstraction is mainly due to reduced flows reaching the Groot River. The presence of the dam will dramatically alter sediment transport regimes through retention of sediment which may exacerbate erosion downstream. Small areas of the recently cleared dam basin have been colonised by *Opuntia* sp. and *Datura* sp., and downstream there are numerous *Eucalyptus* sp. trees adjacent to the eroded river channel. The natural course of the river downstream of the dam will be altered by the dam as the spillway is on the western side of the dam wall, but the original watercourse was towards the east.

**Table 7.** Index of Habitat Integrity assessment of instream and riparian habitat

| Habitat Modification | Score without dam | Score with dam | Notes |
|---|---|---|---|
| **INSTREAM HABITAT** | | | |
| Water abstraction | 5, Small | 10, Moderate | Water abstraction will increase |
| Flow | 5, Small | 10, Moderate | Increase volume and area of lentic vs. intermittent lotic flow |
| Bed | 10, Moderate | 15, Large | Destruction of river bed in dam basin |
| Channel | 10, Moderate | 15, Large | Destruction of river channel in dam basin |
| Physico-chemistry | 5, Small | 10, Moderate | Altered sediment deposition |
| Inundation | 5, Small | 10, Moderate | Periodic inundation of dam basin |
| Alien macrophytes | 0, None | 0, None | Limited by ephemeral water source |
| Introduced aquatic fauna | 0, None | 0, None | Limited by ephemeral water source |
| Rubbish dumping | 0, None | 0, None | None observed |
| | **C, Moderately Modified** | **D, Largely Modified** | |
| **RIPARIAN HABITAT** | | | |
| Vegetation removal | 5, Small | 15, Large | 2.5 ha vegetation cleared |
| Exotic vegetation | 5, Small | 8, Moderate | *Opuntia* sp., *Datura* sp., *Eucalyptus* sp., present and colonising disturbed areas |
| Bank erosion | 10, Moderate | 10, Moderate | Currently no worse, but is likely to deteriorate if dam becomes operational |
| Channel modification | 10, Moderate | 15, Large | Riparian vegetation destroyed in the vicinity of the dam |
| Water abstraction | 5, Small | 10, Moderate | Reduced flows downstream |
| Inundation | 5, Small | 10, Moderate | Much larger area of inundation |
| Flow modification | 3, Small | 10, Moderate | Reduced flows downstream |
| Physico-chemistry | 0, None | 5, None | Altered sediment deposition |
| | **C, Moderately Modified** | **D, Largely Modified** | |


a)
Dam wall
Erosion
b)
c)
d)


**Figure 8.** Photos from various points assessed along the watercourse including the area upstream of the dam with erosion of the banks and channel (a and b) and accumulated sediment in the river bed (c), part of the watercourse in relatively good condition that lies within the full supply level of the dam but hasn't been cleared yet (d); and, flood damage and erosion of the watercourse (e), along with sedimentation in areas (f) downstream of the dam wall.

### 5.3 Ecological Importance and Sensitivity

The watercourse assessed in this study had an EIS score classified as **Moderate**. As an intermittent stream, the watercourse is not as sensitive to flow modifications resulting from the dam as a perennial river would be. This is because taxa dependent on flowing water would naturally not be present. However, the riparian zone linking the lower foothills to the upper catchment along the river bed serves as a corridor for non-riverine fauna linking the floodplain of the Groot River with the protected area in the Klein Swartberg Mountains. This feature is important at a local scale.

## 6. IMPACT ASSESSMENT OF THE BYENVANGERS DAM

### 6.1 Methods of impact assessment

This section was prepared according to guidelines for specialists published by DEA & DP (Brownlie, 2005). The basis for the impact assessment is the construction of the dam as outlined in Section 2, and takes into account pre-existing impacts discussed in the Index of Habitat Integrity. The assessment considers direct, indirect and cumulative impacts to the aquatic ecosystem that may arise during the design, layout, construction and operational phases of managing the dam.

Individual impacts are rated according to criteria which include their intensity, duration and extent. The ratings are then used to calculate the consequence of the impact which can be either negative or positive as follows:

**Consequence = type x (intensity + duration + extent)**

Where type is either negative or positive. The significance of the impact is then calculated by applying the probability of occurrence to the consequence as follows:

**Significance = consequence x probability**

The criteria and their associated ratings are shown in Table 8.

**Table 8.** Categorical descriptions for impacts and their associated ratings

| Category | Description | Rating |
|---|---|---|
| **Intensity** | Negligible | 1 |
| | Very low | 2 |
| | Low | 3 |
| | Moderate | 4 |
| | High | 5 |
| | Very high | 6 |
| | Extremely high | 7 |
| **Duration** | Immediate | 1 |
| | Brief | 2 |
| | Short term | 3 |
| | Medium term | 4 |
| | Long term | 5 |
| | Ongoing | 6 |
| | Permanent | 7 |
| **Extent** | Very limited | 1 |
| | Limited | 2 |
| | Local | 3 |
| | Municipal area | 4 |
| | Regional | 5 |
| | National | 6 |
| | International | 7 |
| **Probability** | Highly unlikely | 1 |
| | Rare | 2 |
| | Unlikely | 3 |
| | Probably | 4 |
| | Likely | 5 |
| | Almost certain | 6 |
| | Certain | 7 |

Categories assigned to the calculated significance ratings are presented in Table 9.

**Table 9.** Value ranges for significance ratings.

| Significance rating | Range | |
|---|---|---|
| Major (-) | -147 | -109 |
| Moderate (-) | -108 | -73 |
| Minor (-) | -72 | -36 |
| Negligible (-) | -35 | -1 |
| Neutral | 0 | 0 |
| Negligible (+) | 1 | 35 |
| Minor (+) | 36 | 72 |
| Moderate (+) | 73 | 108 |
| Major (+) | 109 | 147 |

Each impact is considered from the perspective of whether losses / gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence is also determined and rated as low, medium or high (Table 10).

**Table 10.** Definition of reversibility, irreplaceability and confidence ratings.

| Rating | Reversibility | Irreplaceability | Confidence |
|---|---|---|---|
| **Low** | Permanent modification, no recovery possible. | No irreparable damage and the resource isn't scarce. | Judgement based on intuition. |
| **Medium** | Recovery possible with significant intervention. | Irreparable damage, but is represented elsewhere. | Based on common sense and general knowledge |
| **High** | Recovery likely. | Irreparable damage, and is not represented elsewhere. | Substantial data supports the assessment |

## 6.2 Layout and Design Phase Impacts

A summary of impacts with and without the implementation of mitigation measures is presented in Table 11.

### *6.2.1 Fragmentation of the watercourse*

This impact is inherent in instream dams, while it may be less of a concern in off-channel dams which don't physically intersect the watercourse. As an instream dam, the Byevanger Dam alters the hydrological regime from intermittent flowing water which mostly reached the Groot River (as the previous dam was small and susceptible to damage), to long periods of lentic (standing) flow within the impoundment as water would be held back from the Groot River. Given the lack of perennial flow in the watercourse at the study site, fragmentation is less concerning for aquatic-dependent species than it is for the reduction in flows that would help maintain the connection to and ecological flows in the Groot River. A potentially positive impact of standing water in the dam is the additional habitat available to fauna such as frogs and birds. But the latter would be also be achieved if the dam was constructed off channel.

Recommended mitigation measures

The layout and design phase has already been concluded with the current location of the dam being selected. Had the applicant followed the correct authorisation process however, due consideration should have been given to alternative options and the no-go option. Important criteria that should have been considered in terms of reducing fragmentation of the watercourse are:

- Investigation of possible sites on the land-owners property for an off-channel dam;
- Investigation of sites that don't collect water from such a complex and extensive drainage network, therefore abstracting such a large volume of water and reducing flood flows into the Groot River. There are other drainage lines on the property which are less extensive and would have less of an impact on ecological flows in the Groot River;
- Develop operating rules which reduce fragmentation of the watercourse. Ie. Manage the release of flows that consider ecological requirements downstream. This measure can still be implemented.

### *6.2.2 Alignment of the watercourse with dam outlets*

The dam has two outlets. The piped outlet in the base of the dam wall that is channelled to the orchards for irrigation and the spillway located to the west of the dam wall. It is not clear how the water from either of these outlets will reach the Groot River as neither of them are

aligned with the original watercourse located to the east of the dam wall. If the dam fills and overflows in its current state there is likely to be severe erosion in the area below the dam wall as the water makes its way to the original watercourse. Therefore this impact must be prioritised for mitigation.

Recommended mitigation measures

- Review layout plans and ensure that physical connectivity with the original watercourse and the Groot River is maintained. This must be achieved through aligning outlets with the original watercourse.

**Table 11**. Summarised impact rating table for the layout and design phase.

| Impact | Intensity | Duration | Extent | Probability | Significance | Reversibility | Irreplaceability | Confidence |
|---|---|---|---|---|---|---|---|---|
| *Impact: Fragmentation of the water course* | | | | | | | | |
| Without mitigation | 5 | 6 | 3 | 7 | Moderate (-) | Medium | Medium | High |
| With limited mitigation options | 4 | 6 | 3 | 6 | Moderate (-) | Medium | Medium | High |
| *Impact: Alignment of the watercourse with dam outlets* | | | | | | | | |
| Without mitigation | 5 | 6 | 2 | 5 | Minor (-) | Medium | Medium | Medium |
| With mitigation | 3 | 4 | 2 | 2 | Negligible (-) | Medium | Medium | High |

## 6.3 Construction Phase Impacts

A summary of impacts with and without the implementation of mitigation measures for the construction phase is presented in Table 12.

### *6.3.1 Removal of Vegetation*

Approximately 2.5 ha of vegetation was cleared for construction of the dam basin and wall. Based on vegetation present above and below the dam, this would have consisted of a fairly well defined riparian zone along with vegetation beyond this area. Cleared vegetation was likely to include plants associated with both mapped vegetation units (Western Gwarrieveld and Matjiesfontein Quartzite Fynbos) as the dam occupies a transitional zone. While both units are defined as 'Least Threatened' there may be individual plants of importance on site. As approximately 0.6 ha of vegetation remains to be cleared in the Full Supply Area, the mitigation measures recommended below must be applied if construction continues.

Recommended mitigation measures

- A botanical specialist must assess the remaining vegetation prior to further clearance to determine the presence / absence of important taxa.
- Only vegetation within the full supply area of the dam basin may be cleared.
- Where vegetation can be rescued and replanted it should be used on site to stabilise exposed soil prone to erosion. Large Spekboom are likely to survive replanting and should be utilised as opposed to discarded. A botanical specialist must be consulted in this regard.

### 6.3.2 Disturbance to the river bed and banks

The bed and banks of the watercourse have already been irreparably modified by excavation of the dam basin and construction of the dam wall. In order to complete the project it is likely that further work with heavy machinery will be required within the original bed and banks of the watercourse. This would be necessary for the clearance of vegetation and construction of infrastructure associated with irrigation downstream of the dam. Further disturbance is likely both upstream and downstream of the dam.

Recommended mitigation measures

- Any sensitive plants identified by the botanical specialist should be relocated for protection if they are located in the construction area.
- A limited disturbance area of 10m adjacent to the footprint of the dam and associated infrastructure is permissible. No more than 5 m upstream of the full supply area must be disturbed in the watercourse. These areas must be demarcated using temporary fencing and be considered absolute no-go zones.
- Areas below the high water level mark in the basin of the dam may be used to store materials, provided they don't pose a risk of soil or water contamination.

### 6.3.3 Sedimentation of downstream watercourses

The constructed dam has extensive areas of soil and vegetation disturbance which are prone to erosion. These include steep slopes, access roads, recently cleared areas and runoff from newly established outlets including the spillway, dam embankment and irrigation outlet. Construction required to finish the project is likely to result in increased areas prone to erosion. Erosion of these areas will lead to degradation of habitat downstream in the Groot River. This occurs where sediment accumulates, forming bars and smothering the river bed. This form of disturbance can have long-reaching consequences for aquatic macro-invertebrate and fish communities which depend on river substrates such as cobbles and gravel for feeding, breeding, and shelter. Creation of new sand bars also provides ideal habitat for colonisation by invasive plants (alien or indigenous) which further alters the instream habitat.

Recommended mitigation measures

- Alignment between the original watercourse leading to the Groot River and outlets from the dam should be prioritised in case of heavy rainfall requiring the discharge of water exceeding the lawful allocation.
- The next priority should be to establish sediment traps or stabilisation on areas prone to erosion such as the downstream side of the dam embankment, area below the spillway (once alignment has been planned), and the access road. Allowance must be made to clear sediment from the traps if erosion occurs during the construction period. Traps should be implemented immediately as construction has not concluded at the site, and there are many exposed areas susceptible to erosion if it rains heavily.
- If active erosion results in the formation of gullies, these areas must be infilled with topsoil and covered with hessian or a geotextile (e.g. GeoJute) prior to revegetation.

- Where sedimentation downstream occurs as a direct result of construction activities (past or future) this must be removed manually (using spades) under the supervision of a freshwater ecologist or environmental site officer.
- Large quantities of sediment are already present in the basin of the previous dam (see Figure 8f) which is located downstream of the new dam wall. Alignment of the spillway, outflow and watercourse are urgently required to prevent this sediment from being deposited in the Groot River. Any sediment accumulated in the original watercourse must be manually removed using spades.

### *6.3.4 Water quality impacts downstream*

Construction activities have the risk of introducing a range of detrimental contaminants into the watercourse. Even if there is no flow at the time of construction, these contaminants may leach into groundwater, or be washed into the river system during periods of flowing water. Possible contaminants include hydrocarbons (fuel and oil from vehicles) or cement waste. In addition, solid waste such as plastic litter could be dispersed by construction workers. Furthermore, erosion (as described above) results in increased suspended sediment loads which negatively affects aquatic biota by clogging their gills and reducing visibility.

Recommended mitigation measures

- Vehicle parking and refuelling areas must be located > 50m from the high water mark and edge of the watercourse, and be clearly defined.
- Any fuel storage areas must be bunded to prevent spills spreading if they occur.
- Waste collection and removal must be arranged on a regular basis, and allowance must be made for conducting a litter clean-up for up to a 100m downstream and upstream of the watercourse.
- Follow recommended mitigation measures for sedimentation of downstream watercourses as above.

### *6.3.5 Import and spread of alien seed and plants to the site*

Alien seed and/or plants may be introduced or spread at the site and through the watercourse in imported material such as sand or compost. The recently disturbed soil and vegetation makes the site highly vulnerable to alien plant invasion as can be observed on the edge of the dam basin where *Opuntia* sp. and *Datura* sp. are becoming established.

Recommended mitigation measures

- Any imports of foreign material to the site should be cleared with a botanical specialist to ensure they do not pose a risk and do not originate from areas with high levels of alien invasion.
- Alien plants must be continually removed from disturbed areas throughout the construction period. This activity should commence immediately as there are already alien plants on the perimeter of the dam basin.

**Table 12**. Summarised impact rating table for the construction phase impacts.

| Impact | Intensity | Duration | Extent | Probability | Significance | Reversibility | Irreplaceability | Confidence |
|---|---|---|---|---|---|---|---|---|
| ***Impact: Removal of vegetation*** | | | | | | | | |
| Without mitigation | 4 | 6 | 2 | 7 | Moderate (-) | Low | Medium | High |
| With mitigation | 4 | 6 | 2 | 7 | Moderate (-) | Low | Medium | High |
| ***Impact: Disturbance to the river bed and banks*** | | | | | | | | |
| Without mitigation | 5 | 7 | 2 | 7 | Moderate (-) | Low | Medium | High |
| With mitigation | 5 | 7 | 2 | 6 | Moderate (-) | Low | Medium | High |
| ***Impact: Sedimentation of downstream watercourses (in the event of rainfall during construction phase)*** | | | | | | | | |
| Without mitigation | 4 | 4 | 3 | 6 | Minor (-) | Medium | Medium | High |
| With mitigation | 3 | 2 | 1 | 3 | Negligible (-) | High | Medium | Medium |
| ***Impact: Water quality impacts downstream*** | | | | | | | | |
| Without mitigation | 4 | 3 | 3 | 4 | Minor (-) | High | Medium | High |
| With mitigation | 3 | 3 | 2 | 3 | Negligible (-) | High | Medium | High |
| ***Impact: Import of alien seed and plants to the site*** | | | | | | | | |
| Without mitigation | 4 | 5 | 2 | 5 | Minor (-) | Medium | Low | High |
| With mitigation | 3 | 2 | 2 | 2 | Negligible (-) | High | Low | High |

## 6.4 Operational Phase Impacts

A summary of impacts with and without the implementation of mitigation measures for the operational phase is presented in Table 13.

### *6.4.1 Risk of reduced flows reaching the Groot River*

This is the most important operational phase impact of constructing the dam. The loss of floods from an extensive network of drainage lines will lead to increased sedimentation of the river channel. Resulting sandbars are stabilised by vegetation leading to a narrowing of the channel. In the case of the Groot River, this may happen on a localised basis where flood flows would have scoured sediment at and below the confluence, but will be locally reduced in future due to the presence of the Byevanger Dam. Particularly if the increased water allocation is approved. In addition, the volume of water reaching the Groot River will be reduced. This impact is a recognised cumulative impact in the Groot River system leading to the recently developed RQOs (DWS, 2018) stating that "*flows shall be sufficient to maintain the Groot River in an ecological condition that is equal to or better than the ecological condition in summer 2014 (Category D).*"

Understanding the implications of constructing the dam on the flow regime in the Groot River is constrained by the lack of knowledge of the relationship between Mean Annual Runoff (MAR) in the catchment of the dam, and the volumes of water proposed for storage. For instance if the volume of the dam exceeds the M.A.R. then we can safely assume that very little, if any water will reach the Groot River, which would not be acceptable. Therefore, in order to comment meaningfully on the impacts and mitigation measures for this impact, more detailed information on the hydrological features of the catchment is required. Subsequent to

writing this report, a hydrological study was conducted by Mr B. Haasbroek, and the results are summarised in the conclusions of this report.

Recommended mitigation measures

- Appoint a hydrologist to determine the Mean Annual Runoff from the Byevangers Dam catchment and how this relates to the requested water allocation and full supply level of the dam. This is a first and necessary step to understand the implications of constructing the dam on the flows that can be expected to reach the Groot River.
- Operating rules must consider the release of water that is sensitive to ecological requirements downstream (informed by the above study). The success of this measure is also dependent on restoring the alignment of the original watercourse with the Groot River. ** Update ** The results of the hydrological study conducted by Mr. B. Haasbroek indicate that no water release is required for maintenance of the EWR in the Groot River.

### *6.4.2 Risk of alien fish introductions for recreation*

Despite the likelihood that the dam may periodically dry out, the introduction of alien fish (from other countries or other areas in South Africa) for recreational purposes is a distinct possibility. Many farms in the area stock bass and banded tilapia in their dams which, along with introductions of smallmouth yellowfish, have invaded the Groot River and had a detrimental impact on indigenous fish. Human-assisted dispersal can facilitate and extend the distribution of harmful alien fish in South Africa's freshwater systems. This practice is strongly discouraged. Any decision to introduce alien fish into the dam must be made with prior knowledge of the restrictions of the National Environmental Management: Biodiversity Act (NEMBA, 2004). The act lists invasive species including freshwater fish (List 7) that may or may not be introduced to various catchments in South Africa. Problem fish already occurring in the Groot River included banded tilapia and bass. Advice from Cape Nature and/or a freshwater ecologist must be sought to ensure any fish introductions are legal.

Recommended mitigation measures

- Consider the hydrological regime of the dam before introducing fish to determine whether it can realistically sustain a fish population.
- Do not introduce any fish without ensuring their introduction is legal by consulting the NEMBA act.

### *6.4.3 Creation of lentic habitat for aquatic biota*

When the dam fills it would provide habitat for a range of plants, macro-invertebrates, amphibians and birds. The presence of water could also potentially support wildlife in the area. However, given the intermittent nature of flows in the watercourse, the dam will not be permanently inundated. This would automatically limit colonisation of the dam to mobile species or species able to withstand extended periods of desiccation. While this impact is considered mostly positive, it also creates the opportunity for establishment of alien fauna or flora. Therefore caution must be taken to ensure no alien species including macrophytes/water weed (e.g. water hyacinth and Kariba weed) are introduced.

Recommended mitigation measures

- Ensure no alien fauna or flora are introduced or allowed to persist in the dam when it is inundated.

**Table 13**. Summarised impact rating table for the operational phase impacts.

| Impact | Intensity | Duration | Extent | Probability | Significance | Reversibility | Irreplaceability | Confidence |
|---|---|---|---|---|---|---|---|---|
| *Impact: Risk of reduced flows reaching the Groot River* | | | | | | | | |
| Without mitigation | 4 | 6 | 3 | 7 | Moderate (-) | Medium | Medium | Low |
| With mitigation | 3 | 6 | 2 | 6 | Minor (-) | Medium | Medium | Medium |
| *Impact: Risk of alien fish introductions for recreation* | | | | | | | | |
| Without mitigation | 5 | 4 | 3 | 4 | Minor (-) | Low | Medium | Medium |
| With mitigation | 0 | 0 | 0 | 0 | Neutral | High | Low | High |
| *Impact: Creation of lentic habitat for aquatic biota* | | | | | | | | |
| Without mitigation | 2 | 3 | 1 | 5 | Negligible (+) | Medium | Medium | Medium |
| With mitigation | 3 | 3 | 1 | 6 | Minor (+) | Medium | Medium | Medium |

## 6.5 Decommissioning Phase Impacts

Had the environmental authorisation process been followed correctly, the 'no-go option', alternative options, and need and desirability of the dam would all have been considered prior to confirmation of the site and required volume of the dam. Impacts of decommissioning the dam are an important consideration given that the dam was constructed unlawfully and that reduction in the dam's capacity, relocation of the dam, or complete removal of the dam are possible outcomes of the process.

The impacts of dam removal, capacity reduction or relocation (e.g. to an off-channel site) would all involve the excavation of sediment used to construct the dam wall, and replacement within the original watercourse. While this would restore flows to varying degrees (dependent on the selected option) to the Groot River, it would inevitably result in erosion of the watercourse at the site, and downstream sedimentation. This could be mitigated by stabilising the sediment with extensive re-vegetation and erosion control measures. A comprehensive rehabilitation plan would need to be compiled using relevant expertise in this event. This process is potentially highly damaging to the watercourse if not executed carefully, and therefore expert inputs from engineers and environmental practitioners would be required.

## 6.6 Cumulative Impacts

Cumulative impacts occur where the activity (in this case, dam construction for storage of increased capacity) is likely to be one of a number of activities in the affected area causing similar impacts.

### *6.6.1 Alterations in surface flows reaching the Groot River*

The combined capacity of large dams in the catchment of the Groot River (Floriskraal, Verkeerdevlei, Bellair and Miertieskraal) is 82.4 million cubic metres which is approximately

78% of the Mean Annual Runoff (R.H.P., 2007). This combined with general water use authorisations has had a large, cumulative impact on flows in the Groot River. Low rainfall in the region means that water abstraction in the form of large, in-stream dams which store flood flows is very common. The storage capacity of these dams often exceeds the annual runoff of the catchment (R.H.P., 2007).

The volume of the Byevangers Dam is approximately 6 times greater than the existing water allocation which if authorised, will no longer enter the river. A rapid scan of 10 drainage lines leading into the Groot River upstream of the site on both banks indicates that approximately 80% of drainage lines contain one or more impoundments to abstract water. The cumulative impact of these dams includes the reduction of flood flows (important natural disturbance) entering the Groot River. This leads to increased siltation as a result of reduced flushing and scouring, altering the shape of the river channel and resulting in excessive growth of instream vegetation.

This impact has already been identified in the recently published RQOs for the site which specifically state that flows must be sufficient to ensure the ecological condition of the Groot River doesn't decline from its current state. It is unlikely that the increased storage and abstraction provided by the Byevanger Dam would be solely responsible for a decline in the condition of the Groot River, especially given the extent of instream storage upstream. However, if every land-owner in the SQR opted to comparatively increase the capacity of their impoundments without authorisation, the cumulative impact on the ecology of the Groot River would be significant.

From a broader perspective, as the Groot River is an important tributary of the Gourits River, the condition of the estuary must be considered in terms of cumulative impacts in the catchment. The PES of the estuary is B/C with a Recommended Ecological Category (REC) of B (Van Niekerk *et al*., 2015). Relevant recommended mitigation measures are to restore base flows and floods. Management actions for water quantities in the Gouritz River Estuarine Management Plan (Royal Haskoning, 2018) state that water use activities and licenses in the catchment should be assessed for compliance with Reserve requirements. If the ecological reserve requirements are not being met abstraction activities may be declared as streamflow reduction activities and temporarily controlled, limited or prohibited.

## 7. REHABILITATION MEASURES

Based on this assessment a number of rehabilitation actions are recommended in addition to the mitigation measures stipulated in the impact assessment. These actions are intended to restore ecological structure and function where possible, such as improved connectivity, and protect watercourses at the site and downstream.

- Restrict access by livestock to eroded areas of the watercourse upstream of the dam in order to allow vegetation to recover and to reduce sedimentation. Vegetation establishment must be actively supported.
- No livestock must be allowed to access the dam embankment or excavated areas in order to prevent erosion and allow for the re-establishment of vegetation.
- Revegetate the channelled section of the watercourse linking the area downstream of the dam with the Groot River using appropriate indigenous riparian vegetation. Aerial images showed that this section, which traverses land between orchards, has been

cleared. Riparian vegetation clearance (even along an artificially channelled river section) compromises the ability of the watercourse to function as a corridor for the movement of fauna (aquatic and non-aquatic) in the landscape.

- Removal and follow up control of alien and invasive species must be carried out regularly throughout the construction phase of the dam's development and continue on a bi-annual basis during the operational phase.

## 8. CONCLUSIONS

The intermittent drainage line at this site was deemed to be in a Moderately Modified state (C), which has degraded to a Largely Modified state (D) as a result of constructing the unauthorised dam. As part of the impact assessment, a range of mitigation measures have been recommended to limit further degradation of the watercourse at the site and downstream. Flow regimes within the watercourse are naturally ephemeral, and therefore the direct impacts of building the dam within this channel are not as pronounced as those within a perennial watercourse. However, the indirect impact of reduced flow entering the Groot River from a complex network of drainage lines is more difficult to determine and is quite likely to be important when considered from the perspective of cumulative impacts.

Subsequent to compilation of this report, a hydrological study was conducted by Mr. B. Haasbroek (September 2020). The conclusions of this report indicate that Ecological Water Requirement (EWR) for high flows are not met for the Groot River. This is, however, due to the presence of the Floriskraal Dam upstream which represents a significant instream impoundment restricting high flows downstream. Higher flow requirements in the Groot River can only be met by releases and spills from the Floriskraal Dam and are not dependent on incremental downstream catchments such as that for Byevanger Dam.

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