WATERCOURSE REHABILITATION AND MANAGEMENT PLAN FOR THE PROPOSED ENLARGEMENT OF THE DRIEFONTEIN DAM LOCATED ON PORTION 33 OF THE FARM RIETVALLEY NO. 364, NEAR CERES, WESTERN CAPE PROVINCE

Prepared for

EnviroAfrica cc

September 2019

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Report Reference:	**SAS 219167**
Date:	**September 2019**

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurrences).
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may, in turn, have an influence on the ecological characteristics and functioning of wetlands.

LIST OF ABBREVIATIONS

BGCMA	Breede Gouritz Catchment Management Agency
CBA	Critical Biodiversity Area
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GN	Government Notice
HGM	Hydrogeomorphic
m	Meter
MC	Management Classes
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAS	Scientific Aquatic Services
STS	Scientific Terrestrial Services
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WRC	Water Research Commission
WULA	Water Use License Application

Table A: Information required for maintenance and management activities for a single/ multiple owner(s) along a watercourse.

MMP Requirements	Section in Report
Provide a map (at an appropriate scale) of the watercourse or stretch of watercourse being applied for within the stretch where maintenance activities will take place being clearly defined – consideration must be made to mapped features relating to Critical Biodiversity Areas (CBAs) and National Freshwater Ecosystem Priority Areas (NFEPAs).	Section 3 Refer to Watsan Africa (2018) report
GPS coordinates must be provided for all site(s) at which maintenance activities will take place and included on the map which defines the stretch of watercourse. Coordinates must be provided in degrees, minutes and seconds using the Hartebeesthoek94 WGS84 co-ordinate system**.** Where numerous properties/sites are involved (e.g. linear activities), you may attach a list of property descriptions and co-ordinates to this form.	Section 2
Specialist assessment to be undertaken to determine (NOTE: information relating to the specifications and Terms of Reference used for the appointment of all specialist inputs must be provided).	Section 3 Refer to Watsan Africa (2018) report
Hydrological (incl. flood hydrological data etc.) and geomorphological assessment of watercourse functioning.	
The relevant Present Ecological Status (PES) of the stretch of watercourse in question, if not available an assessment is to be done to determine PES in accordance with the Department of Water and Sanitation (DWS) guidelines.	
What is the reason/cause for the maintenance activities based on an ecological and hydrological assessment of the watercourse within the context of the larger catchment.	Section 2 and Section 3
What are the drivers of system functioning within the watercourse and what is the ecological objective – based on historical condition and PES.	Section 3 Refer to Watsan Africa (2018) report
What is the management objective given the ecological status of the watercourse based on historical and PES data; as set out in agreement with the person(s) responsible for undertaking the maintenance activities.	
What is the impact on the watercourse/river system (resource quality characteristics: flow regime, geomorphology, water quality, habitat and biota) for a minimum of 500m both up and downstream of the proposed maintenance activities, with the mitigation measures included;	
An appropriate assessment for risk for each of the proposed types of maintenance activities and linked management actions in terms of the risk matrix for General Authorisations (GA) of Section 21 (c) and (i) by the DWS (GN 509 of 2016) or where applicable.	Section 3.1.2 Refer to Watsan Africa (2018) report
Mapped biodiversity features such as Critical Biodiversity Area, Ecological Support Area, National Freshwater Ecosystem Priority Area (NFEPA), and the National list of Ecosystems that are threatened and in need of protection (2011) gazetted in terms of Section 52 of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA), the Western Cape Biodiversity Spatial Plan 2017, as well as relevant provincial specific plans and classifications etc. Please consult the website www.bgis.sanbi.org.za to determine mapped features.	Refer to Watsan Africa (2018) report
Include a description of existing or previous protection measures or reinforcements (eg. gabions or groynes etc.) and infrastructure. Describe any evidence of erosion and/or siltation at the various sites and outlining possible causal factors and maintenance practices.	Section 2 and 3
Provide historical maps and data (images/flow/water quality/land use) of the river channel (if available) in order to assess the natural to changing flow patterns of the watercourse to determine cause of maintenance and possible impact of the maintenance activities, to inform mitigation measures.	Refer to Watsan Africa (2018) report
Provide a photographic record for the condition of the riparian habitat around maintenance sites, with the presence of important and/or sensitive habitat/species noted.	Refer to Watsan Africa (2018) report
For sites prone to flood damage, a description regarding the history and effect of past floods and include dates of most recent events must be provided. This must inform the process to understand what actions are required along the stretch of the watercourse to reduce such impacts to the resource quality characteristics.	Refer to Watsan Africa (2018) report
Explain the risks associated with the no-go option for the MMP i.e. the risk of not undertaking the maintenance activities as stated in the MMP.	No-go Alternative not considered

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to compile a Watercourse Rehabilitation and Management Plan (WRMP) to provide technical specialist input for the Environmental Authorisation and Water Use Authorisation (WUA) processes for the proposed enlargement of the Driefontein Dam located on Portion 33 of the Farm Rietvalley no. 364, near Ceres, Western Cape Province.

This WRMP was compiled to provide mitigation measures to manage the current, perceived and potential impacts on the watercourses associated with expansion of the dam wall (to increase the capacity of the Driefontein Dam) to protect the downstream watercourses from further degradation.

This WRMP follows a system that seeks to achieve a required end state and describes how activities that have, or could have a negative impact on the watercourses will be controlled and monitored and also identifies the responsible parties and relevant timeframes (where applicable) which will be tasked with implementing these measures. The key aims of the WRMP include:

- Maintenance of the present state of the watercourses associated with the Driefontein Dam, impacted by the proposed activities (refer to Section 2 below);
- Prevention of further degradation of the receiving environment; and
- Prudent monitoring to ensure timeous detection of, and response to, damage as a result of rehabilitation and operational activities associated with the proposed dam enlargement.

This WRMP advocates the use of several environmental management tools and mitigatory measures that are appropriate for the specific proposed dam wall construction activities and fits into the overall planning process of the rehabilitation, management and operational phases of the proposed dam enlargement and should be implemented by the proponent as soon as it has been approved by all the relevant authorities.

1.1 Structure of this report

This report investigates the need for rehabilitation and maintenance activities for the proposed dam enlargement activities. The report has been structured in the following way:

Chapter 1: Introduction
Provides an introduction, the structure of this report, the assumptions and limitations, as well as the relevant legislation.

Chapter 2: Project Description
Provides the location of the Driefontein Dam as well as a brief summary of the proposed activities.

Chapter 3: Receiving Freshwater Environment
This section includes a summary of the desktop and site assessment findings undertaken by Watsan Africa (2018).

Chapter 4: Legal Framework
This section provides a breakdown of the legal framework relevant to the proposed dam enlargement activities as well as the compilation of this WRMP.

Chapter 5: Watercourse Rehabilitation and Management Plan
This section comprises site specific details pertaining to the construction mitigation and rehabilitation measures that must be implemented. A list of the roles and responsibilities of all individuals involved in the implementation of this WRMP is provided.

Chapter 6: Monitoring Plan
This section provides the required monitoring actions during construction, rehabilitation and post-construction of the proposed dam enlargement activities.

Chapter 7: Conclusion
This section summarises the key findings and recommendations based on the recommended rehabilitation and management actions listed and the overall requirements in order to ensure the best possible reinstatement and rehabilitation of the watercourses affected by the proposed dam enlargement activities.

1.2 Watercourse Rehabilitation and Management Plan Framework

1.2.1 Principles of the Watercourse Rehabilitation and Management Plan

To assist in achieving the objectives of the WRMP, a set of principles were applied which contributed to formulating action plans and specific management measures.

Loss of biodiversity puts aspects of the economy, wellbeing and quality of life at risk, and reduces socio-economic options for future generations. This is of particular concern for the poor in rural areas who have limited assets and are more dependent on common property resources for their livelihoods. The importance of maintaining biodiversity and intact ecosystems for ensuring the on-going provision of ecosystem services, and the consequences of ecosystem change for human well-being, were detailed in a global assessment entitled the Millennium Ecosystem Assessment (MEA, 2005), which established a scientific basis for the need for action to enhance management and conservation of biodiversity.

Sustainable development is enshrined in South Africa's Constitution and laws. The need to sustain biodiversity is directly or indirectly referred to in a number of Acts, not least the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) and is fundamental to the notion of sustainable development. In addition, international guidelines and commitments, as well as national policies and strategies are important in creating a shared vision for sustainable development in South Africa.

Impacts on biodiversity can largely take place in four ways:

- **Direct impacts:** are impacts directly related to the dam enlargement activities including project aspects such as site clearing and diversion/abstraction of water.
- **Indirect impacts:** are impacts associated with the dam enlargement activities that may occur within the zone of influence associated with the water scheme, such as the surrounding terrestrial areas and downstream areas on the watercourse.
- **Induced impacts:** impacts that directly attributable to the project but are expected to occur due to the activities of the project.
- **Cumulative impacts:** can be defined as the sum of the impact of a project as well as the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity resources.

Given the limited resources available for biodiversity management and conservation, as well as the need for development, efforts to conserve biodiversity need to be strategic, focused and supportive of sustainable development. This is a fundamental principle underpinning South Africa's approach to the management and conservation of its biodiversity and has resulted in the identification of spatial biodiversity priorities or biodiversity priority areas.

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of anthropogenic activities. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level.

The mitigation hierarchy, as advocated by DEA *et al.* (2013) in general consists of the following in order of which impacts should be mitigated:

1. **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases, if impacts are expected to be too high, the "no project" option should also be considered, especially where it is expected that recommended mitigation measures will not be adequate to limit environmental damage and eco-service provision to suitable levels;
2. **Minimise impact:** can be done through the utilisation of alternatives that will ensure that impacts on biodiversity and ecosystem services provision are reduced. Impact minimisation is considered an essential part of any development project;
3. **Rehabilitate impact:** is applicable to areas where impact avoidance and minimisation are unavoidable. As such, impacted areas must be returned to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation cannot, however, be considered as the primary mitigation as even with significant resources and effort, rehabilitation usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:
    a. **Structural rehabilitation** which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long term sustainable ecological structure;
    b. **Functional rehabilitation** which focuses on ensuring that the functionality of the ecological resources associated with the project and its footprint supports the intended land uses. In this regard, special mention is made of the need to ensure the continued functioning and integrity of the watercourses throughout and after the rehabilitation phase.
    c. Biodiversity reinstatement which focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local land uses. In this regard, special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community or community suitable for supporting the intended land use.
    d. Species reinstatement which focuses on the re-introduction of any ecologically important species which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species reinstatement need only occur if deemed necessary.
4. **Offset impact:** The significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss of irreplaceable biodiversity, the residual impacts should be considered to be of a *very high significance* and offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual

impacts determined to have *medium to high significance*, an offset initiative may be investigated. If the residual biodiversity impacts are considered of low significance no biodiversity offset is required.

A summary of how the above relates specifically to the proposed dam enlargement activities in terms of measures which must be applied in order to ensure the minimisation of negative impacts and maximisation of positive impacts as a result of the dam wall is provided below:

- **Avoiding impacts** by not performing environmentally detrimental actions;
- **Minimising impacts** by limiting aspects of an action, optimising processes, structural elements and other design features; and
- **Rectifying impacts** through rehabilitation, restoration, etc. of the affected environment.

1.2.2 Objectives of the Watercourse Rehabilitation and Management Plan

The objectives of this WRMP are to:

- Meet the requirements of relevant local and regional authorities;
- Identify a range of mitigation measures which could reduce and mitigate the potential impacts on the receiving environment to minimal or acceptable levels;
- Manage activities in order to maintain and/ or improve the ecological integrity of the watercourses;
- Maximise the service provision of the downstream watercourses;
- Maximise the ecological functioning of the watercourses downgradient of the dam;
- Detail specific actions deemed necessary to assist in mitigating the potential environmental impact on the watercourse area;
- Ensure as far as is practicable that the measures contained in the report are implemented; and
- Propose mechanisms for monitoring compliance with the WRMP and reporting thereon.

2 PROJECT DESCRIPTION

The Driefontein Dam is located within the Breede-Gouritz Catchment Management Agency's (BGCMA) jurisdiction within the Western Cape Province, on Portion 33 of the Farm Rietvalley 367, approximately 9km east of the town of Ceres (Figure 1 and 2). The area surrounding the Driefontein Dam primarily comprises cultivation activities which have been the ongoing land use for several decades in the local catchment of the dam.

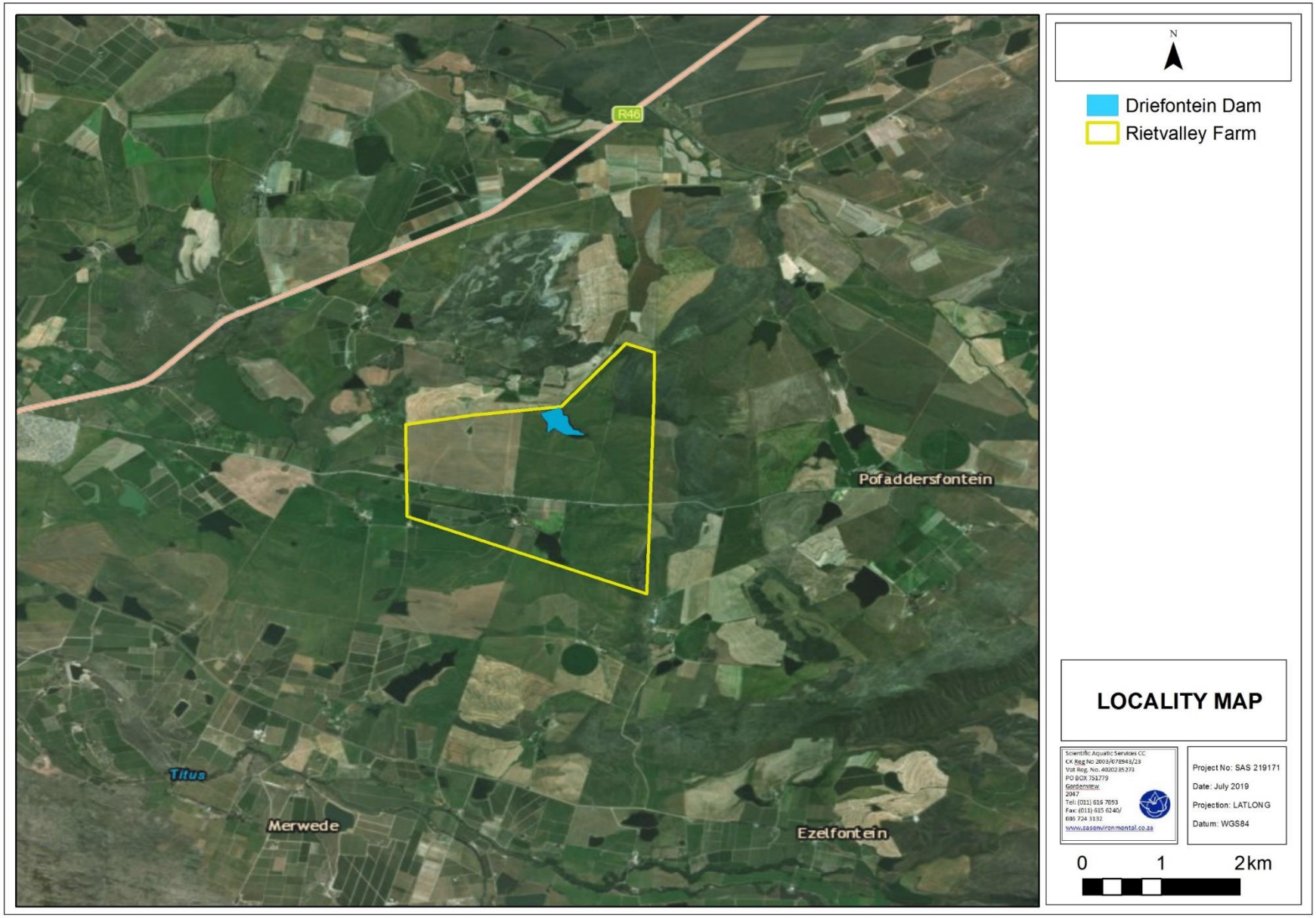


Figure 1: Locality map of the Driefontein Dam in relation to the surrounding areas presented on a digital satellite image.

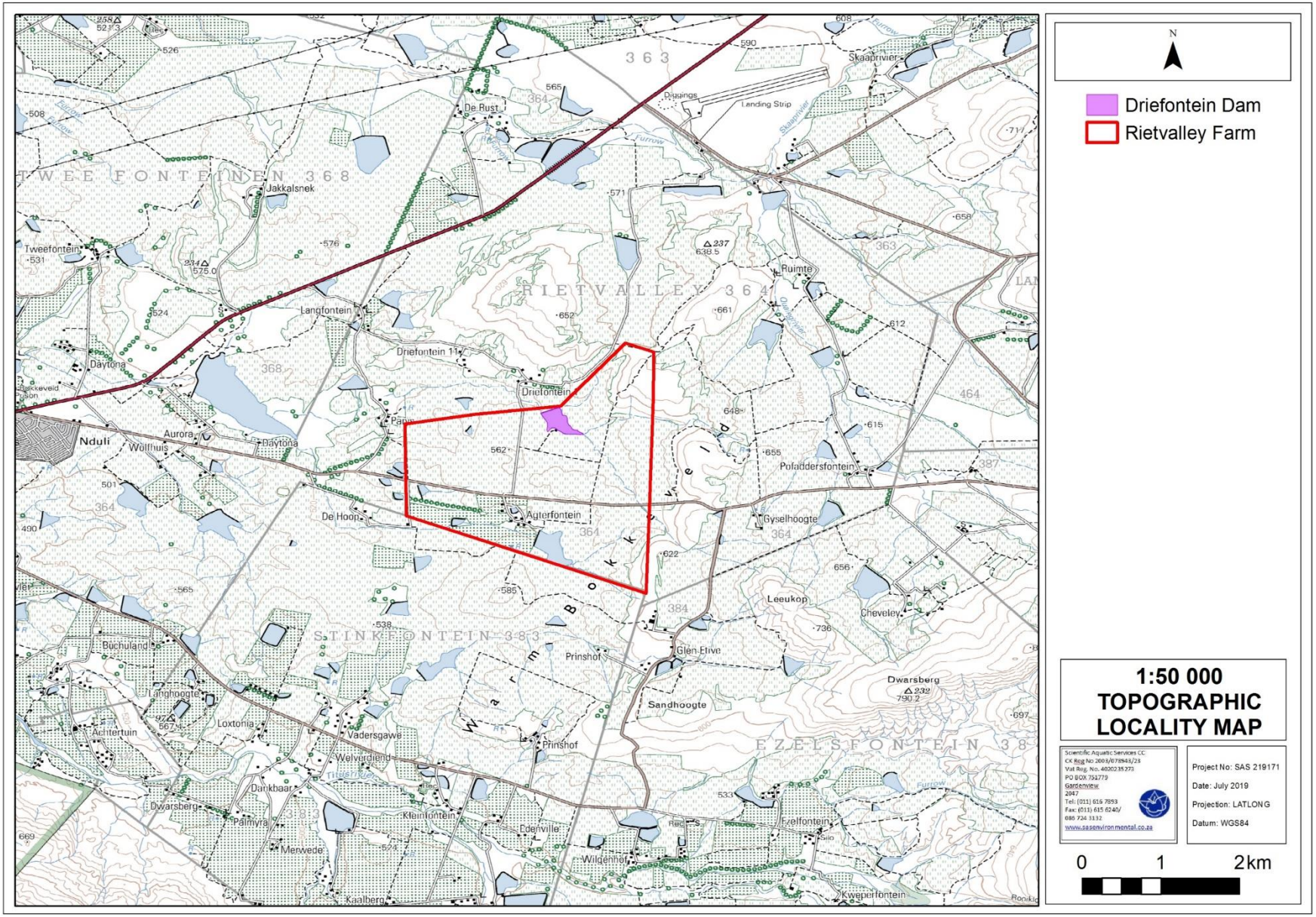


Figure 2: Topographical map of the Driefontein Dam in relation to the surrounding areas presented on a digital satellite image.

According to the Basic Assessment Report for the proposed project (16/3/3/1/B5/2/1064/18, EnviroAfrica, 2019), the Driefontein Dam is used for the storage of irrigation water for deciduous fruit orchards on the Rietvalley Farm. The current capacity of the dam does not provide sufficient storage capacity on the farm for scheduled summer irrigation use by the Warmbokkeveld Irrigation Board Water Scheme, and a substantial portion of the water needs to be released from the dam into the downstream watercourse for the benefit of downstream water users. It is therefore proposed to increase the capacity of the Driefontein Dam by extending the dam wall length and height. A photograph of the current dam wall is provided in Figure 3. Table 1 provides a summary of the proposed size of the dam after the enlargement. The footprint of the dam will increase by a total of approximately 6.4ha from the existing footprint, with additional capacity gained via excavation of the existing dam. Additionally, the current spillway will be decommissioned, and a new spillway be constructed at the eastern end of the dam wall and a pipe outlet constructed under the embankment.

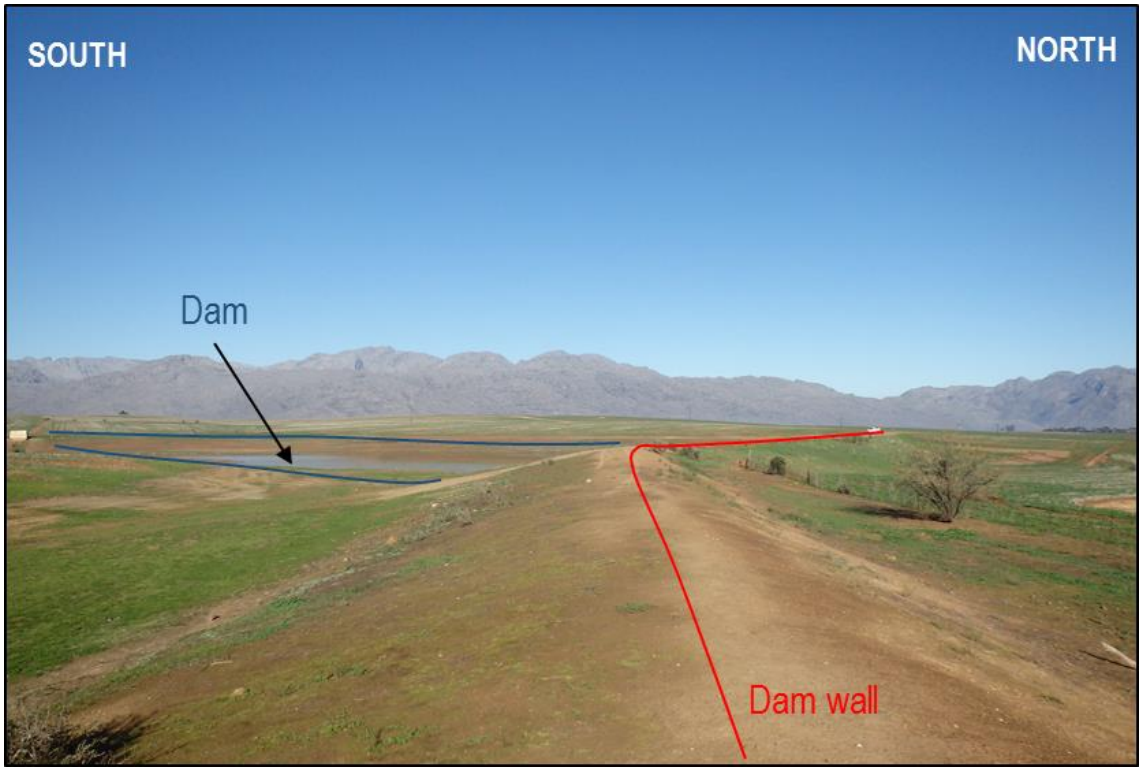


Figure 3: A photograph of the Driefontein Dam and associated dam wall.

The enlargement of the dam will commence in two phases, of which a summary is provided in the table below. The existing spillway (Figure 4) will be demolished during Phase 1, and a new spillway will be constructed. During phase 1, the spillway will be increased with 1,55 m and then a further 0,6 m during phase 2. The spillway footprint will remain the same but with a total increase in height of 2, 15 m.

Table 1: The existing and proposed (Phase 1 and 2) capacity and size measurements of the Driefontein Dam.

Description	Existing	Phase 1 Enlargement	Phase 2 Enlargement
Dam wall length	300 m	390 m	431 m
Dam wall height	7,4 m	8,95 m	9,55 m
Net storage capacity	239 000 m3	±321 000 m^3	±420 000 m^3
Total footprint	10.51 ha	14,2 ha	16,90 ha
Total proposed earthworks	-	17 800 m^3	25 000 m^3

Figure 4: The existing spillway, located at the eastern end of the existing dam wall. Note the erosion and under-scouring at the spillway outlet.

The spillway will be relocated further along the higher up against the right abutment (located at the eastern end of the dam wall) with a concrete sill at the right flank, directing the flood water safely past and away from the embankment toe and back into the stream bed. The erodibility index is 16 on a scale of 1 to 20 with 1 being high and 20 being low (i.e. the index is classified as low). The dry freeboard is provisionally set at ±1,0m based on the flood requirements.

The new outlet pipe which will be encased under the embankment, is currently planned as a single 300mm ø class 9 pipe in reinforced concrete with a flanged sluice-gate control valve and manifold on the downstream side. It will also be fitted with a sieve pipe on pedestals or alternatively a custom built float unit at the upstream inlet end. This will be sufficient for irrigation purposes as well as for emptying the dam or lowering the water level in case of an emergency condition, and to allow for releases for the downstream users.

According to the Basic Assessment Report for the proposed project (16/3/3/1/B5/2/1064/18), it is important to note that the volume of water that will be stored after the completion of Phase 1 and Phase 2, does not represent an increased volume of water that will be abstracted from the larger drainage system. This is water already allocated for irrigation purposes on the Rietvalley Farm, which is delivered to the dam/farm via a canal system. The raising of the dam wall would merely store water that is currently flowing through to downstream farming operations. None of this water is currently flowing back to any river system and therefore not making any contribution to any freshwater health and aquatic ecology (Watsan Africa, 2018).

The detailed layout and design of the dam wall during Phase 1 and 2 and the locality of the spillway as depicted in Figures 5 and 6 below.

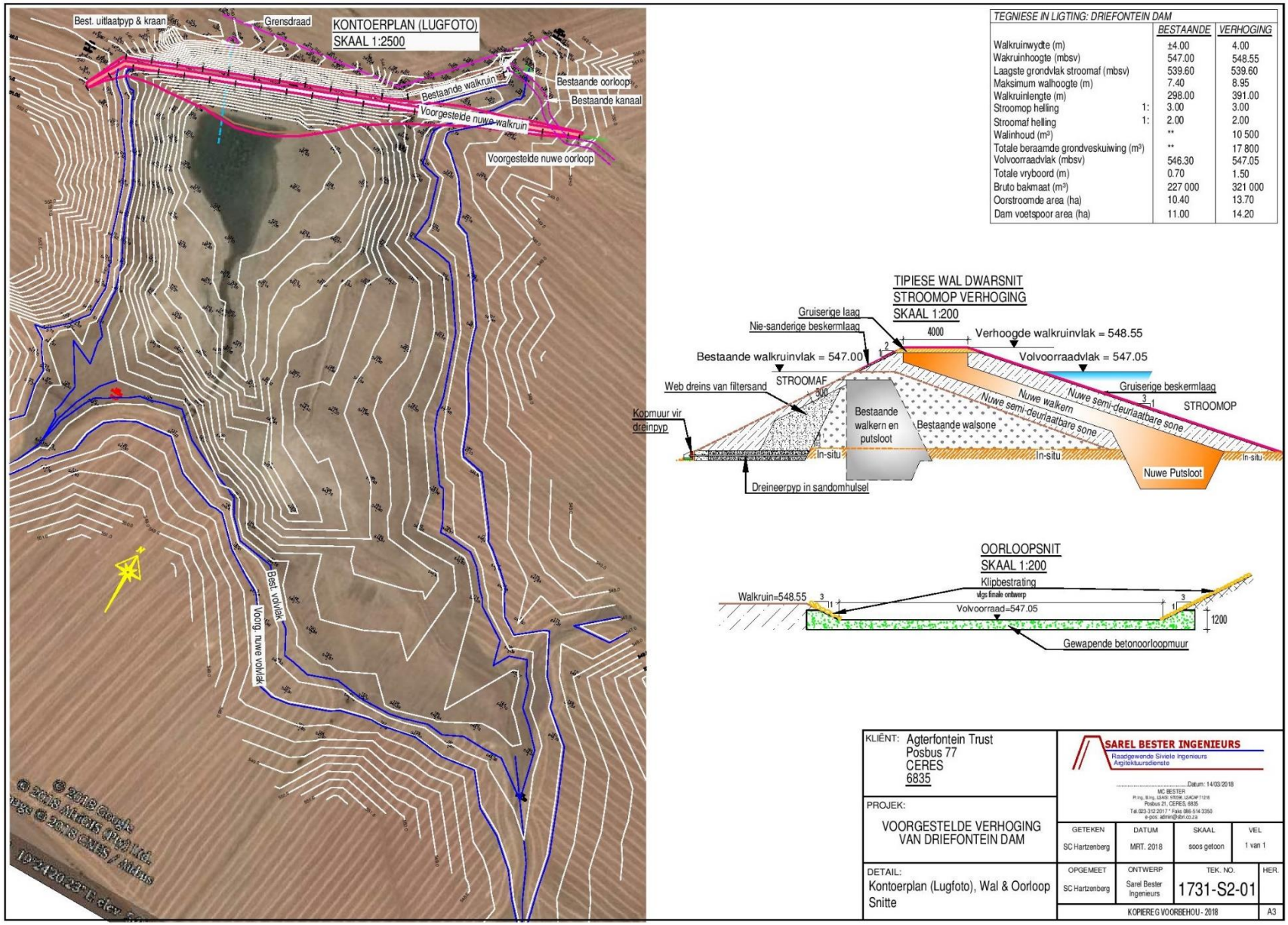


Figure 5: The proposed layout of the dam wall and spillway to be constructed during Phase 1 of the proposed development (Sarel Bester Ingenieurs, 2018).

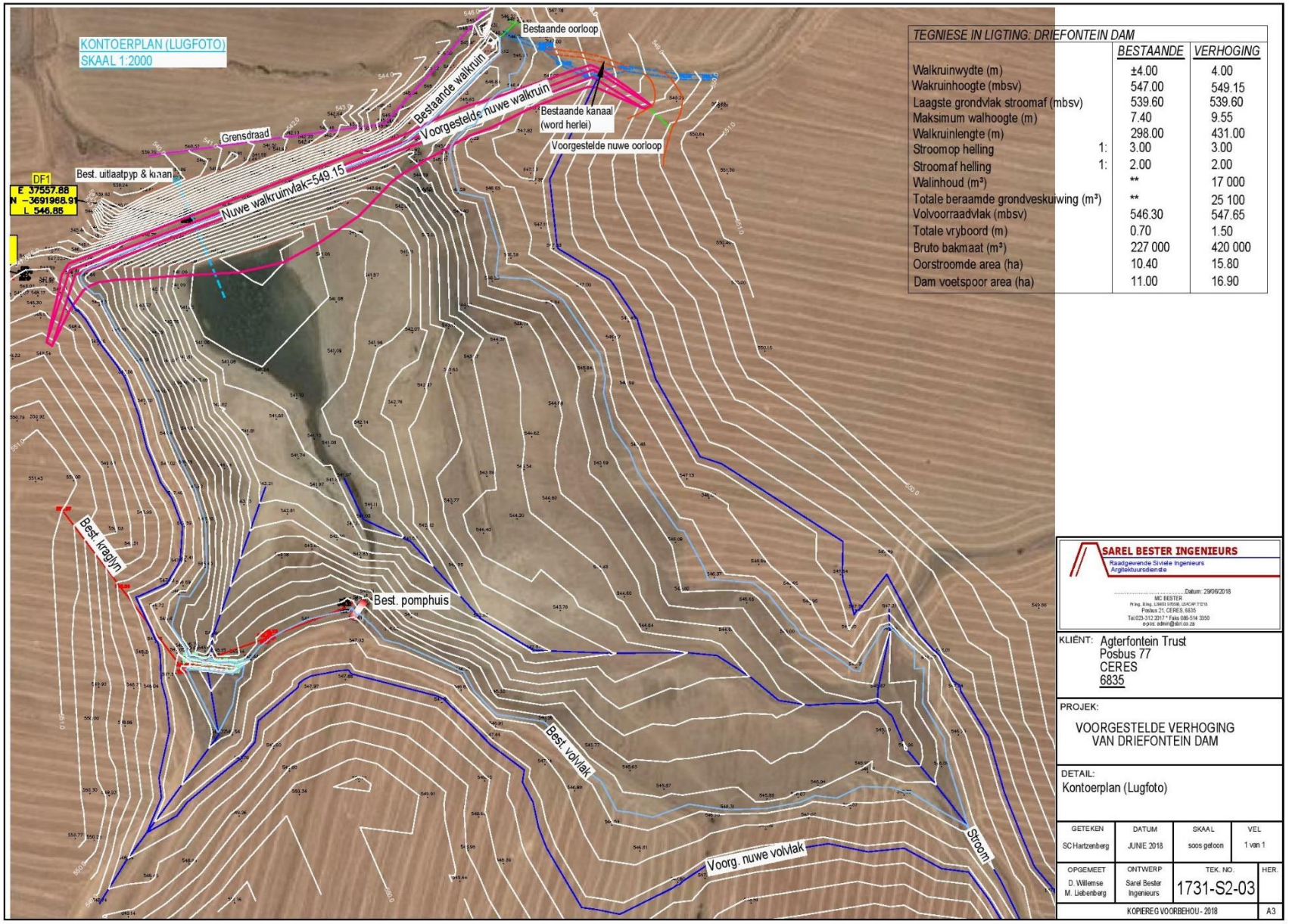


Figure 6: The proposed layout of the dam wall and spillway to be constructed during Phase 2 of the proposed development (Sarel Bester Ingenieurs, 2018).

3 RECEIVING ENVIRONMENT

The following information on the ecological characteristics of the watercourses associated with the Drienfontein Dam is taken from the report titled: “Agterfontein Boerdery (Pty) Ltd, Portion 33 of Farm Rietvalley 367 Ceres. Enlargement of the Driefontein Dam: Technical Report V2.1. Water Use Licence Application Risk Matrix in terms of Section 21 of the National Water Act (Act No. 36 of 1998) (Watsan Africa, 2018), which also provides further information if required.

The Driefontein Dam is not naturally connected to any of the rivers that drain from the surrounding mountainous areas, and rather has a small catchment of its own (Figure 7) (Watsan Africa, 2018). Originally this catchment was larger; it has been divided into two portions by a canal from the Warmbokkeveld Irrigation Board Water Scheme. As the runoff from the local catchment of the Driefontein Dam is insufficient to fill the dam to capacity, water from the Warmbokkeveld Irrigation Board Water Scheme primarily supplies the dam.

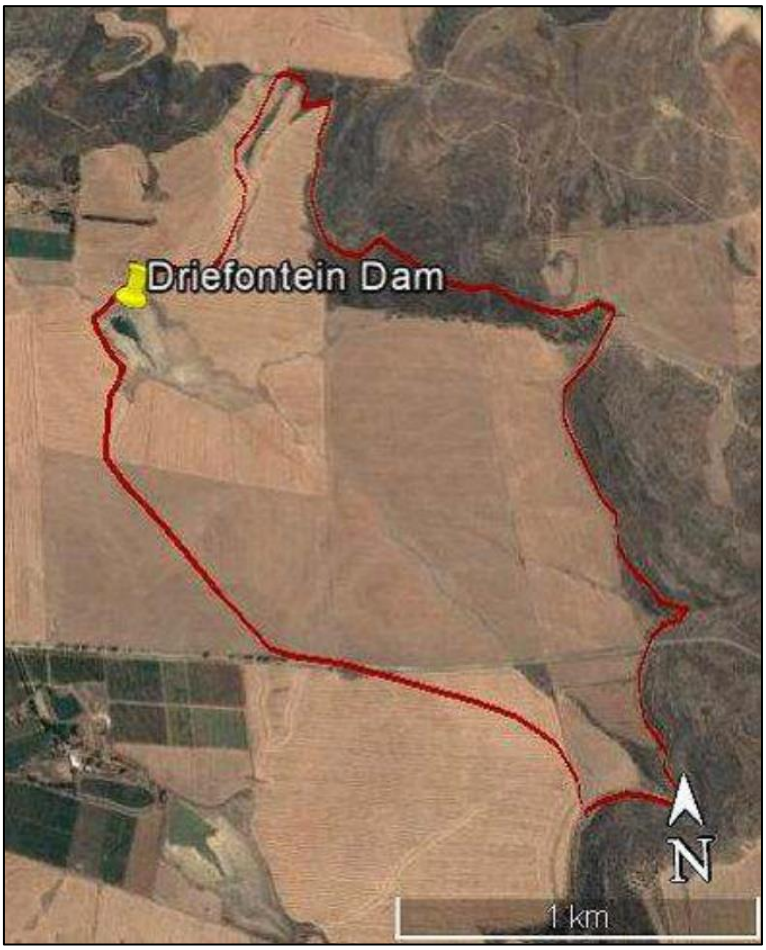


Figure 7: The local catchment of the Driefontein Dam, as per Watsan Africa (2018.)

The watercourse below the Driefontein Dam is considered to be highly impacted (Watsan Africa, 2018). As per the freshwater assessment report (Watsan Africa, 2018), this watercourse is described as an incised furrow through a ploughed-over wheat field devoid of water, aquatic habitat or a riparian zone (Figure 6). A watercourse draining into and adjacent to the Driefontein Dam has similar characteristics to the watercourse below the dam (Figure 7).

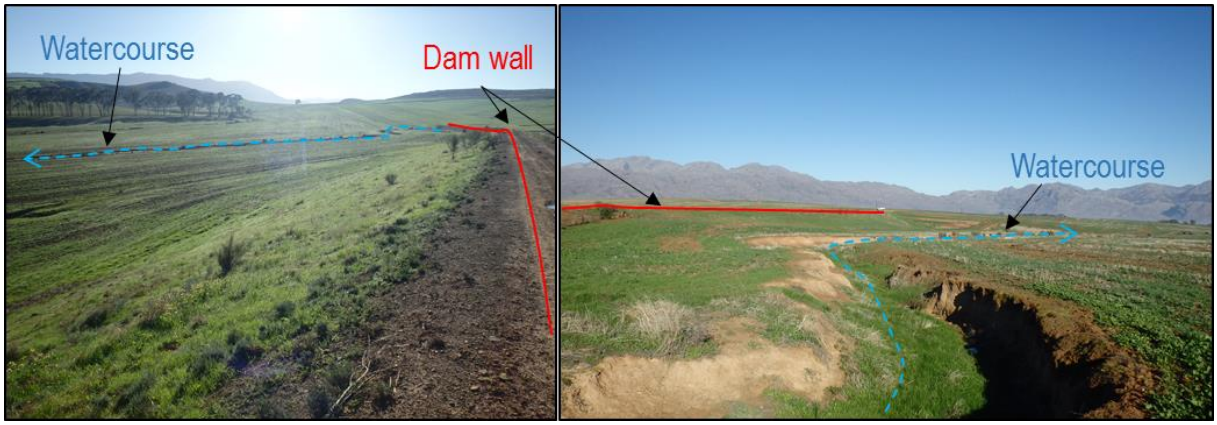


Figure 8: The watercourse located below the dam wall is highly eroded.

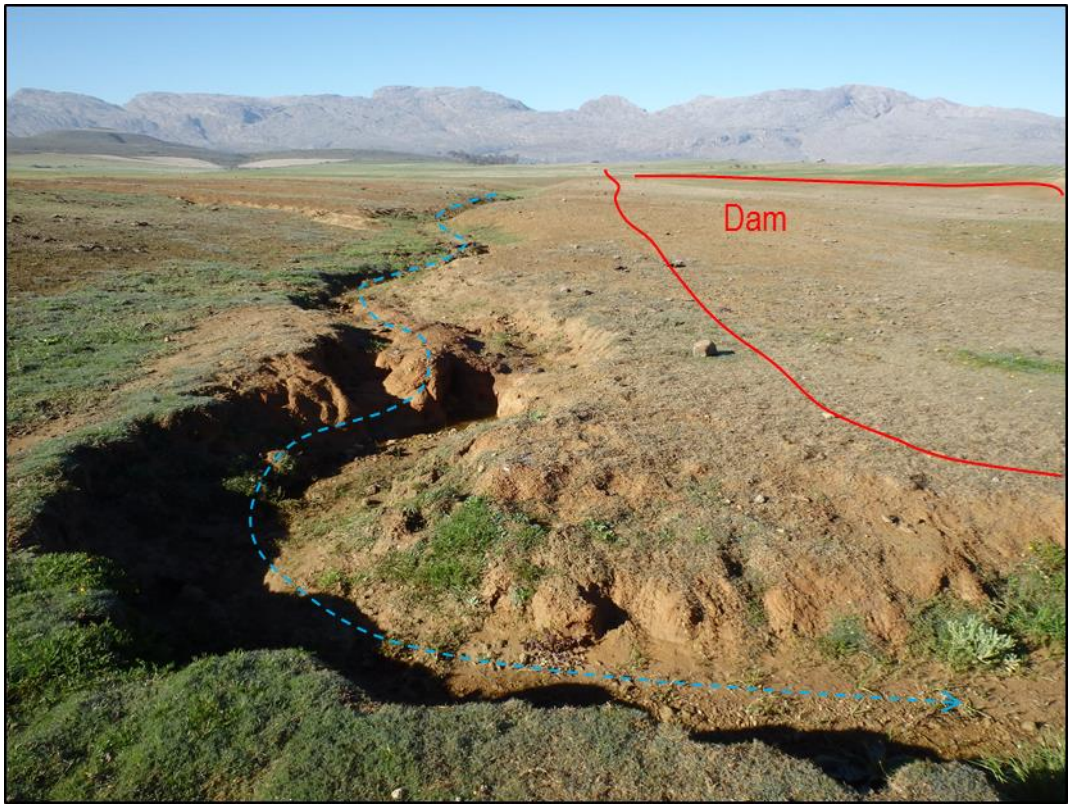


Figure 9: The watercourse adjacent to the dam, is highly eroded.

These watercourses only flow during periods of high rainfall, when the Warmbokkeveld Irrigation Board Water Scheme has filled up the Driefontein Dam and it spills over into the downstream watercourse. When there is runoff in the local catchment, the watercourse adjacent to the Driefontein Dam has flow.

“The raising of the dam wall would merely store water that is now flowing through to downstream farming operations. None of this water is currently flowing back into any other watercourses and therefore is not making any contribution to any downstream river health nor aquatic ecology. The raising of the dam wall is not about to bring any change in the *status quo* of the watercourses it is associated with” (Watsan Africa, 2018). It is, however, important to note that water will still be released from the enlarged dam for use by the downstream users.

A summary of the results of the freshwater resource assessment (Watsan Africa, 2018) of the watercourses is provided in Table 2 below.

Table 2: Summary of the results of the freshwater resource assessment (Watsan Africa, 2018) of the watercourses adjacent and below the Drienfontein Dam.

Present Ecological State (PES)	Ecological Importance (EI)
Instream – Critically Modified (F) Riparian – Critically Modified (F) The instream and riparian habitat have both been critically modified by farming practices and the storage of water.	The dam's water level fluctuates widely due to water used for irrigation. No indigenous fish species, nor other endangered or important species are present in the dam and hence the dam cannot be considered as ecologically important. Thus, the habitat cannot be described as particularly sensitive.

Visual representation of the watercourses in relation to the Driefontein Dam is provided in Figure 8 below. It must be noted that the delineation as provided in Figure 10 was undertaken using desktop methods as undertaking a field delineation was not part of the scope of this WRMP. The above-mentioned delineation is, however, accurate enough to inform the contents of this WRMP.

As per the freshwater ecological study, the watercourses can only return to a more natural state if the entire landscape reverts to less farming and more natural catchment. At present the watercourse is classified as an episodic drainage line which does not have any wetland or riparian characteristics. As such, this system is important for the hydrological conveyance of water and does not provide any ecological functionality.

3.1 Impact and DWS Risk Assessment outcome

A summary of the outcome of the impact and DWS risk assessments, as reported by Watsan Africa (2018), is provided below.

3.1.1 Impact Assessment

It was determined that the increase of the Driefontein Dam storage capacity will not have an impact on the downgradient aquatic environment. No less water would flow into the downstream watercourse, as is currently the situation. The nett effect on the watercourses' water balance due to the dam enlargement (irrespective of which phase) is of insignificant impact.

The spillway may not be constructed higher than the dam's full capacity level. This would ensure that if the dam is at its designed capacity, overflow into the downstream watercourse would be ensured. This water provides little ecological benefit to the degraded watercourse adjacent to and below the Driefontein Dam, however, this water is utilised by downstream users and thus this overflow must be maintained.

3.1.2 DWS Risk Assessment

The risk of the proposed Driefontein Dam was determined to be of Low risk significance (Watsan Africa, 2018). Under the current irrigation system's operating rules, the heightening of the dam wall is ecologically insignificant (Watsan Africa, 2018). Authorisation for the enlargement of the dam can be obtained via General Authorisation from the Department of Water and Sanitation (DWS) (Watsan Africa, 2018).

Figure 10: The locality of the watercourses as assessed in the freshwater assessment report (Watsan Africa, 2018) in relation to the Driefontein Dam.

4 LEGAL FRAMEWORK FOR THIS WATERCOURSE REHABILITATION AND MANAGEMENT PLAN

The following legislative documents were considered and the aspects which are pertinent to watercourse management including the rehabilitation of disturbed areas were utilized.

- The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996);
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA);
- National Environmental Management: Biodiversity Act, 2014 (Alien and Invasive Species Regulations, 2014);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA); and
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

It should be noted that the abstraction of water from the Warmbokkeveld Irrigation Board Water Scheme is considered an existing lawful water use and as such a Water Use Authorisation for Section 21(a) is not required. There is thus no need to apply for a new water use license for the *taking of water.* The Driefontein Dam is however, considered an instream dam and therefore other activities in terms of Section 21 of the National Water Act (Act No. 36 of 1998) will be triggered. Sarel Bester Ingenieurs submitted the EWULA **WULA REF: WU7859** (File no: 27/2/1/H310/4/1) for the Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) activities applicable to the proposed enlargement of the Dreifontein Dam:

- Section 21 (b): storing of water;
- Section 21 (c): impeding or diverting the flow of water in a watercourse; and
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

These activities trigger a Section 21 (b), (c) and (i) water use as it refers to the National Water Act, 1998 (Act No. 36 of 1998) as well as activity 19 of the Environmental Impact Assessment Regulations Listing Notice 1 of 2014 (as amended) as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998). The conditions for Section 21(c) and (i) activities, in terms of Government Notice 509 of 2016 require that a WRMP be developed and must address the following:

1. Identify a WRMP domain, preferably from a whole-catchment perspective;
2. Identify an accountable, representative body that should take unbiased custodianship of the WRMP and drive its implementation;
3. Identify key stakeholders;
4. Divide the watercourses into useful management units;
5. Identify major drivers of watercourse disturbance and instability - human and natural and their primary and secondary effects;
6. Complete a risk assessment as per the Department of Water and Sanitation (DWS) Risk Assessment Matrix (see Watsan African, 2018 - Section 9) for identified impacts and their mitigation activities;
7. Solicit input from stakeholders on their priorities and objectives;
8. Define best practice measures for rehabilitation and maintenance implementation;
9. Design a plan for ecological monitoring which is specifically linked to the stated objectives; and
10. Develop an implementation programme and review mechanism.

The report should contain supporting technical information used to ensure low risk to the resource quality such as:

a) An Impact assessment and mitigation report (see Watsan African, 2018 - Section 9) completed by an independent consultant as required by the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Water Act, 1998 (Act No. 36 of 1998);
b) All the relevant specialist reports supporting the proposed mitigation measures;
   i. Specialists Reports must address the level of modification /risk posed to resource quality, ie: flow regime, water quality, geomorphological processes, habitat and biota of the watercourses and contain Present Ecological state (PES) and Ecological Importance and Sensitivity (EIS) data for relevant watercourses (see Watsan African, 2018).
c) Environmental Management Plan (EMP) giving effect to all actions required to mitigate impacts (What, When, Who, Where and How);
d) Best practices applicable to these activities, where applicable;
e) Generic designs and method statements, where applicable;
f) Norms and standards, where available;
g) A monitoring programme that must include "present day" conditions to be used as baseline values;
h) Monitoring, auditing and reporting programme (reports must be sent on request to the region or Catchment Management Agency (CMA)); and;
i) Internalized controls and auditing, where applicable.

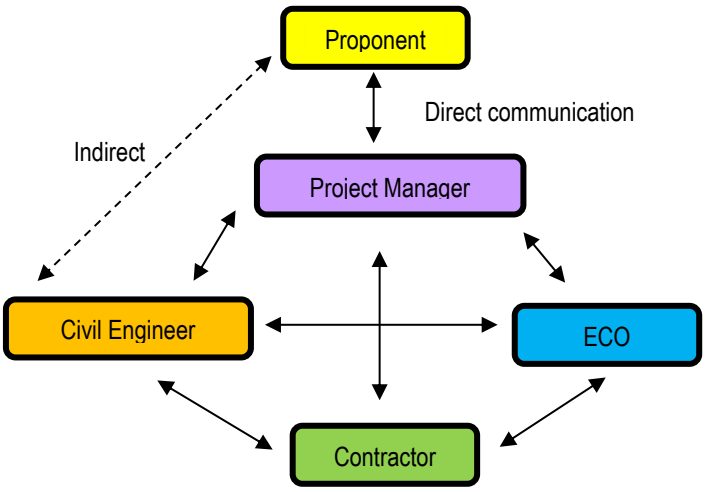
Please refer to **Appendix B** for additional legislative requirements.

5 WATERCOURSE REHABILITATION AND MANAGEMENT PLAN

5.1 Roles and Responsibilities

The following table provides a summary of the various parties that are involved with the implementation of this WRMP as well as their responsibilities.

Table 3: Summary of various parties involved with the implementation of this WRMP.



Party	Responsibility
Proponent	• The Proponent will be responsible for the appointment of a suitably qualified independent Environmental Control Officer (ECO) for the construction phase of the project; • A management body (I.e. Project Manager) must be appointed to ensure compliance with the WRMP; • The Proponent will be responsible for ensuring all Contractors receive a copy of this document and understand its contents; • The Proponent is responsible to ensure there is sufficient funding for the required rehabilitation and management actions as set out in this WRMP; and • The Proponent can also be the Project Manager should they not wish to appoint a separate project manager.
Project Manager	• The Project Manager must ensure a clear communication line between all parties working on the project, to ensure all environmental concerns and measures as stipulated within this WRMP are implemented/adhered to; • The Project Manager should have direct communication with the Proponent; • The Project Manager should call a meeting with all responsible parties should there be conflict/ remediation requirements to ensure a suitable solution is found and implemented; • The Project Manager must ensure that there are sufficient funding and resources for an ECO to adequately perform their role and • The lead project manager must ensure that this WRMP is implemented and that suitable penalties are in place for non-conformance to this WRMP by contractors (as indicated by the ECO).
Registered Civil Engineer	• Issue all instructions/ drawings to the Contractor; • Must immediately inform the Project manager and ECO if any changes to the project are envisaged;

	• Must immediately inform he Project Manager and ECO if any aspects of this WRMP and/or Record of Decision (RoD) for the relevant authorities cannot be complied with; and • Must remain in communication with the ECO and the Project Manager to ensure that any design changes required are issued to the Contractor.
Environmental Control Officer (ECO)	• The ECO is the person responsible for the monitoring of the implementation of this WRMP during the implementation of the activities and for reporting on the degree of compliance. The ECO should ideally be appointed at the start of construction activities and be responsible for ensuring that all rehabilitation activities are implemented. The ECO is mandated to do the following: • Ensure that all contractors/ subcontractors/ employees/ construction workers are fully aware of their environmental responsibilities. This should take the form of an initial environmental awareness-training program in which requirements of this document will be explained; • Monitor site activities on a regular basis to ensure that there is minimal environmental impact due to construction activities. A monitoring report should be submitted to the Contractor, the Civil Engineer (should there be any design changes required) and the Project Manager; • Ensure that a 'hotline' exists for reporting incidents and resolving any problems rapidly; • The ECO must regularly audit the operation and establish whether the measures in this WRMP are applied, where after the ECO reports to the lead project manager; • All reports compiled by the ECO must be submitted to the relevant compliance officer within the BGCMA, DWS and the DEA&DP; • The ECO has the authority to stop works if in his/her opinion there is/may be a serious threat to or impact on the environment caused directly by the construction operations; and • Conduct a final environmental audit and a review of management and rehabilitation measures. • Should the appointed ECO not have any freshwater ecological experience, a suitably qualified Freshwater Ecologist should be appointed to assist the ECO as and when needed.
Contractor	• The Contractor/s, in this case, refers to any contractor/s on site, including the building contractor/s and sub-contractors on any item of infrastructure being erected or demolished; • Such contractor/s will take full responsibility for each of his/her employees and any penalties imposed; • The Contractor must immediately inform the Project Manager and Eco if any changes to the project are envisaged and if any aspects of this WRMP or the RoD cannot be complied with; • All design change instructions must come from the Project Manager and/or Civil Engineers; • It is the responsibility of the Contractor/s to ensure that the measures stipulated within this WRMP are adhered to; and. • Should the Contractor require clarity on any aspect of the WRMP the Contractor must contact the ECO for advice.

5.2 Site Specific Rehabilitation and Management Plan

A detailed site specific WRMP has been developed for the proposed dam enlargement activities and spillway decommissioning and construction activities, as described in Section 2 of this report. Successful rehabilitation depends upon cogent conceptual planning, research and design flexibility. The proposed site-specific mitigation measures for the construction and rehabilitation phases are listed in Tables 4 through 6.

Table 4: General mitigation measures for the planning, construction, rehabilitation and operational phases that must be applied for the enlargement of the Driefontein Dam.

General – applicable to all activities associated with the dam wall enlargement and spillway construction					
Timeframes / Project Phase	**Planning and Construction Phase**		**Rehabilitation**	**Post Rehabilitation**	
Parties Responsible:	**Proponent**	**Project Manager**	**Civil Engineer**	**ECO**	**Contractor**

Pollutant and Waste Management

- No discharge of effluents or polluted water is permitted into or surrounding the watercourses;
- If soil contamination occurs surrounding the watercourses (due to a spill), the soil should be removed from the site and disposed of appropriately; and
- Dust generated by the associated works can have a detrimental impact on agricultural crops. Since the dominant land use surrounding the Driefontein Dam is agricultural, suitable dust suppression actions must be undertaken for the duration of construction activities.

Construction Equipment

- Dedicated parking area for construction vehicles must be located away (approximately 32m, outside of the NEMA zone of regulation) from the delineated watercourses, and drip trays must be located beneath any parked and leaking equipment along with lubricant/fuel absorbing media (e.g. sawdust or moss type products) within the drip trays to contain spilled material. This must be undertaken to prevent compaction of the soil and disturbance of the watercourse habitat and flow regime as well as limit the possibility of contamination of soils;
- All materials used to construct the spillway should not generate toxic leachates or lead to significant changes in pH or dissolved salt concentrations. In this regard, pH should not change by more than 5% between upstream and downstream areas and the Total Dissolved Solids (TDS) value should not increase by more than 15%. This is only applicable if surface water is present at the time of construction;
- No vehicles may be moved indiscriminately through the watercourses. During construction, the footprint areas of the dam wall and spillway must be kept to a minimum. All vehicles must use one single designated track and turn-around areas should be located outside of the watercourses. Due to the relative accessibility of the site, no unnecessary crossing of the watercourses may be permitted. This will limit any further erosion of the watercourses;
- No construction equipment of activities may impact upon or disrupt normal farming activities, associated with the surrounding land use.

Soil Management

- Excavated soils removed (to enlarge the dam capacity) should be stockpiled outside of the delineated watercourses and the footprint of the Driefontein Dam;
- Excavated materials should not be contaminated and it should be ensured that the minimum surface area is taken up, however the stockpiles may not exceed 2m in height;
- The mixture of the lower and upper layers of the excavated soil should be kept to a minimum, so as for later usage as part of rehabilitation activities; and
- All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent dust generation resulting in vegetation smothering and sedimentation of the watercourses. This is especially important since the surrounding landscape is utilised for harvestable fruits that may be sensitive to excessive dust.

Concrete Mixing

- All wet and dry material should be stored within the construction camp, which is located outside of the delineated watercourses and associated 32m NEMA zone of regulation. These materials should be covered and contained to prevent contact with rainfall or runoff;
- Concrete and cement-related mortars can be toxic to aquatic life. Proper handling and disposal should minimize or eliminate discharges into watercourses. High alkalinity associated with cement, which can dramatically affect and contaminate both soil and groundwater. The following recommendations must be adhered to:
    - Fresh concrete and cement mortar should not be mixed near the watercourses. Mixing of cement may be done within the Construction camp, may not be mixed on bare soil, and must be within a lined, bound or bunded portable mixer ;
    - No mixed concrete shall be deposited directly onto the ground within the watercourses or the footprint of the Driefontein Dam whilst it awaits placing. A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited (for the casting of the spillway) whilst it awaits placing;

General – applicable to all activities associated with the dam wall enlargement and spillway construction					
○ A washout area should be designated outside of the watercourses, and wash water should be treated on-site or discharged to a suitable sanitation system (USEPA. 2005); ○ Cement bags must be disposed of in the demarcated hazardous waste receptacles and the used bags must be disposed of through the hazardous substance waste stream; and ○ Spilled or excess concrete must be disposed of at a suitable landfill site. Chain of custody documentation must be provided.					
Timeframes / Project Phase	Planning and Construction Phase		**Rehabilitation**	Post Rehabilitation	
	Proponent	**Project Manager**		**ECO**	**Contractor**

Soil Management

Additional to the soil management activities as proposed above, the following also applies:

- Exposed slopes, especially along the watercourses, are highly prone to erosion, so drainage control features such as earth berms, perimeter berm/swales, diversions (see below) can be used to intercept and convey runoff from above disturbed areas. This helps to reduce potential sedimentation from exposed areas**.** (Walker. 199 *et al*. and USEPA. 2005)
  - **Brush layering** is when branches are placed perpendicular to the slope contour. This method is effective for earth reinforcement and mass stability. Brush layers break up the slope length, preventing surface erosion, and reinforce the soil with branch stems and roots, providing resistance to sliding or shear displacement. Brush layers also trap debris, aid infiltration on dry slopes, dry excessively wet sites, and mitigate slope seepage by acting as horizontal drains. Brush layers facilitate vegetation establishment by providing a stable slope and a favourable microclimate for growth of vegetation (USEPA. 2005);
  - **Live gully repair** is a technique that is similar to branch packing but is used to repair rills and gullies. Live gully repairs offer immediate reinforcement and reduce the velocity of concentrated flows. They also provide a filter barrier that reduces further rill and gully erosion and must be used where gully erosion is taking place on the project footprint (USEPA. 2005).
- Any gullies occurring as a result of erosion from the construction activities must be actively repaired;
- Stream banks must be reprofiled to the pre-construction upstream and downstream slopes (a 3:1 profile ratio is not recommended as this will change the flood patterning of the watercourse. The existing embankments associated with the watercourses were noted to be steep), covered with a geotextile product such as hessian, with commercially available products such as Geojute, which is to be staked to the surface of the slopes and indigenous freshwater vegetation should be re-instated for all areas disturbed by construction activities; and
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas.

Alien Vegetation Clearing

- During the site inspection undertaken by the specialist compiling this report (July 2019), few individual alien and invasive plant species were identified within the downgradient watercourse. All alien and invasive vegetation must be removed from the watercourses in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)) as provided in **Appendix B**;
- Alien and invasive vegetation have a number of detrimental effects on water quality, from nutrient enrichment to increased erosion and excessive water use, which is especially relevant in dry areas or in important catchments. Invasive species are highly likely to colonise disturbed areas, even after rehabilitation and follow-up clearing must be done until healthy vegetation returns to the site (DWA.2008e, DWAF. Unknown date, MacFarlane, D.M., Wadeson. R *et al,* 2007). Please refer to **Annexure C** for further details pertaining to alien vegetation control;
- Alien vegetation should be manually removed as far as feasibly possible and spot chemical treatment can be undertaken utilising products safe for within watercourses. All directions as stipulated on the proposed herbicide must be strictly adhered to.
- All removed alien plant species must be disposed of at a registered garden refuse site and may not be burned or mulched on site; and
- No invasive plant species may be introduced to the watercourses during the construction phases of the project and particular attention must be paid to ensure that any imported material is certified weed-free.

General – applicable to all activities associated with the dam wall enlargement and spillway construction					
Timeframes / Project Phase	**Planning and Construction Phase**		**Rehabilitation**	**Post Rehabilitation**	
	Proponent	**Project Manager**		**ECO**	

- All areas impacted upon during construction must be monitored post-rehabilitation until basal vegetation cover has been re-established; and
- The area surrounding the watercourses must be managed for all alien vegetation and the area revegetated with indigenous terrestrial vegetation (favour given to drought tolerant unpalatable forb species) in order to create a transitional zone between the terrestrial and the aquatic environment.

Table 5: Specific mitigation measures for the planning, construction, rehabilitation and operational phases that must be applied for the enlargement of the dam wall, construction of the outlet pipe and the spillway.

Dam wall enlargement and pipeline outlet structure					
Timeframes / Project Phase	**Planning and Construction Phase**		**Rehabilitation**	**Post Reha+6bilitation**	
Parties Responsible:	**Proponent**	**Project Manager**	**Civil Engineer**	**ECO**	**Contractor**

- It is imperative that all construction works be undertaken during the dry, summer months as the dam is most likely to be inundated during the wetter, winter period;
- During the proposed dam enlargement activities, it is not recommended that water be pumped into the dam. Should the proponent still require their allocated water for irrigation during the dam construction, a temporary storage facility should be utilised. This can be done by utilising the following:
  - Creating a smaller temporary impoundment within the existing dam footprint, at the toe of the dam; or
  - Due to the absence of a formal Ecological Water Requirement (EWR) determination and in considering the local catchment, it is not deemed entirely necessary or practical to undertake an EWR investigation. An adaptive approach for the water releases should rather be adopted. As stated in Section 3 of this report, the watercourse does not have any wetland or riparian characteristics and therefore its main function is to convey water for downstream users. As such, water releases from the dam are not required for ecological functioning of the watercourse but solely for the use by downstream users and releases from the dam must be adaptive to their needs;
  - A suitably qualified hydrologist must determine the volumes to be released for downstream users, in consultation with an engineer, to develop a water release strategy;
- Construction personnel and vehicles are only allowed within the planned construction footprint of all the proposed activities (dam wall expansion, pipe outlet and spillway construction), and may not indiscriminately traverse through the downgradient watercourse;
- Excavated soils from the dam wall must be stockpiled west of the dam and upgradient of the watercourse (Figure 11). This will limit the sedimentation of the downgradient watercourse. These stockpiles may not exceed 2m in height and must be revegetated if the stockpiles will be on site for longer than 30 days;
- The control measures regarding the use of concrete as per Table 5 must be adhered to;

Dam wall enlargement and pipeline outlet structure

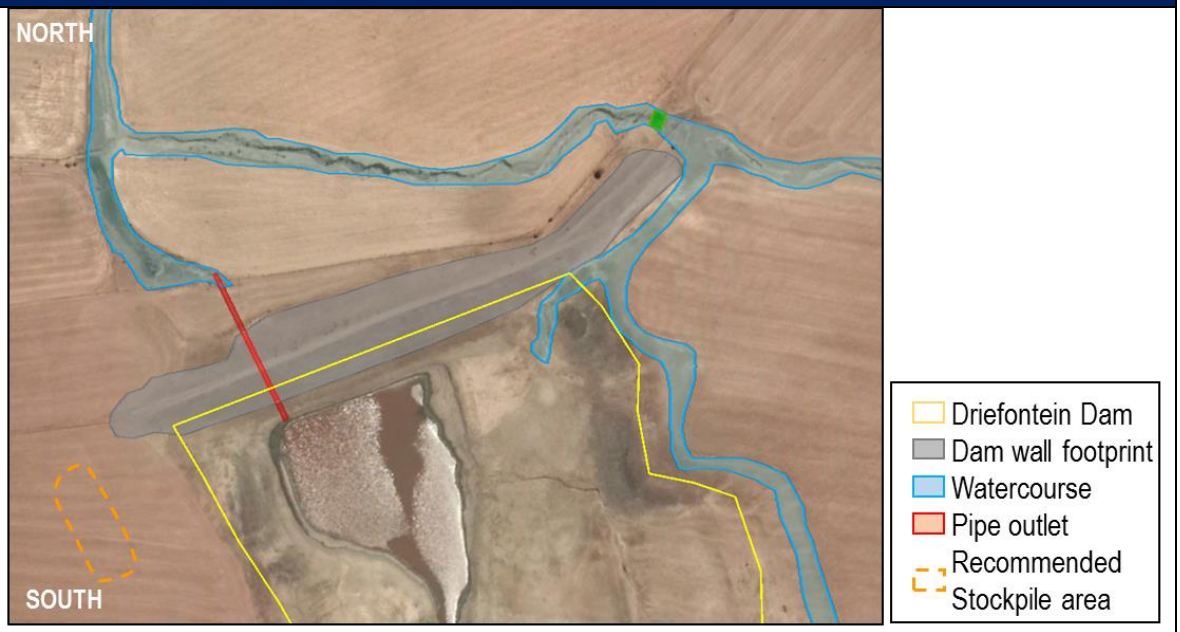


Figure 11: A map depicting the recommended stockpiling area for excavated soils.

- At the proposed outlet pipe, which will convey low flow from the dam into the downstream watercourse for use by downstream users, rocks must be placed, and vegetation established (if applicable considering the highly ephemeral nature of this system) to bind the soil of the bed and to prevent erosion (Figure 12). This will also diffuse flow and lower the velocity of water into the lower reach of the watercourse;

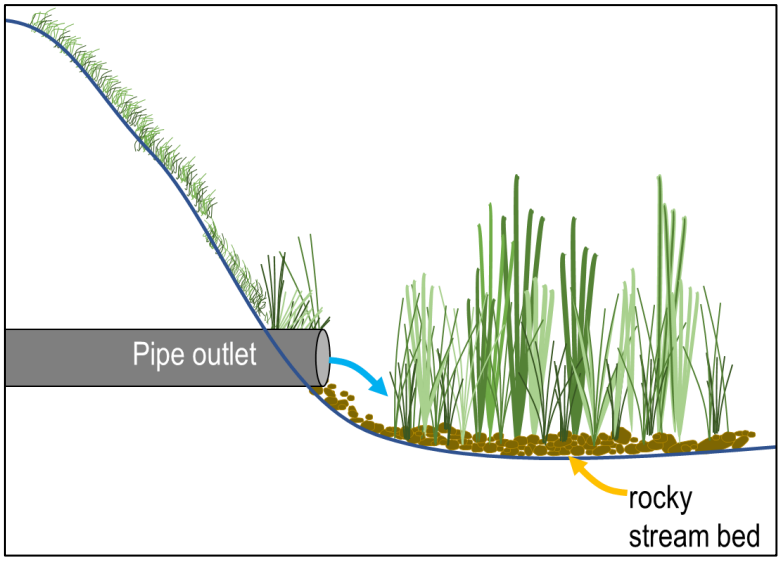


Figure 12: Illustration depicting the proposed outlet structure in the dam wall.

- The soil excavated during the construction activities for the pipe outlet must be used as backfill for the same area;
- Material excavated from the dam must also be stockpiled in the area west of the dam, which should subsequently be used as part of the earth fill material for the dam wall extension. Any imported material to build up the dam wall should also be stockpiled there, with stockpiles not exceeding a height of 2m;
- The slope of the dam wall may not exceed the maximum slope ratio of 3:1 (as per the dam wall design – Figures 3 and 4), and must be stabilised (on the northern embankment of the dam wall) during the construction phase with the use of a geotextile product such as hessian or Geojute, , which is to be staked to the surface of the dam wall slope while revegetation of the dam wall occurs;
- Previously removed soils (removed as part of the site preparation activities) should be used as topsoil for covering of the dam wall, specifically on the crest and the outer side;

Dam wall enlargement and pipeline outlet structure

- It should be ensured that the topsoil used are weed-free to limit the establishment of alien and invasive vegetation species.
- The proposed spillway placement must connect with the upstream and downstream reaches of the watercourse;
- Soils excavated to prepare the construction site for the construction of the new spillway must be stockpiled at least 10m from the new spillway locality, and upgradient of the watercourse it is associated with. This will prevent sedimentation of the watercourse;
- Control measures regarding the mixing and use of concrete as per Table 5 apply;
- As a precautionary principle, it should be ensured that the spillway (when in use) does not cause erosion of the downstream watercourse when water is flowing. As such, hard engineering structures such as gabions mattresses should be constructed at the base of the outlet to decrease the velocity of water and;
- As per the recommendation of the freshwater specialist (Watsan Africa, 2018), the spillway must not be higher than the full supply level of the dam. It should just be below that level to ensure overflow when the dam is at capacity, and be constructed in such a way that water will only flow through the spillway and not over the dam wall (Figure 13);
- The inlet and outlet of the new spillway must be of equal width (as opposed to the outlet being of a smaller width than the current spillway structure – Figure 4) to allow water to enter the spillway and diffusely flow through the spillway and into the downstream watercourse, without the flow being concentrated (Figure 13);

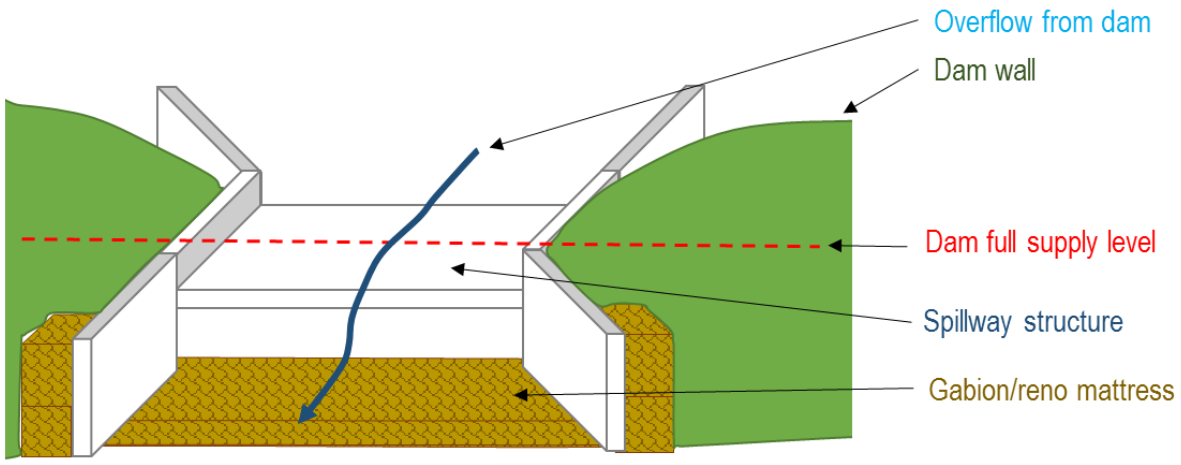


Figure 13: The spillway should be indented in the dam wall. Erosion control structures (gabions/reno-mattress or riprap) should be implemented at the outlet side of the spillway.

- Riprap or reno mattresses must be placed at the outlet side of the spillway to prevent erosion of the downstream watercourse; and
- The areas surrounding the constructed spillway must be backfilled with the material initially excavated and compacted after completion of work.

Timeframes / Project Phase	Planning and Construction Phase		Rehabilitation		Post Rehabilitation	
Parties Responsible:	Proponent	Project Manager		ECO	Contractor	

- Based on the outcome of the Botanical Assessment (PB Consult, 2018[1]) no natural vegetation remains on the site or its immediate surroundings, apart from a few hardy (and mostly weed) species on or just below the dam wall or within the uncultivated areas near the watercourses. The watercourse and the surrounding buffer area can only return to a more natural state if the entire landscape reverts to less farming and a more natural catchment. It is unlikely that this would occur, due to the vested agricultural interests on site. Revegetation of the dam wall and the watercourses are recommended to increase the overall ecological integrity of the site and to improve the stability of the earth dam wall, but this will be challenging given that the site is subjected to intensive agriculture over a long period of time (PB Consult, 2018). Despite this, it is recommended that the dam wall be revegetated after the construction activities, to stabilize the soils and prevent erosion of the dam wall. A graminoid seed mixture (such as the MayFord Fynbos Biomosome seed mixture) can be used for this purpose, as it will allow for quick establishment.

[1] PB Consult Environmental Management Services. 2018. Botanical Statement – Driefontein Dam, Proposed enlargement of an existing dam on portion 33 of the farm Rietvalley No. 367, near Ceres, Witzenberg Local Municipality, Western Cape Province. September 2018.

Dam wall enlargement and pipeline outlet structure
Additionally, drought tolerant unpalatable forb species must be established. The revegetated dam wall should be fenced off during the time of vegetation establishment, to prevent the grazing and trampling of livestock in this area which may hinder vegetation establishment; • All excavated/remaining soil must be stripped, or removed from site to a registered landfill site; • If erosion is apparent on the dam wall, pipe outlet or spillway; immediate measures such as strategic placement of hessian sheets or gum poles (Figure 14) or stabilisation with sandbags must be taken in order to prevent additional erosion from occurring.

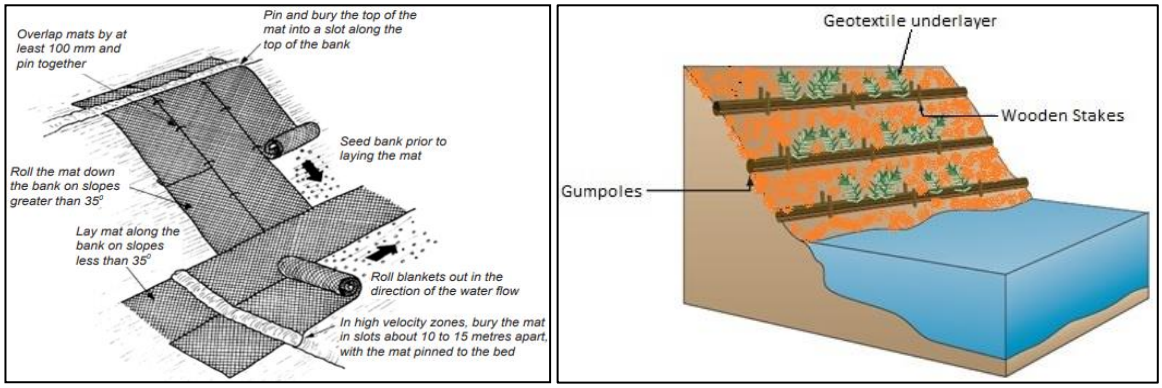


Figure 14: Use of hessian sheeting as a stabilisation method.

Timeframes / Project Phase	Planning and Construction Phase		Rehabilitation		Post Rehabilitation	
Parties Responsible:	Proponent				ECO	

• The dam wall, spillway and pipe outlet must be inspected biannually to ensure they are functioning optimally and specifically for any occurrence of erosion; • The spillway must be regularly inspected (specifically after heavy rainfall events) to ensure it is functioning optimally and specifically for any occurrence of erosion; • If erosion is noted at the pipe outlet structure, remediation activities as provided by a suitably qualified civil engineer in consultation with a freshwater ecologist should be implemented.

6 MONITORING PLAN

Prudent monitoring of the watercourse and buffer zones associated with the dam enlargement activities is of utmost importance, as this will ensure a continual flow of data, enabling all parties involved to accurately assess and manage water resource related progress and issues. To ensure the accurate gathering of data, the following techniques and guidelines should be followed. It is important to note that this report considers the aspects associated with the infrastructure (dam wall, pipe outlet and spillway) development. Furthermore, this WRMP does not provide long term monitoring requirement for the EWR as, when considering the watercourse and the local catchment, it not deemed entirely necessary/practical. Consideration must, however, be given to the downstream users and an adaptive management and monitoring protocol should be implemented. This monitoring plan therefore does provide recommendations for the management of downstream users.

Table 6 below illustrates data capturing for the monitoring plan. This monitoring plan must be implemented by a competent person and the findings are to be submitted to the responsible authority for evaluation. Due to the highly ephemeral nature of the watercourses and recommending that the construction phase be undertaken during the dry summer season, no surface water quality monitoring is recommended.

Table 6: Monitoring actions for the proposed dam enlargement activities and spillway construction activities.

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
Erosion Control	1. The entire length of the dam wall; 2. The pipe outlet structure within the dam wall; 3. The spillway located within the eastern extent of the dam wall.	Monitoring of erosion and sedimentation should occur during construction after every rainstorm and / flood, and for the operational phase, during maintenance activities to check for accumulation of debris, blockages, instabilities and erosion.	1. After every major rainstorm and / flood. 2. Monthly monitoring report compiled by the appointed ECO during the construction phase. Biannually for 3 years during the operational phase.	1. Brief indication of the method of assessment; 2. Assumptions and Limitations must be listed; 3. Photos and GPS point locations taken of existing erosion in the watercourse and buffer zones prior to and post construction and operation must be incorporated into the report. 4. Any erosion observed must be discussed in detail; 5. Map indicating where erosion is present; and 6. Recommended mitigation and remediation actions should be presented.	1. GPS 2. Camera 3. Field Form 4. Measuring tape
Alien Vegetation Control	1. The dam wall and spillway; 2. The upstream and downstream reach of the watercourses from the construction footprint areas.	1. Monitoring will be done during and after growing season; 2. Regrowth of alien vegetation should be monitored monthly during the construction phase; and 3. Monitoring must be done annually during the operational phase until indigenous basal cover has re-established.	1 Monthly monitoring report must be compiled by the appointed ECO during the construction phase and alien vegetation reported on at least quarterly. 2. During operational phase an annual report must be developed for three years following the completion of construction or until indigenous basal cover has re-established.	1. Provide a list of species occurring within the subject property; 2. Discuss the density of species; 3. Fixed point photo (Taking a photo at specific point within priority area to show effect of alien vegetation control.); and 4. Map indicating where alien vegetation is present.	1. GPS 2. Field Form 3. Camera

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
Downstream Water Use	Consultation with the downstream water users to ensure they are receiving sufficient water.	Engagement to be undertaken on a three yearly basis. The water released from the enlarged dam must be adjusted to ensure the applicant is getting their water allocation and to ensure downstream users have sufficient water.	Every three years	A short memorandum should be compiled to document engagement and proposed releases.	1. Paper 2. Pen

7 CONCLUSION AND RECOMMENDATIONS

This WRMP includes suitable management and monitoring measures to effectively manage, maintain and improve the ecological characteristics of the watercourse associated with the proposed dam enlargement activities. Rehabilitation impacts are applicable to areas where impact avoidance and minimisation are unavoidable and where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use. Rehabilitation cannot, however, be considered as the primary mitigation tool as even with significant resources and effort, rehabilitation usually does not lead to adequate replication of the diversity and complexity of the natural system.

The measures as set out in this report are deemed sufficient to guide the construction and necessary rehabilitation of all areas affected by the proposed dam enlargement activities, to a point where the watercourses will not be impacted any further and the downstream water users are not negatively impacted.

The information gathered through monitoring programs such as this, will assist in a better understanding of the ecology of the area and ensuring proactive management of risks to the receiving environment. All measures as stipulated in this report are considered to be in compliance with the conditions and aspects as stipulated in Government Notice 509 of 2016, as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as well as the National Environmental Management Act, 1998 (Act No. 107 of 1998).

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ANNEXURE A – PROJECT TEAM

Contact detail of the responsible people who will implement the MMP.

Table A1: Contact details of the responsible person who will implement the WRMP

Engineer	Sarel Bester Engineers	Tel: 023 312 2017 Email: lizbe@sbri.co.za
EAP Practitioner	EnviroAfrica cc	Tel: 021 851 1616 Email: inge@enviroafrica.co.za
ECO	Still to be appointed	Still to be appointed
Contractor	Still to be appointed	Still to be appointed
Consult who compiled WRMP	Scientific Aquatic Services Environmental CC	Phone: 011 616 7893 Email: christel@sasenvgroup.co.za

Scientific Aquatic Services Team
Stephen van Staden
SACNASP Pr. Sci. Nat. Reg No: 400134/05

Stephen van Staden completed an undergraduate degree in Zoology, Geography and Environmental Management. He then undertook an honours course in Aquatic health. In 2002 he began a Master's degree in environmental management, including his dissertation in aquatic resource management. Stephen built a career at a firm specialising in town planning development, after which he moved to a larger firm in late 2002 where he managed the monitoring division and acted as a specialist freshwater resource consultant and other environmental processes and applications. In 2003, Stephen started consulting independently specialising in water resource management. In addition to freshwater assessments, clients enquired about terrestrial ecological assessments. Stephen started working in the wetland consulting arena and has become recognised as a national expert combining science, engineering principles and an in-depth understanding of the legislative framework to provide turnkey advisory services. Stephen launched soil and land capability assessment and visual impact assessment services with other specifically qualified specialists. Stephen is registered by the SA RHP as an accredited biomonitoring specialist and is SACNASP registered in ecology. Stephen is a member of the Gauteng Wetland Forum, SASSO, LARSA and IAIA. Stephen has also attended the DWS training courses on the various Ecostatus models, as well as the implementation of Regulation 509 of 2016 and has attended the course Tools for Wetland Delineation and Assessment by Rhodes University and presented by Prof. F. Ellery, whom was instrumental in the development of the various wetland Ecostatus tools.

Kim Marais
SACNASP Pr. Sci. Nat. Reg No: 117137/17
Kim obtained her undergraduate BSc. at Wits University in Ecology, Environmental Science and Conservation (EEC). During the course of her undergraduate degree she was involved in microbiological and water quality assessments of several urban rivers as well as the Bruma lake in Johannesburg. In 2012 she obtained her BSc. Honours degree, at Wits University in Zoology and published her Honours thesis titled "A Comparative analysis of the diets of *Varanus albigularis* and *Varanus niloticus* in South Africa*"* in African Zoology, April 2014.

Upon graduation Kim worked as a Junior Environmental Assessment Practitioner for 2,5 years, working throughout South Africa and Uganda before joining the SAS team in 2015 as the lead Environmental Scientist and Manager of the Cape Town branch. Kim has extensive knowledge of the environmental legislation as well as faunal and freshwater ecology, undertaking various freshwater and faunal assessments as well as Water Use Licence Applications in the Western Cape and having completed the short course on tools for wetland assessment held by Prof. Fred Ellery at Rhodes University and a wetland and aquatic plant identification course by Dr. G van Grinkel. Kim is registered as a Professional Natural Scientist with SACNASP in the field of Environmental Science, is a member of the South African Wetland Society.

Christel du Preez

Christel holds a Masters degree in Environmental Sciences with a focus on urban wetlands and ecological processes. During her employment at Scientific Aquatic Services since 2016, she has been involved in a variety of projects, primarily focussing on the assessment of freshwater systems (wetland and riparian) within South Africa. Additionally, Christel has also attended a variety of recognised freshwater related training courses presented by a variety of universities in order to further her knowledge of current best practise as accepted by the relevant authorities. As a freshwater ecological consultant, she is involved in the compilation of ecological assessment studies, undertaking risk and impact assessments and mitigation measure development, client liaison and advising in terms of relevant legislation, and also contributes to GIS map development and analysis and the development of Landscape Plans.

Christel is based in the Scientific Aquatic Services Cape Town office but has undertaken freshwater ecological studies associated with a variety of assessment spheres, within a variety of provinces in South Africa.

ANNEXURE B – LEGAL REQUIREMENTS

The sections below present each legislative document and the aspects, which are pertinent to water resource management including the rehabilitation of disturbed areas.

The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive normalization of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
The National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA)	The National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
The National Water Act, 1998 (Act No. 36 of 1998) (NWA)	The National Water Act, 1998 (Act No. 36 of 1998) (NWA) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)	Amendments to regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) ensures that landowners are legally responsible for the control of invasive alien plants on their properties. The CARA legislation divides alien plants into weeds and invader plants, with weeds regarded as alien plants with no known useful economic purpose, while invader plants may serve useful purposes as ornamentals, as sources of timber and may provide many other benefits, despite their aggressive nature.
National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004) (NEMBA)	The objectives of this act are (within the framework of NEMA) to provide for: ➢ The management and conservation of biological diversity within the Republic of South Africa and of the components of such diversity; ➢ The use of indigenous biological resources in a sustainable manner; ➢ The fair and equitable sharing among stakeholders of the benefits arising from bio prospecting involving indigenous biological resources; ➢ To give effect to ratify international agreements relating to biodiversity which are binding to the Republic; ➢ To provide for cooperative governance in biodiversity management and conservation; and ➢ To provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act. This act alludes to the fact that management of biodiversity must take place to ensure that the biodiversity of the surrounding areas are not negatively impacted upon, by any activity being undertaken, in order to ensure the fair and equitable sharing among stakeholders of the benefits arising from indigenous biological resources. Furthermore, a person may not carry out a restricted activity involving either: a) A specimen of a listed threatened or protected species;

	b) Specimens of an alien species; or c) A specimen of a listed invasive species without a permit.
National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004) (Alien and Invasive Species Regulations, Notice number 864 of 29 July 2017 in Government Gazette 40166)	NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. In terms of alien and invasive species. This act in terms of alien and invasive species aims to: ➢ Prevent the unauthorized introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur, ➢ Manage and control alien and invasive species, to prevent or minimize harm to the environment and biodiversity; and ➢ Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats. Alien species are defined, in terms of the National Environmental Management: Biodiversity Act, 2004 (Act no 10 of 2004) as: (a) A species that is not an indigenous species; or (b) An indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention. Categories according to NEMBA (Alien and Invasive Species Regulations, 2017): ➢ **Category 1a**: Invasive species that require compulsory control; ➢ **Category 1b**: Invasive species that require control by means of an invasive species management programme; ➢ **Category 2**: Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread; and ➢ **Category 3**: Ornamentally used plants that may no longer be planted.

ANNEXURE C – ALIEN FLORAL SPECIES CONTROL

The dominant alien floral species are predominantly associated with agricultural activities and should be identified by the ECO prior to the commencement of construction. An Alien and Invasive Plant (AIP) species control program should be developed for control of these species. The basic principles of a control program are presented below.

AIP control programs must include the following three phases (Campbell, 2000):

- Initial Control Phase: The existing population must be drastically reduced.
- Follow-up Control Phase: Control of coppice regrowth, root suckers and seedlings.
- Maintenance Phase: Low AIP density and numbers with a low annual control cost. During this phase, AIP is no longer considered a problem. It is important to monitor the situation of infestation during the growing season of the plants as to avoid re-infestation and to keep the control cost at a minimum.

Control Methods

To control AIP successfully, one must use a number of control methods. When using herbicides, the recommendations that are stated on the label of the specific product must be adhered to (Campbell, 2000).

Integrated Control Strategies

A combination of the most suitable and effective methods should be used to control a specific species in a particular situation. The following selection of appropriate control methods should take into account the following (Campbell, 2000):

- Species of alien and invasive weeds;
- The type of growth form (i.e. seedling, sapling, shrub or tree);
- The density of infestation;
- The terrain where the infestation is present;
- Rehabilitation requirements
- What resources are available;
- Speed or urgency that the control of the infestation requires – physical removal and biological control will take longer than chemical control.

- **Initial control phase**
  - **Hand pull:** saplings and seedlings must be pulled out by hand and regrowth must be controlled with herbicide (Campbell, 2000). All guidelines for the application of herbicide listed in this Rehabilitation Plan must be adhered to;
  - **Frill:** a cane knife is used to cut frills into the stem. Herbicide must be applied (1-2 mm per frill) and must be done in 30min after frilling;
  - **Soil application:** herbicide is applied to the soil and taken up by the plants roots

Methods for controlling Coppice, saplings and seedlings:

AIP infestation can comprise different growth forms, and some of the growth forms cannot be utilised. These plants need to be cut with a brush cutter and the stumps treated with herbicide that was mixed with a dye to show where treatment was done (however stumps must not be removed as they significantly contribute to soil stability).

Integrated strategies to control alien shrubs	**Alien shrubs that are less than 1 m in height**: • A foliar application must be used in the general control of alien shrubs that are less than 1 m in height. • Registered herbicide must be used and where grass is present, selective broadleaf herbicide that will not impact on the grass. When grass is not present, a selective or non-selective registered herbicide must be used. • For dense seedling growth that is of uniform height a flat fan nozzle with knapsack must be used. • For seedling growth that is of uneven height, root suckers, short saplings, and coppice growth a cone nozzle must be used. **Alien shrubs that are taller than 1 m (Campbell, 2000):** • Shrubs that are taller than 1 m must be reduced cutting using brush cutter or cane knives. • When large areas with dense growth are present a tractor mounted gyro-motor must be used. • For low – medium density infestation a cut stump treatment must be used. Stumps that are must be treated immediately. The best time to treat is during the active growing season. • Medium – High-density infestations must be slashed to knee height so that the plants can coppice. The best time to do this is during the winter months as the plants are dormant and the coppice will come out during the active growing period after good rain. The coppice must be sprayed when enough leaves are present to absorb the herbicide, and a dye must also be used to indicate treated areas. • Pathways must be cut to increase exposed areas so that a foliar spray treatment is more effective without compromising the indigenous vegetation. • Mechanical uprooting of shrubs is not always a preferred method because the soil is disturbed and this increases the risk of alien vegetation infestation. This activity also promotes erosion, and soil loss will occur. Mechanical uprooting can be done in areas that have a dense grass cover, as the roots of the grass will keep the soil intact. After uprooting the soil must be levelled and if grass seeds are present, some grass seeds must be placed on these areas to promote grass regrowth.
Integrated strategies to control alien herbs (Campbell, 2000)	**Chemical Control:** ➢ Alien herbs are soft non-woody species. ➢ Some of the alien herbs have registered herbicides to control them and are either pre- or post-emergent herbicides. ➢ When alien herbs are associated with woody alien plant, herbicides that are registered to control woody alien species are often used to control alien herbs. Alternatively, glyphosate can be used as it is often registered for both alien herb and alien woody species.

Follow up control (Campbell, 2000)

Introduction

Follow-up control is essential to control alien saplings, seedlings and coppice regrowth to achieve and sustain the progress that was made with the initial control work in the initial phase. If the follow-up control phase is neglected, the alien infestation will become worse and denser than before the eradication process started. It is essential to sustain the follow-up phase because it will prevent the suppression of alien seedlings on planted grasses.

Follow up treatment control must use the following methods:

- Chemical control methods: Only use registered herbicides to control any alien species. Instruction on the herbicide labels must be followed carefully.
- Mechanical control methods
- Biological control methods that are available.

Control methods for dense regrowth: After initial control operations dense regrowth may arise as new regrowth will sprout in the form of stump coppice, seedlings and root suckers.	
Chemical control / foliar application:	• Plants that are less than 1 m in height must be controlled by foliar application. • Dense seedling growth must be controlled with knapsack sprayers with a flat fan nozzle. • If grass is present, the use of a registered selective herbicide must be used so as not to harm the grass, and if grass is not present a registered non-selective or selective herbicide can be used. • Suitable dye must be used at all times to limit over- or under spray of areas.
Mechanical control:	• Areas with dense seedlings should not be uprooted or hoed out, as these areas will result in soil disturbance and will in return promote flushes and germination of alien seedling growth. • When stump density is high, plants should not be cut. This is impractical, and there will be many untreated stumps. Instead cut the stumps in dense areas with brush cutters and remove the top growth. Stumps will start to coppice, and foliar spay must be used to control the coppice regrowth.
Control methods for low-medium density regrowth: Neglecting to control low-medium density regrowth will result in densification and spreading as well as additional control costs.	
Chemical control:	• Cut stump method must be used and stumps must be cut up to a height of 15 cm and must be sprayed within an hour of cutting the plant with a registered herbicide. Herbicide must be applied with knapsack sprayers set to low pressure, using cone nozzles, e.g. TG1 or CE1. Hand sprayers can also be used to apply herbicide. A suitable dye must be used to ensure all stumps are treated. Only the cut surface must be treated with herbicide, and the side of the stumps must not be treated. • Foliar spray can be applied to regrowth that is up to the height of 1m. Herbicide must be applied using knapsacks with solid cone nozzle and must be mixed with a suitable dye to prevent over- or under spraying of treated areas.
Mechanical control:	• Seedlings can be removed from wet soil by hand pulling. Gloves can be used for hand protection during the operation.