Freshwater Rehabilitation, Maintenance and Management Plan (FRMMP):

Calcutta, Farm 29, Stellenbosch, Western Cape

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Glossary[1]

Alluvial soil: A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.

Biodiversity: The number and variety of living organisms on earth, the millions of plants, animals 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, in order to reduce the impact of adjacent land uses on the wetland or riparian area.

Catchment: The area contributing to runoff at a particular point in a river system.

Chroma: The relative purity of the spectral colour which decreases with increasing greyness.

Critical Biodiversity Areas: Areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services.

Delineation (of a wetland): To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.

Ecoregion: A recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region.

Ephemeral stream: A stream that has transitory or short-lived flow.

Groundwater: Subsurface water in the saturated zone below the water table.

Habitat: The natural home of species of plants or animals.

Hue (of colour): The dominant spectral colour.

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.

Hydrophytes: Also called obligate wetland plants - plants that are physiologically bound to water where at least part of the generative cycle takes place in the water or on the surface.

Halophytes: Salt tolerant plants.

Helophytes: Also called facultative wetland plants - essentially terrestrial plants of which the photosynthetically active parts tolerate long periods of submergence or floating on water.

[1] As provided by DWA (2005) and WRC Report No. TT 434/09.

Indicator species: A species whose presence in an ecosystem is indicative of particular conditions (such as saline soils or acidic waters).

Intermittent flow: Flows only for short periods.

Macrophyte: A large plant - in wetland studies usually a large plant growing in shallow water or waterlogged soils.

Perennial: Permanent - persisting from year to year.

Riparian area delineation: The determination and marking of the boundary of the riparian area.

Riparian habitat: Includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils (deposited by the current river system) and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

Shrub: A shrub is a small to medium-sized woody plant.

Temporary zone: The zone that is alternately inundated and exposed.

Terrain unit morphological classes: Areas of the land surface with homogenous form and slope.

Watercourse (NWA):

(a) A river or spring;
(b) A natural channel in which water flows regularly or intermediately;
(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 in the Gazette, declare to be a watercourse.

Water table: The upper surface of groundwater or that level below which the soil is saturated with water. The water table feeds base flow to the river channel network when the river channel is in contact with the water table.

Wetland: An area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

Acronyms

CCT	City of Cape Town
CBA	Critical Biodiversity Area
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
FEPA	Freshwater Ecological Support Area
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
IHIA	Intermediate Habitat Integrity Assessment
MAP	Mean Annual Participation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
OESA	Other Ecological Support Area
PES	Present Ecological State
QDS	Quarter Degree Square

REC Recommended Ecological Category
SANBI South African National Biodiversity Institute
Sub-WMA Sub - Water Management Area
VEGRAI Riparian Vegetation Response Assessment Index
WCBF Western Cape Biodiversity Framework
WMA Water Management Area
WUL Water Use Licence

Specialist Details and Experience

Joshua Gericke (Pr.Sci.Nat. 117997)

Joshua holds a Bachelor of Science Honours degree in Environmental Management from the University of Cape Town and graduated in 2008. He has completed several short courses in freshwater, estuarine and coastal resource management and in identification of freshwater and marine fish, birds and plants. He has more than 8 years of experience in management of freshwater, estuarine and coastal systems with the City of Cape Town. He has also consulted periodically on topics related to freshwater, estuarine and coastal ecology and management since 2010, and in 2017 began consulting full time.

Jocelyn Anderson (Cand.Sci.Nat. 120338)

Jocelyn graduated from the University of Cape Town with a Bachelor of Science degree in Applied Biology, and Ecology & Evolution. She later went on to complete her honours in Environmental Management from the University of South Africa. Jocelyn has just over two years of experience working in the nature conservation field where she has honed her bird and plant identification skills. Jocelyn began consulting part-time in the beginning of 2018 and has working experience in wetland assessments, wetland delineations, and risk assessments.

Natasha van de Haar (Pr.Sci.Nat. 400229)

Natasha is a registered Professional Natural Scientist (Pr.Sci.Nat) with the South African Council for Natural Scientific Professions (SACNASP). She also holds a Masters Degree in Science (M.Sc.) in the field of Botany. Over the course of Natasha's career, she completed a number of floral identification short courses and also obtained a certificate of competence for wetland assessments from Rhodes University. She is also a member of the South African Wetland Society, Botanical Society of SA as well as the Western Cape Wetlands Forum.

Her career kicked off as a field ecologist in 2009, focusing on floral biodiversity and ecological functioning, with special mention of wetland ecology and functioning within South Africa (all provinces). She further worked as a specialist project member in Mauritius, Lesotho and Ghana. During the course of her career she obtained extensive experience in conducting terrestrial as well as wetland related surveys in the mining, residential and infrastructure development industries as well as development of several alternative energy facilities. Natasha also gained experience in Biodiversity Offset Initiatives as well as RDL/protected plant permit applications. Presently her main focus is wetland assessments including delineation as well as present ecological state and function assessments.

1 Introduction

EnviroSwift Western Cape has been appointed to compile a Freshwater Rehabilitation, Maintenance and Management Plan (FRMMP) for Calcutta Farm 29, Stellenbosch (hereafter referred to as the proposed site) for the proposed establishment of a memorial park. A Freshwater Assessment of Farm 29 has been completed by EnviroSwift Western Cape (2018, updated 2019) in relation to the proposed development. Several watercourses were identified and delineated including five depression wetlands and an ephemeral drainage line fed by these wetlands (refer to Figure 1). The majority of the proposed development does not encroach on any of the watercourses identified but it does include construction and maintenance of two pedestrian bridges and a low water 'drift' bridge constructed from grass blocks. The remainder of the proposed development falls outside of the buffer zone and includes installation of a large graveyard, an office and maintenance yard, a chapel, staff accommodation and visitor facilities, municipal water, sewage and electrical services, a stormwater retention reservoir (used for irrigation and augmented by a proposed borehole if needed) and a landscaped parkland area (refer to Figure 2). Note that the proposed access road traverses the artificial drainage channel and a culvert crossing is indicated in the proposed layout in Figure 2. It is however proposed in the rehabilitation plan that the artificial drainage channel is closed, and the culvert would therefore become unnecessary.

The aim of the FRMMP is to ensure that the Recommended Ecological Category for each watercourse as defined in the EnviroSwift Western Cape (2018) freshwater impact assessment (FIA) is attained through rehabilitation during the construction phase and is maintained throughout the operational phase. Broad mitigation measures were included in the FIA with similar objectives. This FRMMP does not replace these mitigation measures, but compliments them by providing detail beyond the scope of the FIA for watercourse and buffer rehabilitation and operational phase infrastructure and ecological maintenance activities within the regulated zone that may impact the watercourses and therefore require authorisation in terms of the National Environmental Management Act (NEMA) and/or the National Water Act (NWA). Implementation of this FRMMP should be included among the conditions of the Environmental Authorisation and Water Use Licence, if granted.

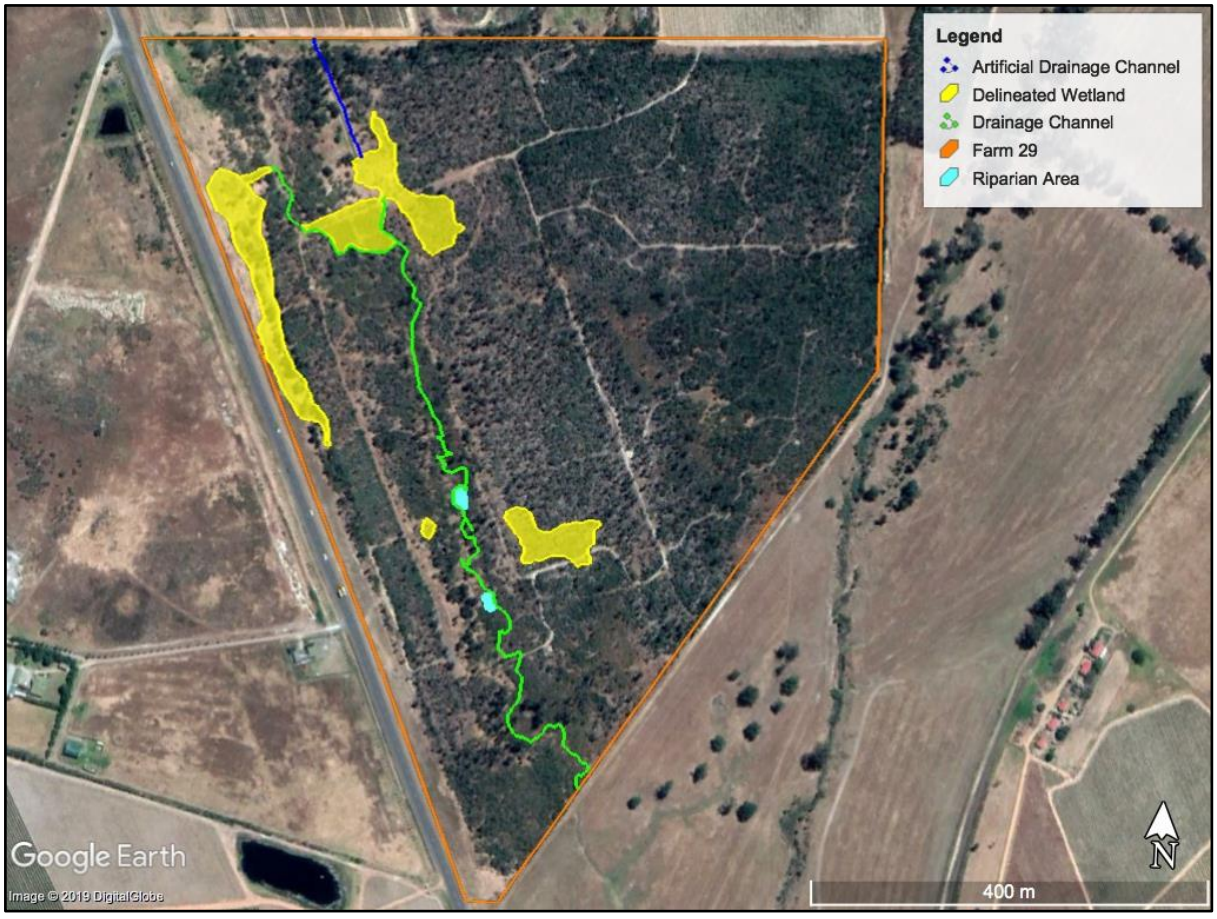

Figure 1: Watercourses delineated within the proposed site (Google Earth, 2019).

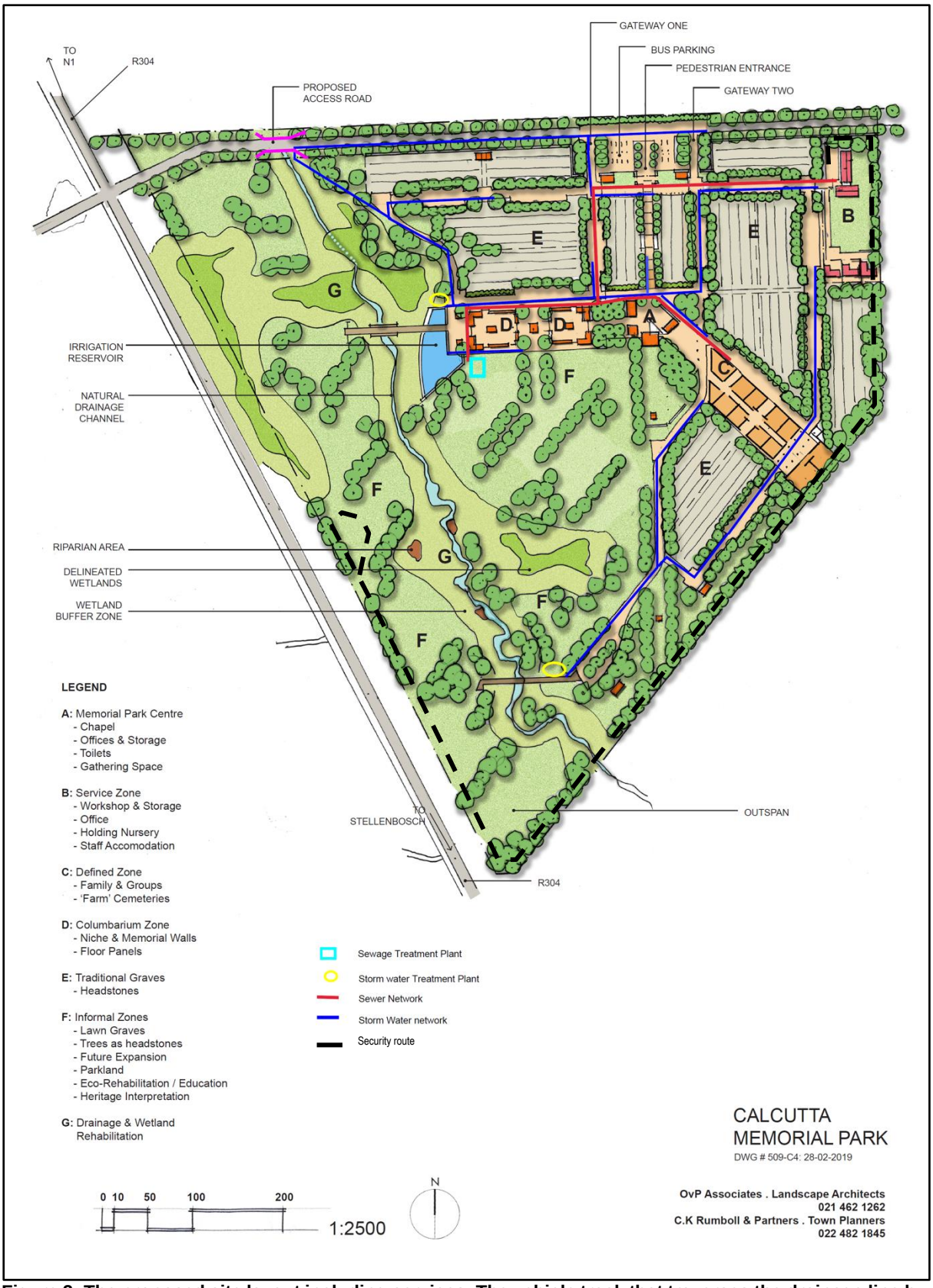

Figure 2: The proposed site layout including services. The vehicle track that traverses the drainage line by means of a grass-block drift is indicated by the black dashed line. The two pedestrian bridges that cross the drainage line are indicated in grey. Note that the artificial drainage line is not distinguished from the natural watercourses on the layout and that the culvert indicated under the proposed entrance road will not be necessary.

2 Rehabilitation Plan

The purpose of the Rehabilitation Plan is to provide, in detail, the steps required to increase the PES of the watercourses from the current categories of E (mosaic of depression wetlands) and D (drainage line) to the Recommended Ecological Category (REC) of C for all watercourses (EnviroSwift Western Cape, 2018 updated 2019). Implementation of this rehabilitation plan is responsibility of the Stellenbosch Local Municipality. The municipality may employ suitable contractors to implement the rehabilitation plan in part or whole, but the Municipality maintains responsibility for ensuring that the contractors act in accordance with the rehabilitation plan.

2.1 Preparation for Rehabilitation

2.1.1 Appointment of Relevant Contractor(s) and Specialists

Role Player	Qualifications	Mandate	Timing
Implementation contractor (optional)	Landscaping contractor with experience in aquatic rehabilitation projects.	○ Implement the portions of the rehabilitation plan that the Municipality elects not to implement themselves, under the guidance of the ECO and Freshwater Specialist.	Appoint the contractor (if required) at least 2 months before the construction phase begins, such that the contractor is able to arrange procurement of plants and materials to begin site work at the commencement of the construction phase.
Environmental Control Officer (ECO)	The ECO must be a registered member of the IAIA.	○ Undertake daily inspections of the watercourses and buffers. ○ Monitor compliance with the rehabilitation plan and note all instances of non-compliance in a compliance log. ○ Address non-compliance issues by providing guidance on ○ Undertake all other tasks assigned elsewhere in this rehabilitation plan.	The ECO must be appointed prior to commencement of the construction phase for duration thereof.
Freshwater Specialist	The Freshwater Specialist must be SACNASP registered and have experience in freshwater rehabilitation	○ Provide specialist input into the procurement of plants and materials for implementation of the rehabilitation plan. ○ Undertake an inspection and provide specialist input on the first day of rehabilitation. ○ Undertake monthly inspections during rehabilitation, and 6-monthly inspections thereafter for the duration of the construction phase. ○ Assess vegetation cover, erosion and invasive species cover in the rehabilitated areas at each 6-monthly visit, post rehabilitation and provide specific guidance where needed for successful rehabilitation. ○ Note all other incidents or emerging threats to rehabilitation success and provide specific guidance where needed. ○ Provide specialist guidance upon request from the ECO or implementer. ○ Undertake all other tasks specifically assigned elsewhere in this rehabilitation plan.	The freshwater specialist must be appointed prior to initial procurement of plants and materials so that guidance may be given on the appropriateness of the plants and materials to be procured.

		○ Undertake baseline monitoring of the proposed site upon completion of the rehabilitation including application of all monitoring protocols included in the Maintenance Management Plan.	

2.1.2 Authorisations and Site Documentation

The Environmental Authorisation, Water Use Authorisation and this FRMMP must be available on site in hard copy prior to the commencement of rehabilitation activities, for the construction and operational phases of the development. The only exception is alien invasive species control which does not require an authorisation and may be undertaken immediately in terms of the National Environmental Management Biodiversity Act (NEMBA) (Alien and Invasive Species Regulations, 2014).

2.2 Rehabilitation of Watercourses and Buffer Zones

2.2.1 Access and Demarcation

- Demarcate the outer boundary of the buffer areas by means of danger tape, fencing or a similar barrier prior to initiating any construction or rehabilitation work within the proposed site, thereby enclosing the watercourses and buffers and setting them apart for rehabilitation.

- Demarcate the location and boundary of the vehicle and pedestrian tracks, grass-block drift, pedestrian bridges and perimeter fence within the demarcated rehabilitation area.

- Only allow access to demarcated rehabilitation area for the purpose of conducting rehabilitation work and for construction of the three tracks (along with their pedestrian bridges and grass blocked drift) and perimeter fence.

- Ensure that vehicles remain outside of the designated area, except were required for construction of the infrastructure within the demarcated rehabilitation area. Vehicles within the demarcated rehabilitation area must remain only on the three tracks as indicated in the layout plan above (Figure 2). The two pedestrian tracks may be increased to a maximum of 3m in width to provide vehicle access during construction of the bridges and pathways if required.

- Stockpiles related to construction of the infrastructure that falls within the demarcated rehabilitation area may be placed within the footprint of such infrastructure, but ensure that no stockpiling of any other material takes place within these footprints, and that no stockpiling of any material takes place outside of the infrastructure footprints, within the rehabilitation area.

- Fences may be removed after the construction phase is complete, but signage designating the rehabilitation area where the three tracks enter it must not be removed.

2.2.2 Alien Invasive Species Removal and Control Methods

The entire proposed site is currently dominated by dense stands of woody invasive alien species such as *Acacia saligna* (Category 1b) and *Eucalyptus* species (Category 1b), and alien annual grasses, particularly *Lolium perenne* (Category 2) (NEMBA Alien and Invasive Species List, 2016). This has resulted in almost complete loss of indigenous wetland vegetation. Category 1b species require compulsory control and must be removed. Alien invasive species must be controlled or eradicated across the entire proposed site, not just the watercourses and buffers, to prevent seed dispersal into the rehabilitation areas.

Numida meleagris (Helmeted guineafowl) (Category 3) (NEMBA Alien and Invasive Species List, 2016) were not encountered within the proposed site, however *N. meleagris* was noted on the adjacent property. While these birds are native to South Africa, they are not native to the relevant vegetation type

and are considered extra-limital. Seed dispersal mechanisms in this vegetation type are adapted to the feeding habits of the native *Pternistis capensis* (Cape Spurfowl) which cannot dig as deeply as *N. meleagris* and can therefore not reach many of the seeds and bulbs that *N. meleagris* routinely feeds on. *N. meleagris* may therefore have a severe negative impact on the success of rehabilitation through seeding and of the successful reseeding of species planted (Memani et. al. 2016). *N. meleagris* also frequently dig up young plants, but the impact thereof on rehabilitation success is limited. Revegetation is therefore to be undertaken through planting, rather than seeding, and *N. meleagris* numbers within the rehabilitation areas are to be controlled.

Initial and follow-up control measures to be implemented by the proponent are presented in detail in Table 1 below.

Table 1: Invasive species removal and control measures.

Initial Control				
Activity	**Details**	**Aim**	**Frequency and Timing**	**Risk and Comments**
Clearing of all *Acacia saligna, Eucalyptus* spp. and any other woody alien invasive plant species within the proposed site.	All mature *Acacia* and *Eucalyptus* spp. must be felled, leaving stems of no more than 20cm in height. Stumps must be treated within 5 minutes of felling with a herbicide containing Triclopyr as the active ingredient in the manufacturer's recommended mix (usually 3% for Triclopyr) with water and an indicator dye only. No diesel or other substances may be added. The herbicide may be applied by painting or spraying the stump, but in either case it must be applied without spillage. *Acacia saligna* seedlings must be hand pulled and no herbicide is needed. Young trees must be removed by hand-pulling, tree popping, or by felling with loppers, hand saws or chainsaws, and stump-treated as for mature trees if complete removal is not possible. Felled invasive trees are to be stored for use in erosion control, or once erosion control is measure are in place, may be chipped for use in the parkland.	Eradicate all *Acacia saligna, Eucalyptus* spp. and other woody alien invasive species from the proposed site.	Initial clearing is to take place in year 1 during the summer months (November - April). Herbicide application should not take place when rain is predicted within 24 hours as rain may reduce herbicide effectiveness and may wash herbicide onto other plants. Follow-up clearing should take place quarterly, after the initial clearing has been completed, and continue throughout the construction period and indefinitely thereafter (refer to the MMP below) in accordance with the same methodology as for the initial clearing.	Herbicide spillage is the only significant risk, and it is limited in scale to the spillage site and immediate surrounds. Wetlands and buffer zones must be physically demarcated by appropriate means prior to commencement of alien clearing. Vehicles must remain on existing roads and must not enter the buffer zone unless necessary for alien clearing purposes under the guidance of an ECO present on site.
Clearing of *Lolium perenne,* and other identified alien invasive grasses and herbaceous species as deemed by the ECO.	Clear each invasive species starting when the emergence is first noted and complete the clearing operation prior to seed setting of each species. Mowing of annual grasses between June and September or the application of a herbicide with the active ingredient Glyphosate may be used in the terrestrial areas only. *Lolium perenne* and herbaceous aliens may be uprooted by hand if possible, but if not possible given time constraints once flowering commences, herbaceous aliens may be cut using a brush cutter.	Control invasive annual grass species and avoid seed setting of any herbaceous aliens.	Initial clearing is to take place in year 1 during June – September before seed setting. Inspect all wetlands and buffer zone once per month from September to February of the year 2 after the initial clearing and commence clearing as soon as the first emergence of any annual grasses and herbaceous alien species are noted, or when cover is 5% or more of the total area.	Some damage to indigenous vegetation is possible through trampling and particularly through mowing or brush cutting should this be required, but this can be limited by focussing the clearing effort in the first year of rehabilitation before planting/seeding begins.
Control of N.*meleagris* within	Should *N. meleagris* be found to be feeding within the wetlands	Limit the impact of *N. meleagris*	*N. meleagris* maintain fixed daily and annual	Ensure that any methods employed are

the demarcated rehabilitation area	and buffer area in numbers exceeding 2 birds at any one time, then the excess birds should be trapped or shot in accordance with the provisions of the Western Cape Nature Conservation Ordinance. Note that trapping and shooting of game birds with prohibited hunting methods such as air rifles or cage traps requires application for a specific permit from Cape Nature in terms of the Ordinance, and use of non-prohibited methods requires a hunting permit for anyone other than the landowner.	feeding on the seedbank of the wetlands and buffer.	rhythms. For this reason, they can be expected to be feeding within the wetland and buffer during the early to mid-morning and through the mid to late afternoon. They will also be easier to observe from October to June before the flocks disperse into breeding pairs. This should continue until 80% indigenous vegetation cover has been achieved in the wetland and buffer.	selective and will not negatively impact the populations of birds indigenous to the site. Traps must be checked twice daily in the late morning and evening.

2.2.3 Infilling of the Artificial Drainage Channel

A key measure in the rehabilitation plan of the wetlands and drainage line is the infilling of the artificial drainage channel which drains in a northerly direction from the larger wetlands, against the slope. At present the artificial drainage channel significantly impacts upon watercourse hydrology, draining the northerly wetlands and reducing flow and residency time of water within the wetlands and natural drainage line. Refer to Table 2.

Table 2: Earthwork activities associated with the artificial drainage channel

Activity	Details	Aim	Frequency and Timing	Risk and Comments
Infilling of the artificial drainage channel.	Prior to infilling the artificial drainage channel, sediment fences must be installed at the southern extreme of the artificial drainage channel where it meets the wetlands. Infilling of the artificial drainage channel must be done using spades where the channel falls within the buffer and wetland. A digger loader or other heavy machinery may only be used outside of the buffer. Fill material used for the artificial drainage channel must be clean soil taken from areas levelled or landscaped within the proposed site. Infill the artificial drainage channel starting from the wetland working northwards toward the boundary of the proposed site such that if insufficient soil is available, for the entire artificial drainage channel to be filled, at least the area within the wetland and buffer are filled and drainage away from the wetlands is considerably reduced. The fill material must be compacted.	To reduce the artificial draining of the associated wetlands.	Infilling should be done during the summer months in the first year of the construction phase (October to March).	Sedimentation of the wetlands and stream is possible as the infilling occurs slightly upslope.
Erosion control	Rrip all compacted soil within the infilled drainage channel and any incidentally compacted areas surrounding it to a depth of 30cm. Plant all ripped areas with appropriate vegetation (as per	To promote infiltration of precipitation and reduce erosion.	During the first year of the construction phase in the dry summer months (October to March).	Sedimentation of the wetlands. Ensure that sediment fences are installed at the boundary of all cleared areas.

	2.2.5 below) as a first priority for erosion control purposes.			

2.2.4 Drainage Line Shaping and Erosion Control

The ephemeral drainage line was found to have been subjected to substantial unnatural erosion related to the presence of alien invasive species, which has resulted in an almost complete loss of indigenous catchment and streamside vegetation which would ordinarily have stabilised the bed and banks of the drainage line and reduced storm peak flows by increasing surface roughness within the catchment. In addition, reduced surface roughness from site clearing activities during the construction phase may result in additional runoff and increased storm peak flows and therefore increase erosion further.

The drainage line presently has very steep erodible banks, resulting in a strongly u-shaped channel with very little vegetation present. This has further increased flow away from the wetlands, thereby decreasing residence time of water within the wetlands. The channel has fortunately not been straightened and retains a normal meandering path.

It is therefore the proposed that the channel be reshaped towards a more natural profile along the entire drainage line, and that the surface roughness be increased by planting in accordance with the measure laid out in Table 3 below. The latter will also help to reduce erosion that occur as a result of bank destabilisation as a result of reshaping.

Table 3: Earthwork activities and erosion control measures associated with the drainage line

Activity	Details	Aim	Frequency and Timing	Risk and Comments
Drainage line re-shaping	Channel banks must be re-sloped to a slope of 1:5 such that the channel profile forms a wide V-shape. All material removed from the banks is to be used to fill in the centre of the water course to assist in forming the correct profile. Soil is to be compacted by hand across the entire channel. Ensure that no straightening of the channel occurs and that the current position of the watercourses does not change. Re-shaping must be done by hand using spades, and no vehicles or machinery is to be used.	Return the channel to a more natural profile to increase attenuation.	Re-shaping should be conducted within the first year of the construction phase, during the dry summer months (October to March).	Little indigenous vegetation exists, so re-shaping will not result in significant habitat damage.
Erosion control	Plant the reshaped banks of the drainage line as per section 2.2.5 below to increase surface roughness and bank stability. Planting must take place right across the reshaped channel. Where significant erosion occurs during the first winter after reshaping and planting, geotextile blankets must be laid, with small holes cut to allow plants to protrude. Geotextile fabrics must be staked to the bank in rows across the channel at 50cm intervals, with the rows also 50cm apart. use stakes cut from	Stabilise the reshaped banks and reduce erosion.	Planting must take place during the first April after reshaping.	None.

	previously felled alien vegetation of at least 20mm thick and at least 30cm long with at least 20cm driven into the underlying soil.			

2.2.5 Re-vegetation

2.2.5.1 Wetland revegetation

A preliminary species list for re-vegetation of the wetland mosaic has been compiled (refer to Appendix 1), but this not exhaustive. While limited planting will take place for the purpose of erosion control in the drainage line and for establishment of the buffer, the wetlands must not be planted until two years after alien clearing has taken place to allow species dormant within the seed bank to re-emerge. After two years (or sooner if advised by a SACNASP botanical specialist), spring species lists are to be compiled by a SACNASP registered Freshwater Specialist or Botanist and recommendations for additional planting can then be supplied in order to reach adequate vegetation cover within these portions of the wetlands. Seed may then be harvested and seedlings grown in a nursery for later planting. This ensures that the correct species and genetic material is used to rehabilitate the wetlands. The practicality of this approach can only be assessed two years after initial alien clearing.

2.2.5.2 Planting for erosion control

Planting must be undertaken in the affected areas as soon as possible after completion of alien clearing and any form of soil disturbance within the watercourses, buffer and surrounding parkland so as to minimise the likelihood of erosion from these areas, and to increase surface roughness as soon as possible. In addition, planting must be undertaken in April, just before the winter rainfall season start so as to minimise or avoid the need for watering.

The species listed for use in erosion control are all wind pollenated cosmopolitan species with wind dispersed seeds. While these species are indigenous to wetlands within the local vegetation type, they share genetic material over a great range and those present within the vegetation type do not therefore form a distinct genetic group. The advantage thereof is that these plants may be purchased from a good nursery such as the Cape Flats LIFE or Kirstenbosch nurseries and they do not have to be sourced from seed within the Swartland Shale Renosterveld vegetation type.

The areas to be planted for erosion control and the techniques to be used are in Table 4 below.

2.2.5.3 Planting within the buffer areas

The buffers presently include little indigenous vegetation, but none may be removed or disturbed during rehabilitation. Planting of the buffer zones must take place in April, after invasive alien clearing within the buffer zone and watercourses, but before levelling or excavation of foundations takes place such that the buffer is present and functional in its vegetated state during construction for it to perform its protective function.

Plants of the species listed in Appendix 1 for both buffer and riparian areas may be planted within the buffer zones as per Table 4. The plants must be purchased from a reputable nursery and may not be a horticultural cultivar but of wild genetic stock. The buffer zone is to be planted at a density of 4 plants per m^2, which amounts to approximately 19500 plants for the entire area. Small areas do contain natural vegetation, so the actual number of plants required will be slightly lower. For a nursery to prepare this volume of plants will require a full year, so arrangements must be made at least 12 months before the anticipated planting date, approximately 18 months before the anticipated start of the construction phase of the development.

2.2.5.4 General planting procedure

All planting is to take place in the following manner:

1 Dig square holes by hand with a spade at least 1.5 times the height, width and breadth of the plant's container.
2 Re-fill the hole with soil loosely until the top of the soil in the planting bag is approximately 5cm below ground level when placed in the hole.
3 Remove the bag and place the plant in the hole.
4 Replace soil removed from the hole and compact by hand until the hole takes the form of a shallow depression with the plant at its centre at approximately 5cm below the level of the surrounding soil.
5 Do not add fertilizer or compost.
6 The ECO or appointed site officer must inspect the plants daily.
7 Water the plants only when beginning to wilt visibly, and only during the first 12 month period after planting.

Table 4: Re-vegetation of buffer and for erosion control purposes.

Activity	Details	Aim	Frequency and Timing	Risk and Comments
Revegetation of wetlands	Allow two years of growth before inspecting the wetlands and updating the species list. If the indigenous plant density is less than 4 per square metre, then draft and implement a seed collection and planting plan.	Re-instate indigenous wetland vegetation within the wetlands.	Regrowth occurs in the first two years after initial alien clearing. The assessment is undertaken in late April and mid September of the following year (year 3), with seed collection being conducted the following January (year 4), and planting taking place in April of the following year (year 5).	The density assessment and the seed collection and planting plan are to be undertaken by a SACNASP registered Freshwater Specialist or Botanist.
Planting for erosion control.	Plant the entire reshaped drainage line and the infilled artificial drainage channel at a density of 4 plants per m^2. Plant the drainage line and wetland portion of the infilled artificial drainage channel with plants from the erosion control list. Plant the remainder of the infilled drainage channel with plants from the riparian and buffer lists. Monitor during monthly inspections until 80% cover is achieved. If 80% cover is not achieved within 6 months, additional planting is to take place on instruction form a Freshwater Specialist.	Ensure that erosion is controlled within the reshaped drainage line and the infilled drainage channel.	Plant in April immediately after completion of the infilling and reshaping operations to ensure the plants are able to establish during the winter rainfall season.	Monitoring of plant density and additional planting instructions are to be provided by the Freshwater Specialist.
Planting within the buffer zone	Plant plants off the buffer and riparian lists at a density of 4 plants per m^2. Monitor during monthly inspections until 80% cover is achieved. If 80% cover is not achieved within 6 months, additional planting is to take place on instruction form a Freshwater Specialist.	Ensure that the buffer performs its function through construction and operational phases.	Plant in April after alien clearing, but before any excavation of foundations or levelling occurs within the development.	Monitoring of plant density and additional planting instructions are to be provided by the Freshwater Specialist

3 Maintenance and Management Plan (MMP)

Maintenance and management activities are pertinent to ensure that the PES achieved through the rehabilitation measures is maintained or gradually improved.

3.1 Management and Oversight

3.1.1 Roles and Responsibilities

Stellenbosch Municipality

The day to day implementation of this MMP will be undertaken by Stellenbosch Local Municipality. The Municipality may appoint a service provider to implement this management plan in part or whole, but the responsibility remains that of the municipality.

Independent Auditor

The Auditor appointed by the Municipality for each 5-yearly audit will be responsible for conducting a compliance and effectiveness audit, and for recommending changes to this MMP, in accordance with Section 3.1.2 below.

Department of Environment Affairs and Development Planning (DEA&DP) and the Department of Water and Sanitation (DWS)

DEA&DP and DWS are responsible for:

- Reviewing all audit reports.
- Addressing non-compliance appropriately in terms of their respective legislation where needed.
- Reviewing and approving or declining changes to this MMP proposed by the auditor and Municipality. Approval is required from both departments in order to change the MMP.

3.1.2 Auditing and Review

Stellenbosch Municipality shall appoint a Freshwater Specialist with experience in aquatic rehabilitation and local fire ecology and management to audit this MMP once in five years from the date of completion of the initial rehabilitation activities. This review process may form part of the standard WUL and EA audits, and may be conducted by the same auditor.

The auditor must undertake the following:

- Evaluate compliance with the MMP.
- Comment on management effectiveness. This comment should be informed by the following evaluations to be conducted by the auditor:
    - Determination of the PES using the WET-Health (Macfarlane, 2007) method;
    - Estimation of changes in indigenous and alien vegetation cover since the previous audit informed by a brief site assessment, by fixed-point photography undertaken by the managing authority (see monitoring below), and by aerial/satellite photography available from the Chief Directorate, National Geospatial Information or Google Earth;
    - Estimation of the degree of thicket encroachment and senescence and advise on whether fire or clearing of vegetation is necessary;
    - Evaluation of changes in water quality since the development commenced, using data collected during monitoring conducted by the Municipality (see ‘water quality’ in 3.2 below);
    - Evaluation of the need for additional erosion control measures.
    - Note any new threats that may impact on the PES.
- Propose changes to the MMP where required to address new or growing challenges such that the REC reached through rehabilitation is maintenance.

3.2 General Management Activities

Natural areas such as the rehabilitated watercourses and buffers that fall outside of a completely natural context are exposed to direct threats such as polluted runoff, changes in the hydrological regime and sedimentary balance, direct habitat destruction and the proliferation of alien invasive species. They are furthermore subjected to changes in or sometimes complete absence of key ecological drivers such as herbivory, flooding, fire and similar aspects. In this case, changes to the natural fire, flood and herbivory regimes are likely to result in a reduction in cover, increased thicket encroachment and/or a sustained state of senescence.

Direct threats and absence of or changes to key drivers both need management interventions to ensure that the ecological state does not degrade over time. Below are the general management actions required to maintain the ecological state of the watercourses and buffer zones within the proposed site. All proposed general maintenance and management activities are detailed in Table 5.

Table 5: General Maintenance and Management Measures

Activity	Aim	Details	Frequency and Timing	Notes
Access and Demarcation				
Control Vehicular Access	Avoid vegetation disturbance, soil compaction and soil disturbance within the watercourses and buffer zones.	Do not allow vehicular access to the watercourses and buffer zones, except within the confines of the security track.	Continuous	Emergencies are exempted.
Restrict access to appropriate activities.	Minimise edge effects.	Allow pedestrian access to the watercourses and buffer zones only for recreation, security patrols, inspections and management/maintenance activities undertaken in terms of this MMP.	Continuous	Emergencies are exempted.
Maintain signage	To remind staff and make the public aware of the above restrictions.	Maintained signage at all entrances to the rehabilitated areas (watercourses and buffers) listing prohibited activities including, but not limited to picking of flowers, littering, disposal of cigarettes, and accessing the watercourses and buffer areas anywhere but at the security track.	Continuous	None
Alien and Invasive Species Clearing				
Inspections	To identify alien clearing priorities including re-emergences or new populations of previously cleared species and new invasive species.	Inspect the entire proposed site on foot, with particular emphasis on the watercourses and buffers and assign clearing priorities. The lowest density areas or populations receive the highest priority and vice versa.	Quarterly (once per season) and once during the 5-yearly audit.	The person who conducts the inspections must be formally trained to identify both indigenous and alien species.
Invasive Species Removal	To eradicate all category 1a alien invasive species and to manage other alien and extra-limital species.	Apply the methods mentioned in the rehabilitation plan to all known invasive and extralimital species. When new invasive species are identified, seek help from a botanist, freshwater specialist or other specialist in invasive species control to determine the most effective control/eradication methods and apply these methods	Continuous.	
Control of *Typha capensis*	To ensure that the indigenous, but problematic species *Typha capensis* does not gain a foothold.	Remove Typha capensis within its roots by hand within 2 weeks of identifying it anywhere within the proposed site.	Ad-hoc.	
Indigenous Vegetation Management				

Monitoring	To evaluate indigenous vegetation cover, senescence and the degree of thicket encroachment.	○ Estimate the indigenous vegetation cover throughout the watercourses and buffer zones and note (for action) any areas where vegetation cover is less than 80%. If a reason for this is evident, then note the reason. ○ Note (for action) any areas larger than 100m^2 where thicket occupies more than 50% of buffer zone or more than 20% of watercourse. ○ Note (for action) if a general state of senescence has been reached to the degree that intervention is necessary (provide and opinion).	Undertaken during the 5-yearly audit.	To be undertaken only by the auditor during the 5-yearly audit.
Ensure indigenous vegetation cover remains above 80%	To address areas where vegetation cover is less than 80%.	Where vegetation cover is noted as less than 80%, address the issue as directed by the Auditor.	Undertaken after the 5-yearly audit if necessary.	
Clear excessive thicket	Maintain the natural veld mosaic in the absence of large herbivores and other ecological drivers.	Where excessive thicket encroachment has been noted, remove sufficient number of individual thicket plants such that the thicket cover is reduced to half the threshold value (i.e. to 25% in the buffer and 10% in the watercourses).	Undertaken after the 5-yearly audit if necessary.	
Clear or block burn senescent vegetation	Maintain the diversity of the ecosystem.	Clear all senescent vegetation noted during the audit, by cutting approximately 20cm above ground level with a brush cutter or similar device, or Undertake an optional ecological block burn as per 'Fire Management' below.	After the 5-yearly audit, if necessary.	Ecological burning is the preferred method, but this requires a permit and assistance from the Municipal fire department.
Cut or burn reed beds and vegetation within the swales and retention/irrigation reservoir.	Ensure that the vegetation within the swales and reservoir remains within a growth phase with a net nutrient uptake, and do not mature to become nutrient neutral	Cut reeds and vegetation by means of a brush cutter or similar device approximately 10cm above the roots throughout the swales and in areas within the reservoir where vegetation is desired. Remove all cut material by hand and compost for use in the parkland or dispose of at an appropriate land-fill site.	Once in 10 years.	Burning is the preferred method, but is dependent on an open burning permit and buy-in from the fire department and other municipal entities. Burn if possible, but if not, then use the brush cutting method.
Erosion and Sedimentation				
Inspect the drainage line for signs of unnatural erosion or sedimentation.	Identify unnatural erosion and sedimentation	Inspect the entire length of the drainage line and identify areas of unnatural erosion and sedimentation. Provide guidance on how to address the unnatural erosion or sedimentation. The cause of the unnatural erosion or sedimentation should be addressed if possible, with direct erosion control measures applied only if the cause cannot be addressed, or if necessary in combination.	Undertaken during the 5-yearly audit.	To be undertaken by the auditor.
Address erosion and sedimentation	Control unnatural erosion and sedimentation	Control unnatural erosion and sedimentation as directed by the Auditor.	After the 5— yearly audit if necessary.	
Removal of sediment and unwanted vegetation from the swales and	Ensure effective performance of the swales and retention/irrigation	Should sediment or vegetation accumulation interrupt the operation of the swales or of the reservoir, it may be cleared by hand or by means of heavy machinery. Dredged spoil is considered	Undertaken as needed.	The auditor must provide guidance on the need for vegetation or sediment removal, or

retention/irrigation reservoir.	reservoir in accordance with their functions.	hazardous waste and must be disposed of at Visserhok landfill site or another site licenced for hazardous waste.		indicate where vegetation or sediment removal has been excessive, as needed.
Fire Management				
Maintain fire breaks	Prevent spread of fire from the watercourses and buffers to the adjacent infrastructure.	Ensure that a firebreak of at least 10m is present between the buffer zone and the nearest flammable infrastructure. The firebreak may take the form of grassy parkland or non-flammable infrastructure. Remove vegetation higher than 10cm within the firebreaks.	Continuous	The wetland, riparian and terrestrial vegetation present within the watercourses and buffer zones has a natural fire cycle and potentially represents a fire hazard.
Undertake ecological block burns if possible.	Prevent senescence and thicket encroachment.	If the Auditor (with local experience in fire ecology and management) has determined that the vegetation within all or part of the buffer and watercourses is senescent and requires an ecological burn, then an ecological burn must be conducted if relevant fire management resources are available, and if a permit has been granted by the Municipality. No more than 50% of the rehabilitated area may be burnt within a 3 year period. Conduct the burn in accordance with a burn plan drafted by a competent member of the Municipality or by a competent consultant (possibly the auditor) and approved through the municipal open burning permit process.	After the 5-yearly audit if needed. Conduct burns only in February or March	Fire cycles within the local Swartland Shale Renosterveld are not well defined and estimates vary between 3 and 15 years (de Viliers et. al. 2006) which is why it should be assessed by a specialist prior to conducting an ecological burn.
Water Quality				
Monitor Water Quality	Identify significant changes in the water quality within the watercourses.	Conduct quarterly water quality tests on the storm- and borehole water used for irrigation within the proposed site and ensure that they fall within the DWS guidelines for discharge of wastewater into a watercourse. This is a standard test that can be requested at most water quality laboratories. Note any non-compliance with the standard for action below. Conduct an annual water quality test (same suit of variables as above) during July under moderate (non-flood) flow conditions at two locations, namely at 50m upstream, and 50m downstream of the stormwater inflow from the southern portion of the development (refer to Figure 3), within the drainage line. Note any changes larger than 50% from the baseline values in any variables tested.	Quarterly (irrigation water) and Annually (drainage line).	
Investigate and rectify non-compliance or significant changes noted above.	Minimise water quality impacts.	Seek advice from a freshwater specialist and implement the advice given. Appoint a freshwater specialist for further sampling and investigation should it be necessary to address the cause of the water quality issue.	As needed.	
Waste Management				

Locate and remove litter.	Keep the watercourses and buffers litter free as far as possible.	Inspect the watercourses and buffer zones and remove all litter found to a recycling or landfill facility.	Weekly	
No Bins	Keep the watercourses and buffers litter free as far as possible.	Do not install bins within 50m of the watercourses or buffers.	Continuous	It is well documented that bins attract more litter than a no-bins policy.

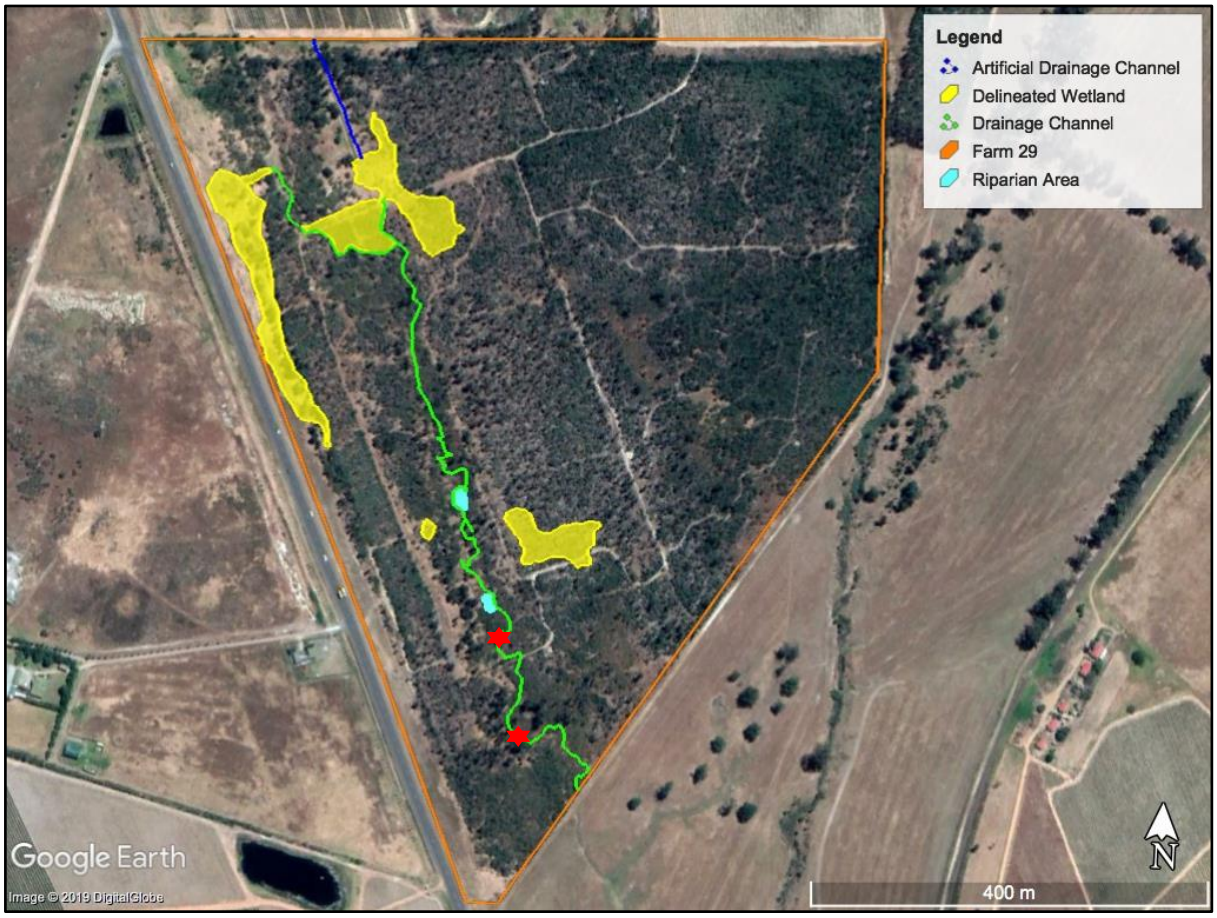

Figure 3: Approximate positions of the recommended water quality testing points, indicated by red stars, approximately 50m above and 50m below the outflow of the swale.

3.3 Infrastructure Maintenance

Some activities associated with the maintenance of infrastructure within the proposed site may impact the watercourses significantly. The measures that follow ensure that the potential impact is minimised to ensure that PES of the drainage line and wetland mosaic remain within the REC.

3.3.1 Pedestrian Crossings over the Drainage Line

Two pedestrian bridges over the ephemeral drainage line are proposed. Any repairs to the bridges must utilise materials and techniques that are in accordance with the mitigation measures described in the impact assessment. In other words:

- Do not use any materials containing Copper Chrome Arsenate (CCA) which is commonly used to treat timber.
- Ensure that the vehicle crossing is no wider than 3m and that the pedestrian bridges are no wider than 1.8m.

- Ensure that in replacement of the pedestrian bridges, no excavation occurs within 1m of the channel bank.
- Ensure that no part of the grass-blocked vehicle crossing protrudes more than 20mm above the bed of the drainage line.

Undertake routine maintenance during summer and emergency maintenance is to be undertaken at any time when deemed necessary.

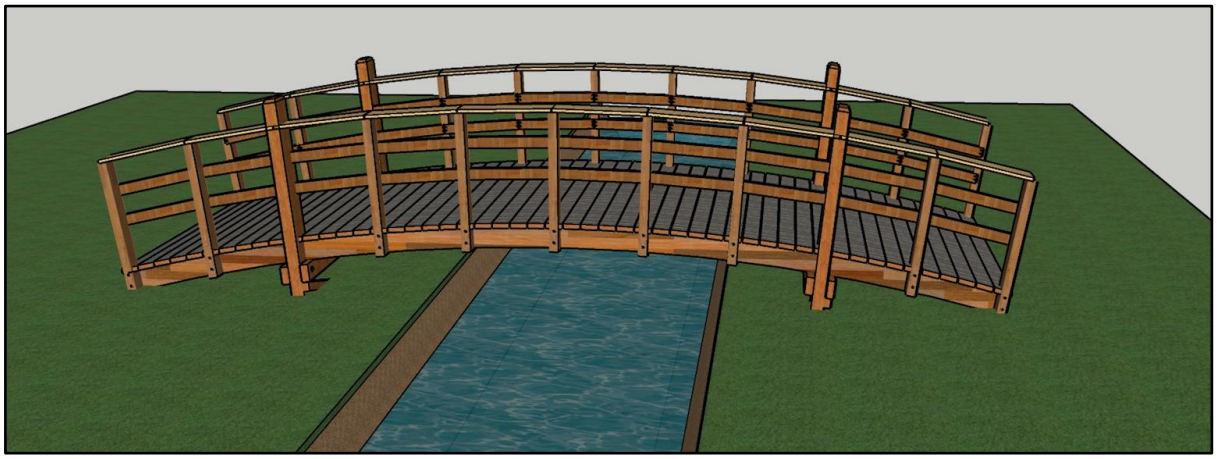

Figure 4: Example of the design for the pedestrian crossings illustrating a potential design that does not require construction within the channel bank.

3.3.1.1 Vehicle Crossing

A single grass-blocked vehicle crossing is proposed over the stream along the southern boundary. Maintenance and replacement of the grass-blocked vehicle crossing point as required must be with similar packed grass blocks that encourage vegetation growth. Install the grass blocks for the crossing at an elevation of no more than 20mm above the bed of the stream, such that no significant barrier to flow is presented by the grass blocks.

During maintenance, grass blocks are to be removed and replaced by hand with a pick or similar implement if needed, and not with heavy machinery such as a digger loader so as to minimise sediment disturbance. Routine maintenance is to take place during summer and emergency maintenance may be undertaken at any time if necessary.

3.3.1.2 Fence Crossing

Replacement or maintenance of the single proposed fence crossing must be undertaken with similar materials or other appropriate materials. Check and clear the portion of the fence that crosses the stream on a daily basis once it is constructed. Routine maintenance is to take place during summer, emergency maintenance is to be undertaken at any time when deemed necessary.

3.3.2 Maintenance of Vehicle and Pedestrian Tracks

Vehicle and pedestrian tracks within the demarcated buffers may be repaired or maintained using any materials that do not involve CCA or other aquatic pollutants. They must also not be a source of significant nutrient load and laterite should be avoided as a surfacing material within the buffers and watercourse.

3.3.3 Maintenance of Stormwater Infrastructure

A stormwater retention reservoir and a swale/artificial wetland are proposed to facilitate the treatment of stormwater prior to its use for watering of the parklands and prior to its release into the ephemeral drainage line. Refer to the Freshwater Assessment completed by EnviroSwift Western Cape (2018, updated 2019) for details. Water levels within the stormwater retention reservoir must be managed by irrigation and augmentation from the borehole such that while irrigation needs are met, overflow of the

pond only occurs in floods greater than a 1:100-year event. The Municipality is to manage the sediment and vegetation within the stormwater retention pond and swales such that these structures maintain their functionality in accordance with the measures described under the relevant sections in Table 5.

Replacement of the concrete walls of the retention reservoir or any other stormwater infrastructure must be undertaken during the summer months if possible and must be undertaken in such a manner that ensures that stormwater does not flow directly into the watercourses but is directed into the swales or similar structures. Repair and replacement of such infrastructure must be undertaken in a manner that ensures that sedimentation of the watercourses is minimised.

3.3.4 General Infrastructure Maintenance

Maintenance of all infrastructure within the watercourses, buffer and the remainder of the proposed site must adhere to the following measures:

- No chemicals of any description may be mixed, poured or stored in locations where spillage will enter the stormwater system and subsequently the watercourse.
- No stockpiling or disposal of any vegetation matter or other material or substance may take place within the watercourses or buffer.
- No maintenance work that can be conducted outside of the watercourses and buffer may be undertaken within the watercourses and buffer.

4 Conclusion

EnviroSwift Western Cape were appointed to undertake a freshwater impact assessment of Farm 29 Stellenbosch. A mosaic of depression wetlands and an ephemeral drainage line were identified and assessed. The Present Ecological State (PES) for these were found to fall within classes E and D respectively and an Recommended Ecological Category of C was determined for both.

The proposed Rehabilitation Plan (Section 2 above) clarifies the steps required to increase the PES of the watercourse from their present ecological categories to attain the REC. It assigns the responsibility, mechanisms and timing for each facet of the rehabilitation process.

The Maintenance Management Plan (MMP – Section 3 above) addresses all reasonably foreseeable future threats in such a manner that the PES of the watercourses is likely to be maintained into the future. Management and maintenance measures that address threats related to infrastructure maintenance, invasive species, vegetation encroachment, fire, erosion, water quality impairment and waste management are all addressed in detail.

Despite the detailed planning, it is unlikely that all future threats have can be reasonably foreseen and for this reason, a mechanism has been included in this FRMMP to evaluate not only compliance with both portions of the plan, but also to evaluate the effectiveness thereof, identify weaknesses as they emerge and address them. In the case of the MMP section, this entails a review period every five years through which the MMP can adapt to changing circumstance and new information that becomes available.

The FRMMP therefore provides not only a plan, but a system of management that will ensure the long term maintenance of the gains made through rehabilitation.

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Appendix 1 – Preliminary Plant List

Planting Area	Plants
Wetland Areas	*Juncus acutus*
	Ficinia nodosa
	Carpha glomerata
	Cyperus textilis
	Ficinia elatior
	Isolepis diabolica
	Isolepis incomtula
	Isolepis natans
	Juncus punctorius
	Pennisetum macrourum
	Imperata cylindrica
	Calopsis paniculata
Buffer / Parkland	*Eriocephalus africanus*
	Juncus acutus
	Cyperus congestus
	Geranium incanum
	Salvia Africana lutea
	Leucadendron lanigerum
	Osteospermum moniliferum
	Senecio halmifolius
	Tetraria thermalis
	Helichrysum patulum
	Stoebe plumose
	Dicerothamnus rhinocerotis

	Felicia filifolia
	Erepsia anceps
	Pycreus polystachyos
	Zantedeschisa aethiopica
	Chasmanthe aethiopicum
	Cliffortia odorata
	Senecio pterophorus
Erosion Control	*Juncus effusus*
	Pycreus nitidus
	Cyperus longus
Riparian Areas	*Searsia angustifolia*
	Searsia laevigata
	Xanthedeschia aethiopica
	Chasmanthus aethipica