Wetland Rehabilitation and Management Plan

Clanwilliam Housing Development, Remainder Erf 279, Clanwilliam, Western Cape

For: Enviro EAP

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Report Information

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Executive Summary

Cederberg Local Municipality proposes the Clanwilliam Housing Development on Remainder Erf 279, Clanwilliam, with about 1 277 residential erven, a stormwater system and the expansion of the Clanwilliam WWTW. The central valley-bottom wetland system (referred to in previous assessments as Wetlands 1 and 2) lies within the public open space of the development and drains to the Jan Dissels River. CapeNature requested a rehabilitation plan for the wetlands, to be implemented as part of the EMPr.

The wetland is seriously modified (PES E, WET-Health score 39.9%). It receives polluted stormwater from the informal settlement and township upslope, and is affected by dumped waste and tyres, alien invasive plants (notably Port Jackson, *Acacia saligna*) and changes to its hydrology caused by the golf course, a road and drainage channels. Its Recommended Ecological Category is D (Van Zyl and Morton, 2026).

This plan combines the rehabilitation of the wetland with stormwater polishing. Stormwater from the existing settlement and from the new development is to be treated by litter traps, settling ponds or sediment forebays and vegetated swales before it enters the wetland as diffuse flow, including a vegetated settling pond or forebay before the discharge into the wetland at Pond 7, which forms part of the wetland.

Stormwater should be conveyed through vegetated swales as far as possible, and the rehabilitated wetland then provides a final polishing step before flow reaches the Jan Dissels River.

Rehabilitation comprises the removal of waste and tyres, alien plant clearing, reshaping and stabilisation of disturbed areas, and revegetation with indigenous wetland species, followed by monitoring and long-term management by the municipality.

It is the opinion of the specialist that implementing this plan would improve the wetland from PES E towards its REC of D and improve the quality of water reaching the Jan Dissels River.

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Kimberley van Zyl is an ecologist and environmental scientist with over 9 years' experience in the environmental management field. She holds a MSc. degree in Water Resource Management from the University of Pretoria and her professional affiliations include the South African Council for Natural Scientific Professions (SACNASP) and the Southern African Society of Aquatic Scientists (SASAqS). Kimberley's work experience has exposed her to a range of projects across various business sectors such as mining, agriculture, and construction, as well as the public sector.

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Robyn Morton has a MSc. degree in Conservation Sciences from the Cape Peninsula University of Technology. Throughout her studies, internships, and consultancy experience, she has gained valuable and informed insight into the functioning of natural and socio-ecological systems, as well as many key research and monitoring skills. Prior to her consulting career, Robyn worked for Zandvlei Estuary Nature Reserve for 4 years and gained experience in the field of urban wetland and estuary management. Robyn specialises in aquatic ecology and is currently working for Delta Ecology as a junior associate under the guidance of Kimberley van Zyl.

A signed statement of independence will be provided as a separate document.

1. Introduction

Cederberg Local Municipality proposes the Clanwilliam Housing Development on Remainder Erf 279, Clanwilliam, with about 1 277 residential erven in two projects, the Clanwilliam Housing IRDP and UISP, and associated stormwater infrastructure and expansion of the Clanwilliam Wastewater Treatment Works (WWTW) (**Figure 1-1**). The central valley-bottom wetland system (Wetlands 1 and 2 in previous assessments) lies within the public open space between the two housing areas and next to the golf course, and drains to the Jan Dissels River (**Figure 1-2**).

The aquatic biodiversity impact assessment for the development (Enviro-EAP, 2026) was peer reviewed by EnviroSwift (2025), and Delta Ecology prepared an addendum on the stormwater infrastructure and the WWTW expansion (Van Zyl and Morton, 2026). In commenting on the assessment, CapeNature requested a rehabilitation plan for the wetlands, to be implemented as part of the Environmental Management Programme (EMPr).

The wetland is seriously modified and currently receives polluted stormwater from the informal settlement and township upslope. The proposed stormwater system will discharge into and next to the wetland. This plan therefore combines the rehabilitation of the wetland with stormwater polishing, so that stormwater is treated before it enters the wetland and the rehabilitated wetland provides a final polishing step before flow reaches the Jan Dissels River.

Delta Ecology was appointed to prepare this Wetland Rehabilitation and Management Plan. It should be read with the addendum (Van Zyl and Morton, 2026), which describes the watercourses, the stormwater design and the mitigation measures in more detail.

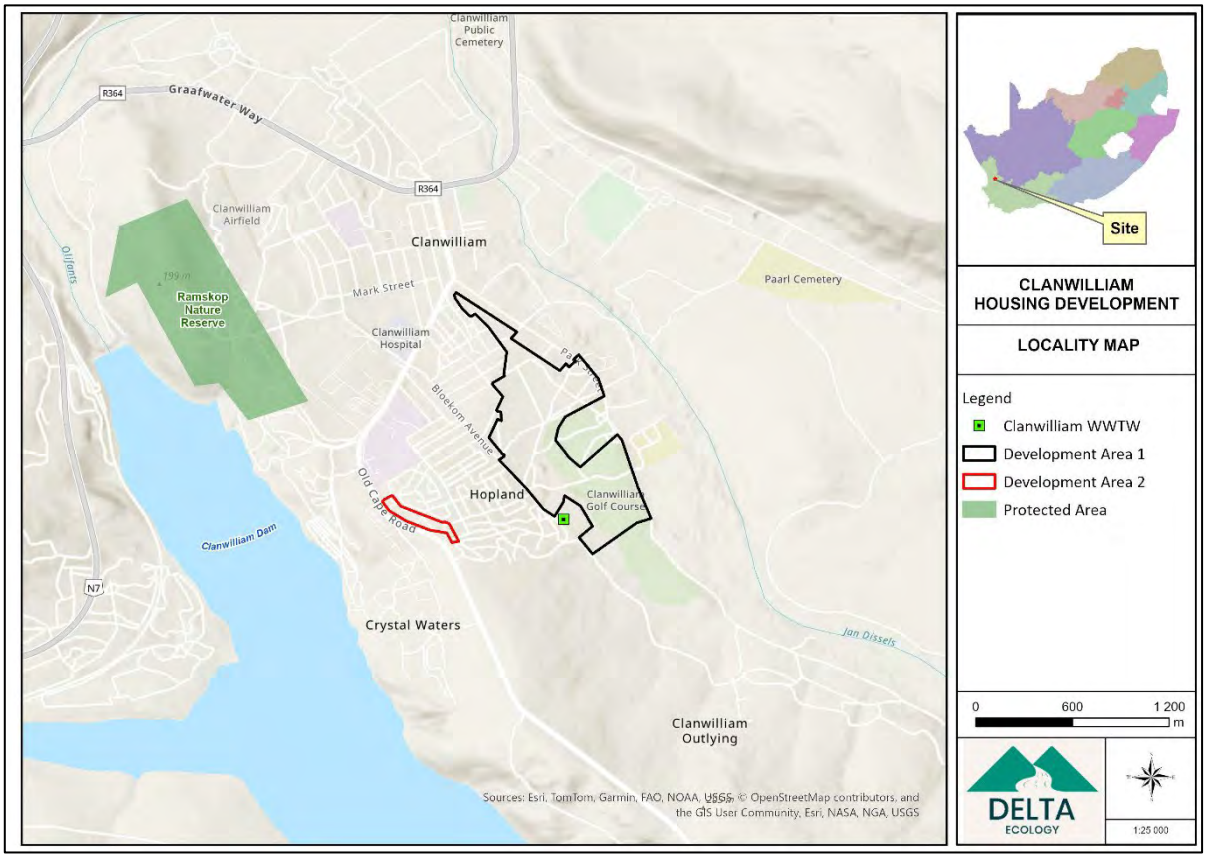

Figure 1-1: Locality of the Clanwilliam Housing Development areas and the WWTW (Eco-GIS, 2026).

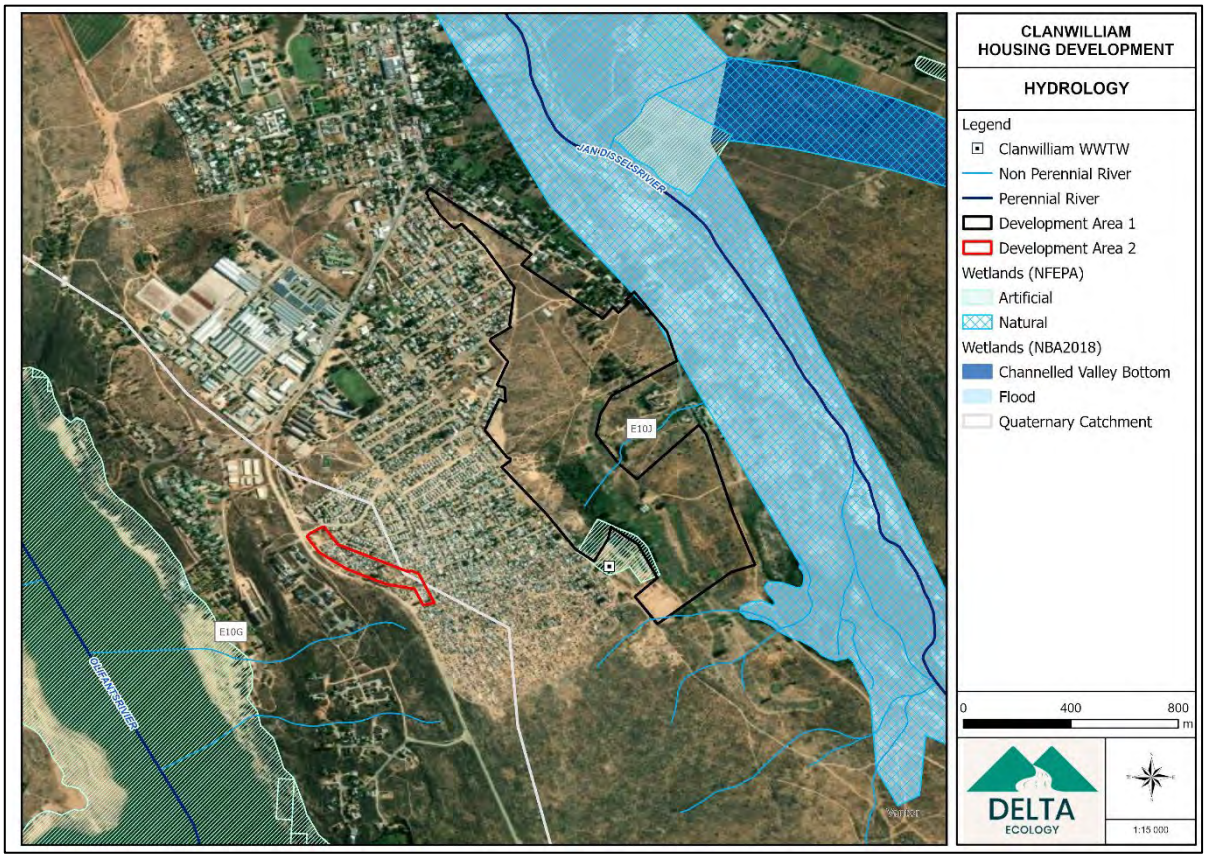

Figure 1-2: Rivers and wetlands in the vicinity of the site (Eco-GIS, 2026).

1.1. Terms of Reference

The terms of reference for this plan are to:

- summarise the condition of the wetland system on site, drawing on the Aquatic Biodiversity Impact Assessment Addendum (Van Zyl and Morton, 2026) and the site visit of 29 September 2026;
- set out practical rehabilitation measures that improve the condition of the central valley-bottom wetland system (Wetlands 1 and 2), including the removal of waste, the control of alien invasive plants and revegetation with indigenous wetland species;
- set out stormwater polishing measures that treat stormwater from the existing informal settlement and township and from the proposed development before it reaches the wetland, so that the wetland can also act as a final polishing step before flow reaches the Jan Dissels River; and
- provide monitoring and management guidelines so that the target ecological condition is reached and maintained, for inclusion in the EMPr as requested by CapeNature.

1.2. Limitations and Assumptions

The following limitations and assumptions apply:

- The plan is based on a single site visit on 29 September 2026, at the end of the wet season, and on the earlier assessments of the wetland (Enviro-EAP, 2026; EnviroSwift, 2025; Van Zyl and Morton, 2026).
- The stormwater layout is the tender-stage design (UDS Africa, 2026b). The stormwater polishing measures will need to be confirmed with UDS Africa at detailed design, and the

positions of outlets and ponds relative to the wetland and its 15 m buffer still need to be confirmed against the wetland delineation.
- Under natural conditions the feature would have been either a non-perennial river or a valley-bottom wetland. The present wetland has developed along this historic watercourse and is referred to as the central valley-bottom wetland system (Van Zyl and Morton, 2026); this does not change the rehabilitation measures. The southern seep south-east of the WWTW is not covered by this plan (Section 3).
- The plan assumes, based on its source, that the stormwater entering Wetland 1 from the informal settlement and township is heavily polluted.
- The plant species list for revegetation is provisional and must be confirmed before plants are ordered.

2. Goals and Objectives

The wetland system on site is seriously modified (PES E, WET-Health score 39.9%). It receives polluted stormwater from the informal settlement and township upslope, has been impounded and drained by the golf course and a road, and is affected by dumping and alien invasive plants (Van Zyl and Morton, 2026). The broad goal of this plan is to rehabilitate the wetland so that it reaches and maintains its Recommended Ecological Category (REC) of D, while using it, together with the stormwater system, to improve the quality of the water flowing to the Jan Dissels River.

The specific objectives are to:

- treat stormwater from the existing informal settlement and township and from the proposed development before it enters the wetland;
- remove dumped waste, tyres and rubble from the wetland and keep it free of dumping;
- clear alien invasive plants and establish a diverse cover of indigenous wetland vegetation;
- maintain hydrological connectivity from Wetland 1 to Wetland 2 and on to the Jan Dissels River without concentrating flow or causing erosion;
- improve the Present Ecological State of the central valley-bottom wetland system from E to at least D within five years; and
- ensure that the wetland and the stormwater system are monitored and maintained by the municipality in the long term.

3. Baseline Wetland Environment

The site lies in quaternary catchment E10H of the Olifants River system. The wetland on site drains east, through a culvert and a channel, to the Jan Dissels River, a perennial river of PES D and Very High Ecological Importance and Sensitivity that joins the Olifants River about 4.7 km downstream of the WWTW effluent release. The Jan Dissels River supports endemic fish of the Olifants–Doring system in its upper reaches, including Barnard's rock catfish (Endangered), Clanwilliam rock catfish and Clanwilliam redfin (Near Threatened), as well as macroinvertebrates sensitive to flow and water quality, and its importance as an instream migration link is rated Very High (DWS, 2014; Van Zyl and Morton, 2026). The Jan Dissels River corridor is mapped as a Critical Biodiversity Area 1 and the wetland and much of the site as an Ecological Support Area 1 (CapeNature, 2023). The NFEPA wetland vegetation group for the area is Northwest Sand Fynbos, which is listed as Critically Endangered (CSIR, 2011), and the surrounding terrestrial vegetation is Citrusdal Vygieveld (SANBI, 2018).

The wetland consists of two areas of wetland habitat, Wetland 1 and Wetland 2, separated by the golf course and connected by a stormwater pipe beneath it (**Figure 3-1**). Wetland 1 is inundated by stormwater from the informal settlement and township upslope, which is likely to be badly polluted. It is dominated by *Phragmites australis* and *Typha capensis*, with arum lilies (*Zantedeschia aethiopica*), the NEM:BA Category 1b invasive species Port Jackson (*Acacia saligna*) and dumped tyres. Wetland 2 is dominated by *Typha capensis*. Downstream of the golf course, the wetland passes through a culvert beneath a road and along a channel to the Jan Dissels River (**Figure 3-2**). This section is dominated by arum lilies and ruderal weeds, provides limited wetland habitat or function, and showed damage from recent floods.

Water quality sampling of the Jan Dissels River on 29 September 2026 showed that the river downstream of the WWTW is strongly influenced by treated effluent (Van Zyl and Morton, 2026; NviroTek, 2026a, b). Ammonia increased from 0.07 to 6.0 mg N/l, with estimated un-ionised ammonia above the Chronic Effect Value for aquatic ecosystems (DWAF, 1996), EC increased at least sevenfold, inorganic nitrogen reached eutrophic levels and E. coli increased from 90 to 300 cfu/100 ml. These results underline the need to treat stormwater and effluent before they reach the wetland and the river, and provide a baseline against which the rehabilitation and stormwater polishing can be monitored.

The terrestrial assessment describes the wetlands as degraded, covered with alien invasive plants, waste and rubble, and notes that their rehabilitation and the removal of alien invasive plants would improve habitat for animal species on site (Hanekom, 2026a).

Wetlands 1 and 2 form a single central wetland system (valley-bottom wetland), which was assessed as one unit with WET-Health Version 2 (Macfarlane et al., 2020). Its final (adjusted) score is 39.9%, PES category E (Seriously Modified), with hydrology (39.7%), water quality (38.7%) and vegetation (32.4%) seriously modified (E) and geomorphology largely modified (D, 49.2%). Vegetation and water quality, the lowest-scoring components, are the main targets of the stormwater treatment, waste removal, alien clearing and revegetation in this plan. The ecosystem services of Wetlands 1 and 2 are Moderately Low, with the highest scores for sediment trapping and nitrate and toxicant assimilation, their Ecological Importance and Sensitivity is Moderate, and their REC is D (Van Zyl and Morton, 2026). The 1948 aerial photograph shows that the area was already transformed by agriculture, so the reference state of the wetland cannot be determined.

Downstream, the Jan Dissels River floodplain wetland, to which the wetland drains, is largely modified (PES D, 46.7%), with seriously modified hydrology, and the Olifants River floodplain wetland is largely modified (PES D, 40.1%). Both floodplains, and the Jan Dissels and Olifants rivers, are of Very High Ecological Importance and Sensitivity and very high importance for biodiversity maintenance, and their REC is C. The Southern Seep south-east of the WWTW, which is sustained by treated effluent before it drains to the Jan Dissels River, is seriously modified (PES E, 25.7%), with critically modified hydrology and water quality (Van Zyl and Morton, 2026). Rehabilitation of the southern seep is not considered practical, because the original drainage line has been lost through a long history of disturbance, so it is not covered by this plan; it is to be retained as a polishing reed bed for the treated effluent (Van Zyl and Morton, 2026). Improving the quality of the water leaving the central wetland therefore also benefits receiving watercourses of Very High importance.

Figure 3-1: (a) Wetland 1 with *Typha capensis, Acacia saligna* and dumped tyres; (b, c) discharge through a piped culvert system beneath the golf course to Wetland 2 – an artificial depression dominated by *Typha capensis* (29 September 2026).

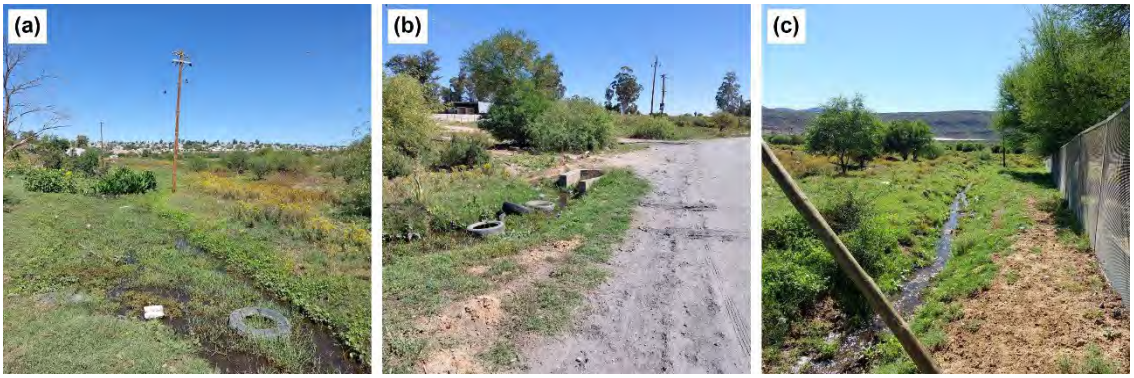

Figure 3-2: (a) Central watercourse downstream of the site resembling a valley bottom system dominated by Kikuyu and ruderal weed species, (b) Culvert under Spokie Street at the downstream end of the wetland; (c) drainage channel to the Jan Dissels River (29 September 2026).

4. Wetland Rehabilitation and Stormwater Polishing

4.1. Objectives

The vision for the wetland is a functioning, vegetated wetland system that receives treated stormwater, polishes it further, and passes it on to the Jan Dissels River as diffuse, clean flow. Achieving this requires:

- a suitably qualified freshwater specialist with experience in wetland rehabilitation to oversee implementation;
- stormwater treatment before water enters the wetland, with settling ponds or forebays and vegetated polishing zones before the discharge into the wetland at Pond 7 and at the inflow to Wetland 1 (Section 4.3);
- removal of all dumped waste, tyres and rubble (Section 4.2);
- appropriate design of the Wetland 1 to Wetland 2 connection and the downstream culvert (Section 4.4);
- reshaping and stabilisation of disturbed and eroded areas (Section 4.5);
- removal of alien invasive plants (Section 4.6) and revegetation to at least 80% indigenous vegetation cover (Section 4.7); and
- long-term monitoring and management (Section 6).

The rehabilitation measures should be read with WET-RehabMethods (Russell, 2009) and must be overseen by a freshwater specialist.

4.2. Removal of Waste, Tyres and Rubble

Dumped waste, tyres and rubble smother wetland soils and vegetation, release pollutants and attract further dumping. All waste must be removed from Wetlands 1 and 2, the downstream channel and the culvert before the other rehabilitation measures start.

- Remove waste by hand or with light machinery working from outside the wetland, to avoid compacting wetland soils and damaging indigenous vegetation.
- Dispose of all waste at a licensed waste facility. No waste or cleared plant material may be stockpiled in the wetland or its buffer.
- Clear the culvert inlet and outlet of tyres and debris so that flow is not impounded.
- Repeat the clean-up at least quarterly, and after large storms, until the stormwater litter traps are in place and dumping has stopped.
- The municipality should provide regular solid-waste collection in the informal settlement and township, and consider signage and community clean-up events to discourage dumping.

4.3. Stormwater Polishing

The main source of pollution in the wetland at present is untreated stormwater from the informal settlement and township, and the proposed development will add runoff from about 1 277 erven, roads and community facilities (UDS Africa, 2026b). The aim is to treat stormwater in stages, a treatment train, so that litter, sediment and much of the nutrient and bacterial load are removed before the water reaches the wetland, and the wetland vegetation then acts as the final polishing step.

4.3.1. Stormwater from the existing settlement and township

- Intercept the stormwater from the informal settlement and township before it enters Wetland 1, as UDS Africa propose (C. Louw, UDS Africa, pers. comm., 25 September 2026).
- Install a litter trap or gross pollutant trap at each inflow point, followed by a settling pond or sediment forebay, sized to retain the first flush and accessible to machinery for cleaning.
- Where space allows, convey the flow from the forebay through a vegetated swale, and then through a shallow, densely vegetated polishing zone at the upstream end of Wetland 1, so that it spreads out and slows down before entering the wetland.

4.3.2. Treatment train for the new development

- Fit litter traps (for example kerb inlet baskets or trash racks) upstream of every headwall.
- As far as possible, convey stormwater to the central valley-bottom wetland system through vegetated swales rather than pipes, so that it is treated before it enters the wetland. Swales should be broad and shallow (for example a 2 m base and side slopes of 1:3 or flatter, as for the open channels in the current design), with gentle longitudinal gradients, planted with dense indigenous grasses, sedges and rushes, and fitted with check dams where gradients are steeper, to slow flow, trap sediment and encourage infiltration and nutrient uptake. Swales must not be lined with concrete. The open channels in the current design, such as Pond/Channel 3, should be designed and planted as swales, and filter strips should be used along road reserves and open spaces where swales are not possible.

- Where possible, provide a settling pond or sediment forebay at the inlet to each attenuation pond and upstream of every discharge into the central valley-bottom wetland system, sized to retain the first flush. This is particularly important before the discharge into the wetland at Pond 7 in the stormwater management plan, as Pond 7 forms part of the wetland. Settling ponds entering the wetland should be constructed as a vegetated detention pond with a shallow permanent wetland zone and a gently sloping, planted edge, so that it polishes low flows as well as attenuating peaks. Raise the low-flow outlets of the ponds, or provide a permanent pool, so that low flows are held long enough for sediment to settle.
- Attenuate post-development peak flows to the wetland to pre-development levels, as recommended by EnviroSwift (2025).

4.3.3. Outlets and energy dissipation

- Place headwalls and any new ponds outside the wetland where possible, and preferably outside the 15 m buffer.
- Fit every outlet with an energy dissipator (for example a stilling basin, riprap apron or gabion mattress) and a level spreader, so that water enters the wetland as diffuse flow.
- Never discharge stormwater as a concentrated jet into the wetland, where it would cause scour and channel incision.

4.3.4. Design and maintenance

- The stormwater system must be designed by the appointed engineers (UDS Africa) with input from a freshwater specialist, who must confirm that settling ponds or forebays and vegetated swales are included in the detailed design before construction.
- The municipality must inspect and clean inlets, litter traps, forebays, settling ponds, swales, ponds and outlets at least quarterly and after large storms, remove sediment from forebays before they are half full, and dispose of it off site.
- Repair damaged stormwater infrastructure and erosion immediately.
- The municipality must confirm who is responsible for long-term maintenance of the stormwater system and the polishing zones.

4.4. Wetland Connection and Downstream Culvert

Wetland 1 is connected to Wetland 2 by a stormwater pipe beneath the golf course, and the wetland drains through a culvert beneath a road to a channel that joins the Jan Dissels River. These structures control water levels in the wetland and, if poorly designed or blocked, can either drain it or impound it.

- Set the levels and capacity of the Wetland 1 to Wetland 2 connection so that Wetland 1 keeps its natural water levels and only overflow is conveyed.
- Where culverts are replaced or upgraded, use several smaller culverts spaced along the embankment, or bottomless culverts, to spread flow and keep the wetland substrate intact.
- Fit culvert inlets and outlets with wing walls and aprons to guide flow and prevent scour.
- Inspect culverts regularly and keep them clear of sediment, vegetation and waste.
- Any new or upgraded culvert or connection must be designed by the engineers in consultation with a freshwater specialist.

4.5. Reshaping and Erosion Control

Reshaping is only needed where waste or rubble has been removed, or where erosion has formed channels or headcuts. An unchannelled valley-bottom wetland has a very gentle slope: nearly flat (0 to 1%) in the central floor, 1 to 3% along the transitional edge, and steeper towards the surrounding land. Reshaped areas should replicate this, so that water spreads and ponds seasonally rather than draining through a channel.

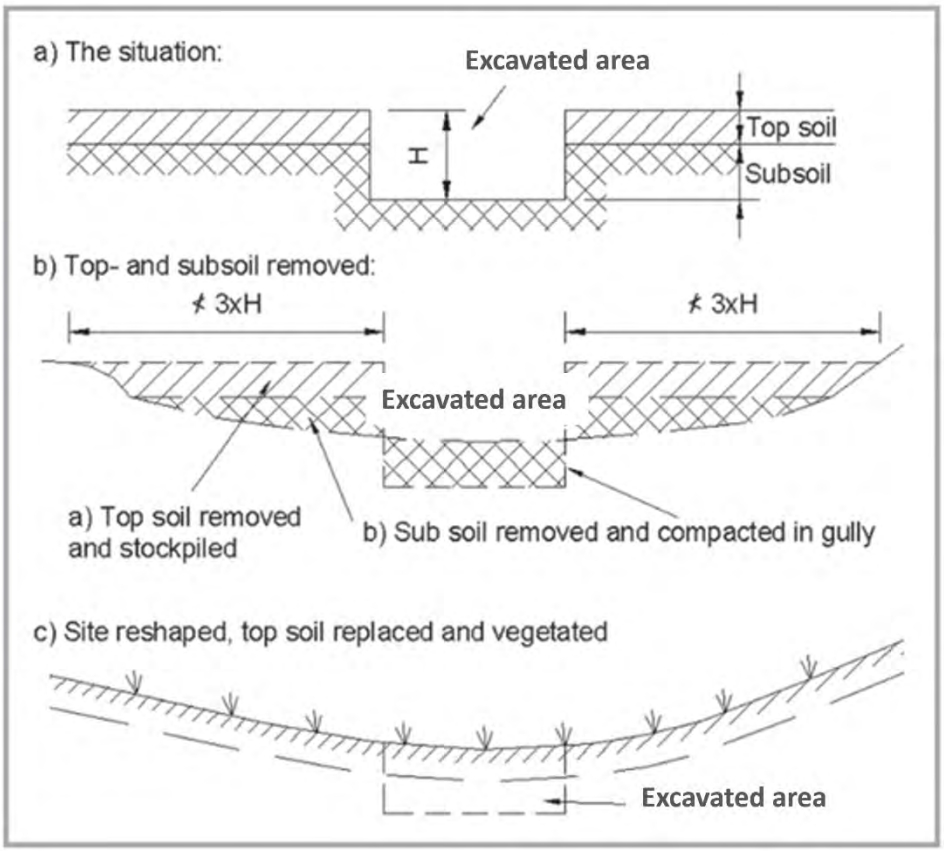

Figure 4-1: Sloping wetland banks.

- Carry out reshaping in the dry season, and early enough for plants to establish before the winter rains.
- Keep slopes no steeper than 1:3 (Figure 4-1), so that temporary, seasonal and permanent zones can develop.
- Do not disturb areas already dominated by indigenous wetland vegetation.
- Stabilise exposed soil with biodegradable geotextile or brush packing and plant it as soon as earthworks are complete.
- Fill erosion rills and gullies with rock of 5 to 20 cm diameter and protect them with silt fences or fascines until vegetation has established.

4.6. Removal of Alien Invasive Plants

Port Jackson (*Acacia saligna*) which is a NEM:BA Category 1b invasive species, was recorded on site, and ruderal weeds occur in the downstream section. All alien invasive plants must be cleared from the wetland and its buffer using the methods in Appendix A, with follow-up clearing until alien cover remains below 5%.

Arum lilies (*Zantedeschia aethiopica*), *Typha capensis* and P*hragmites australis* are indigenous and must not be cleared as aliens. Their dominance reflects nutrient enrichment and changed hydrology. As stormwater treatment improves, their cover should be monitored, and localised thinning may be considered to create space for a more diverse plant community.

4.7. Revegetation

Revegetation must be undertaken under the guidance of a freshwater specialist and a suitably experienced landscaper or restoration practitioner. Vegetation reduces erosion, traps sediment, assimilates nutrients and toxicants, provides habitat and slows flow, and established indigenous vegetation prevents alien plants from returning. The aim is to reach at least 80% indigenous vegetation cover within 12 months of planting in all cleared, reshaped and polishing areas.

4.7.1. Procurement

- Use healthy, locally appropriate plant material, sourced as close to the site as possible.
- Order plants at least six months, and ideally twelve months, before planting is due, as nurseries need time to propagate the required numbers.
- Plants may also be propagated from healthy indigenous plants on site, such as divisions of rushes and sedges.

4.7.2. Species for revegetation

A provisional list of indigenous species for revegetation is given in **Table 4-1**. All of them were recorded on site or in the Jan Dissels River downstream, so they are suited to local conditions. *Typha capensis* and *Phragmites australis* already dominate the wetland and colonise readily, so they should not be planted. Species must be planted in the correct hydrological zone (permanent, seasonal or temporary), and a minimum of six species should be used, covering all zones.

Table 4-1: Provisional list of indigenous plant species for revegetation of the wetland.

Family	Species	Status	General information	Wetland plant type	Hydrological zone
Thurniaceae	*Prionium serratum (palmiet)*	LC	Endemic; recorded in the Jan Dissels River downstream	Obligate wetland	Permanent (channel margins)
Araceae	Zantedeschia aethiopica (arum lily)	LC	Indigenous; recorded on site	Facultative wetland	Seasonal/temporary
Cyperaceae	*Cyperus thunbergii* (giant sedge)	LC	Endemic; recorded on site	Obligate wetland	Seasonal/temporary
Cyperaceae	*Ficinia nodosa* (stembract clubrush)	LC	Indigenous; recorded on site	Obligate wetland	Permanent/seasonal
Juncaceae	*Juncus lomatophyllus* (leafy rush)	LC	Indigenous; recorded on site	Obligate wetland	Permanent/seasonal
Salicaceae	*Salix mucronata* (Cape willow)	LC	Indigenous; recorded on site	Riparian tree	Banks of the channel and river

4.7.3. Planting and seeding techniques

- Plant at about four plants per square metre, in autumn (March to May), so that plants establish roots before the winter rains.
- Dig holes 1.5 times as deep and twice as wide as the plant bag, plant with as much soil as possible around the roots, leave a slight depression around each plant and firm the soil by hand.
- Water plants in the temporary zone about every three days for the first six months, unless it has rained in the previous 24 hours.
- Sow seed of indigenous wetland species on lightly raked bare soil in autumn, and weed the seeded areas.
- Photograph the planting areas before planting, and have a freshwater specialist inspect them after planting and every six months until 80% cover is reached.

4.7.4. Landscaping of the public open space

- Use only indigenous species when landscaping the public open space around the wetland. Alien grasses such as kikuyu must not be planted next to the wetland.

5. Role Players

Implementing this plan requires several role players (**Table 5-1**). The practical and financial responsibility for the plan lies with the applicant, and long-term management with the municipality.

Table 5-1: Responsibilities of key role players.

Role player	Responsibility
Applicant / developer	Implement and fund this plan. Appoint the implementing agents and the freshwater specialist.
Cederberg Municipality	Long-term management of the wetland and public open space. Maintain the stormwater system, polishing zones and ponds. Solid-waste collection and enforcement against dumping.
Engineers (UDS Africa)	Design the stormwater treatment train, ponds, outlets and the Wetland 1 to Wetland 2 connection, with input from a freshwater specialist.
Contractor (under ECO supervision)	Remove waste and rubble, carry out earthworks and erosion control, and build the stormwater infrastructure.
Rehabilitation implementing agent (freshwater specialist and restoration practitioner)	Alien plant clearing, plant procurement, planting and follow-up. Rehabilitation monitoring and reporting.

Environmental Control Officer (ECO)	Monitor compliance with this plan and the EMPr during construction.

6. Monitoring and Management Plan

Monitoring is needed during rehabilitation to check that the objectives are being met, and afterwards to make sure that the wetland and the stormwater system remain in good condition. A summary framework is given in Appendix B, and these requirements should be included in the comprehensive monitoring plan required by the Aquatic Biodiversity Impact Assessment Addendum (Van Zyl and Morton, 2026).

6.1. Desired State

The desired state is a PES of at least category D for the central valley-bottom wetland system, with at least 80% indigenous vegetation cover, less than 5% alien cover, no dumped waste, no active erosion, and treated stormwater entering the wetland as diffuse flow. Once reached, this state must be maintained or improved.

6.2. Monitoring

6.2.1. Rehabilitation phase

- A freshwater specialist must inspect the site after the waste removal and earthworks are complete, after planting, and 12 months after planting.
- The stormwater settling ponds, forebays and polishing zones, including those before the discharge into the wetland at Pond 7, must be inspected by the engineers and a freshwater specialist after construction and after the first wet season.
- If the targets have not been met, annual inspections must continue until they are.

6.2.2. Post-rehabilitation phase

- A freshwater specialist must assess the PES of the central valley-bottom wetland system with WET-Health Version 2 (Macfarlane et al., 2020) three and five years after rehabilitation is complete, and audit the wetland every five years thereafter.
- Each audit must record vegetation cover, alien cover, erosion, waste and the condition of the stormwater infrastructure, compared with the fixed-point photographs.
- Sample water quality at the stormwater inflow to Wetland 1 and at the outflow of the wetland system to the Jan Dissels River twice a year (wet and dry season), for ammonia, nitrate, phosphate, EC, pH, suspended solids and E. coli, with detection limits below the aquatic ecosystem guidelines, to show whether the stormwater polishing is working. This should form part of the comprehensive monitoring plan required by the addendum (Van Zyl and Morton, 2026).

6.2.3. Fixed-point photography

- Set up at least six fixed photograph points, recorded with GPS coordinates, covering the inflows to Wetland 1, Wetland 1, the pipe outlet into Wetland 2, Wetland 2, and the downstream culvert.

- Take photographs annually in the same month during rehabilitation, and every five years thereafter.

6.3. Management Interventions

6.3.1. Erosion

- Check for erosion monthly in the wet season and after large storms, and repair it as soon as possible on the advice of a freshwater specialist, using soft engineering where possible.

6.3.2. Alien invasive plants

- Remove any alien invasive plants listed in Appendix A as soon as they are noticed, using the methods in that appendix.

6.3.3. Waste and dumping

- Remove dumped waste and tyres at least quarterly, and report persistent dumping to the municipality for enforcement.

6.3.4. Stormwater infrastructure

- Keep litter traps, forebays, settling ponds, swales, ponds and outlets clean and in working order, as set out in Section 4.3.

7. Conclusion and Recommendations

The wetland system on site is seriously modified and currently receives polluted stormwater from the informal settlement and township, which flows on to the Jan Dissels River. This plan combines the rehabilitation of the wetland with a stormwater treatment train, so that stormwater from both the existing settlement and the proposed development is treated before it enters the wetland, and the rehabilitated wetland then acts as a final polishing step before flow reaches the river.

The key measures are interception and treatment of the existing settlement stormwater, a treatment train with litter traps, settling ponds or sediment forebays, vegetated swales (as far as possible, in place of pipes), diffuse discharge through energy dissipators outside the wetland, removal of waste and alien invasive plants, revegetation with indigenous wetland species, and long-term monitoring and maintenance by the municipality.

It is the opinion of the specialist that implementing this plan would improve the condition of the wetland from PES E towards its REC of D and improve the quality of water reaching the Jan Dissels River. The plan should be included in the EMPr and implemented as a condition of the environmental authorisation and the water use licence, for which a full WULA is required (Van Zyl and Morton, 2026). Water quality sampling in September 2026 confirmed that the Jan Dissels River downstream of the works is strongly influenced by treated effluent, so the polishing role of the wetland and the reed bed, together with the WWTW upgrade, is important for the river.

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Appendix A: Invasive Species

Invasive vegetation can have a profoundly negative impact on aquatic systems and can threaten their ecological integrity. Invasive alien species tend to become dominant and can outcompete native plants by forming dense stands. This can result in a reduction of overall biodiversity of the system. When woody alien invasive species occur in high densities near aquatic systems it causes reduced average flow, decreased aquatic biodiversity, and increased erosion and sedimentation. Several invasive species are present in semi natural to disturbed areas within the wetland currently, or close to the wetland on the proposed development site. These could potentially impact the offset areas in the future and will require monitoring as mentioned in **Section 10.3.3** of this report. The appearance of the main invasive species of concern are indicated in **Table A** below. This table serves as a guideline to assist with species identification for monitoring and clearing operations.

Table A: Alien invasive species recorded in the wetland.

Species	Species Appearance
Acacia saligna (Port Jackson willow)	© Invasives.org.za

Methods for removal of invasive plants species of concern

The effective eradication and control of invasive plants requires initial clearing as well as follow-up interventions and continued monitoring. There are several initial clearing methods that can be implemented to remove invasive species of concern found on the identified offset wetlands. It is equally important for erosion control and to keep alien species suppressed, that the cleared areas be planted with locally indigenous wetland species. This is however dealt with in Section 8 above.

Hand Pulling

Use: Seedlings with a stem diameter of <5cm

Hand pulling should be implemented as the preferred clearing technique as far as possible. When implemented correctly, this method is extremely effective, yet its application is limited to seedlings. Thus, regular monitoring and follow-up treatments are important to ensure successful and economical eradication using this technique. The procedure to be implemented is as follows:

1. Wearing gloves, grip the plant firmly at the base of the stem and pull hard to remove the entire plant, including the rootstocks.
2. If the roots of the plant break off during removal, use a spade to dig them out.
3. Shake the plant to remove excess soils and dispose of the plant material at an appropriate waste disposal site.

Tree Popping

Use: Seedlings/Saplings with a stem diameter of approximately 5 cm

This technique is used for medium tree specimens and involves the use of an implement referred to as a "Tree-Popper". This tool consists of a base plate and a leaver that are joined to form a small pair of jaws (**Figure A1**). The tree is placed in the jaws of the tool and the leaver is used to pull the entire tree, including the roots, out. This tool is extremely useful for trees that are too large to be effectively removed by hand pulling yet are not yet large enough to require felling. The method to be used is similar as outlined for hand pulling, however the Tree-Popper is used instead of pulling.

Figure A1: Tree-Popper

Felling

Use: Trees with a stem diameter of >5 cm

Once the stems of trees reach a diameter of greater than 5 cm felling will need to be implemented to remove the individual. Felling can be undertaken using chain saws and bow saws. It is important that trees are cut with a neat straight cut to reduce the chance of resprouting and improve the effectiveness of stump herbicide treatment. Trees must be cut down as close to the ground as possible (between 5cm and 30cm above the ground). Felling must be undertaken by appropriately trained individuals that possess and make use of the required Personal Protective Equipment (PPE) for the task at hand.

Herbicide Stump Treatment

Use: Resprouting species that have undergone felling treatment

To prevent resprout from the stump after felling, an herbicide treatment needs to be applied post felling. Once the tree has been cut down to create a smooth surface that exposes the outer rings of the stem where the trunk grows (the cambium) a 3% Tryclopyr herbicide solution must be applied to the freshly cut surface. All side branches should also be removed and treated with herbicide. The herbicide treatment should be applied as soon as possible after felling (preferably within 3 minutes) to ensure effective treatment. Where trees with a diameter of greater than 10cm are felled, only the outer rings need to be treated with herbicide. Due to the potentially hazardous

nature of herbicides, the precautions outlined in the *Foliar Treatment* section above should also be applied during herbicide stump treatment.

Herbicides can kill indigenous plant species, and some are toxic to people and animals. It is therefore important to **prevent environmental contamination with herbicide**. The following measures are therefore recommended:

- Do not apply herbicide while it is raining and take care to prevent it from spilling, spraying, or spreading onto the ground or onto non-target species.
- Rain may wash herbicide into watercourses and spread it downstream, or across banks that need to be revegetated.
- Never wash herbicide equipment or dispose of waste spray mixture in or near watercourses where contamination can occur.

Disturbed areas from which alien plant species have been removed must be reshaped so that they tie in with the surrounding wetland slope and must be revegetated immediately according to Section 4.7.

Appendix B: Monitoring and Evaluation Framework

Intervention	Target	Indicator	Timeframe	Responsible Party
Removal of waste, tyres and rubble	No dumped waste in the wetland, channel or culvert	Visual inspection; disposal records	Before other rehabilitation (Year 1); then quarterly	Municipality; contractor under ECO
Interception and treatment of existing settlement stormwater	Stormwater from the settlement and township treated before entering Wetland 1	Litter traps, forebay and polishing zone in place and working; no scour	Design in Year 1; install with the stormwater works; inspect quarterly	Engineers; municipality
Stormwater treatment train for the new development	Peak flows at pre-development levels; treated, diffuse flow into the wetland	Litter traps, swales, settling ponds and forebays working; no scour at outlets	Install with the stormwater works; inspect quarterly and after large storms	Engineers; ECO; municipality
Wetland 1 to Wetland 2 connection and downstream culvert	Natural water levels in Wetland 1; connectivity without channelling	Water levels as designed; culverts clear; no erosion	Design in Year 1 with a freshwater specialist; inspect annually	Engineers; freshwater specialist
Alien invasive plant control (Acacia saligna and others)	Alien cover below 5% by Year 3	% alien cover in annual surveys	Initial clearing in Year 1; quarterly follow-up in Years 2–3; annually thereafter	Rehabilitation agent; ECO
Revegetation with indigenous wetland plants	At least 80% indigenous cover in planted areas	Plant survival; % indigenous cover	Plant in autumn of Year 1; inspect every 6 months until cover is reached	Freshwater specialist; rehabilitation agent
Erosion control	No active erosion	Absence of rills, gullies and headcuts	Inspect monthly in the wet season and after large storms; repair within 1 month	Municipality; contractor

Intervention	Target	Indicator	Timeframe	Responsible Party
Monitoring (fixed-point photographs and WET-Health)	PES of at least D for the central valley-bottom wetland system	Photographic record; WET-Health score	Baseline in Year 1; photographs annually; WET-Health in Years 3 and 5, then every 5 years	Freshwater specialist