Langaville Sewer and Water Pipeline, Ekurhuleni Metropolitan Municipality, Gauteng Province

General wetland rehabilitation- and monitoring plan to mitigate the construction related impacts

May 2021

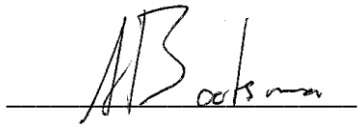
Drafted by
Limosella Consulting Pty Ltd
Reg No: 2014/023293/07
Email: antoinette@limosella.co.za
Cell: +27 83 4545 454
www.limosella.co.za

Prepared for:
Thembeka Environmental Consulting (Pty) Ltd
69 Rudi Neitz Street, Midrand ,1686
Tel: +27 71 678 1951
Email: samantha@thembeka-env.co.za

Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.



2021.05.21

Antoinette Bootsma (PrSciNat) Date

Ecologist/Botanist

SACNASP Reg. No. 400222-09

Document and Quality Control

Project name: Langaville Sewer and Water Pipeline, Ekurhuleni Metropolitan Municipality, Gauteng Province			
Nature of Signoff	**Responsible Person**	**Role/Responsibility**	**Qualifications**
Author Wetland aspect	Antoinette Bootsma	Senior Wetland Specialist	MSc *Cum Laude,* Unisa, Environmental Science Pr.Sci.Nat (400222/09)
Author Aquatic aspect	Bertus Fourie	Aquatic Specialists	MSc Aquatic Science Pr.Sci.Nat: (400126/17)
Document number	**Checked by:**	**Electronic Signature:**	**Date**
Technical Review	Antoinette Bootsma		2021.05.21
Client review			
Final Report	Antoinette Bootsma		

Table of Contents

Figures

Tables

INTRODUCTION

Limosella Consulting was appointed by Thembeka Environmental Consulting to undertake an aquatic biodiversity assessment, including reference to wetlands and riparian areas, to inform the Environmental Authorization, including authorization from the Department of Water and Sanitation for proposed sewer and water pipelines installation and repair located in Langaville, Ekurhuleni, Gauteng. The proposed activities include replacement of sections of old water pipelines within existing road servitudes and the implementation of a sewer pipeline. Pipes will be laid primarily through trenching. Fieldwork was conducted in April 2021.

Watercourses in the 500m area of investigation around each section of pipeline discussed in this report lie in two quaternary catchments. In Quaternary catchment C21E 2 valley bottom and 3 pan wetlands drain into the Blesbokspruit. In Quaternary catchment C22C 3 valley bottom wetlands drain into a tributary of the Rietspruit. A canalised watercourse extends across both catchments. Figure 2 below presents the regional hydrology and Figure 3 shows the delineated wetlands, their buffer zones and DWS regulated area relative. The study area lies in the 5th Water Management Area, Vaal Major.

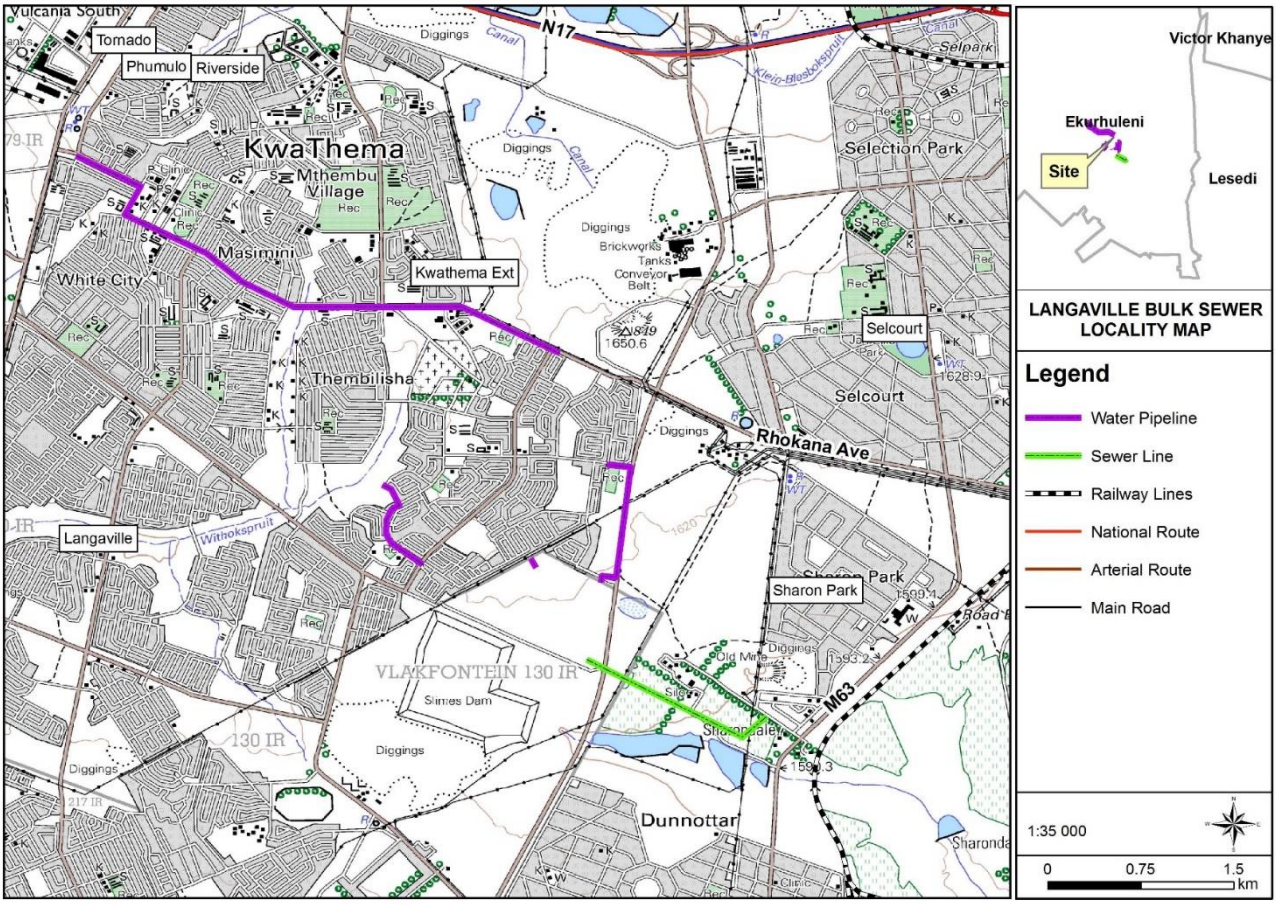


Figure 1: Location of the sewer pipeline alignment discussed in this report

1.1 Assumptions and limitations

- This document is based on information as received by Thembeka Consulting

- The document takes into account likely impacts that can arise during the installation of sewer and replacement of waterof pipeline infrastructure. However, some unique impacts may arise that must be recorded during monitoring and appropriate corrective actions taken.
- Engineering drawings and the specification of rehabilitation structures falls outside of the scope of this general rehabilitation plan.
- This report recognises that construction includes:
  - Stripping and removal of vegetation and topsoil along the alignment;
  - Excavation of sub soil for trenching;
  - Stock piling of top and sub soil
  - Laying of the pipeline upslope of the wetland by means of trenching;
  - Closure of the trench;
  - Reinstatement and rehabilitation of the footprint.

The time lapse between these phases of construction depends on the contactor's work plan. However, it is understood that the three phases will take place in sections e.g. the pipeline is put in place as the trench is opened and thereafter immediately closed before moving on to the next section.

1.2 Objective and aims

The wetland rehabilitation and monitoring plan is specific to the construction of the proposed pipeline upslope of the delineated wetlands that could impact on the wetlands down the slope. Example of upslope activities that impact on downslope wetlands include for example earthworks in the terrestrial area where sediment may wash into downslope wetlands such as the drill entry and exit points.

This document aims to limit localised impacts relating to the construction and to prevent further degradation of the watercourses in the catchment. It also aims to encourage local improvements on the study site and immediate surrounds.

The overall objective is to return the environment in and around footprint of the pipeline to a state as close to the state prior to construction and to limit or negate any construction and operational associated impacts by:

- Ensuring the footprint of the impact on the watercourses is as small as possible;
- Ensuring that the planning phase takes wetland rehabilitation and monitoring into account for both the construction and operational phase;
- Ensuring that the positioning of the proposed pipeline and operation does not lead to any further degradation in the PES of the wetlands;
- Employing preventative measures during the construction phase;
- Providing guidance on rehabilitation of areas that are temporarily disturbed during construction;
- Reducing the likelihood of erosion and subsequent sedimentation during construction and operation; and

- Recommending monitoring and corrective actions in order to mitigate impacts as soon as they become apparent.

2 METHODOLOGY

In order to protect biodiversity and conserve sensitive environments during development, steps that should be followed is to firstly avoid, then minimize, then repair or restore, and finally compensate for or offset the negative effects of any development on biodiversity (SANBI, 2013). Thus where the impact is unavoidable, the impacts must be minimised and the unavoidable and unforeseen impacts restored or rehabilitated. Rehabilitation refers to the measures that are undertaken to return impacted areas to their pre-impact natural state and can occur as an on-going and integral activity during the construction activity. From the perspective of minimizing impacts on biodiversity and ecosystem services, on-going rehabilitation to indigenous vegetation during the construction is preferred as it effectively reduces the time lag during which negative impacts endure. In order to realise the objective of the rehabilitation plan, it is necessary to limit the impact as much as possible to reduce the need for costly rehabilitation and corrective action. Therefore, mitigation should already start in the planning phase in order to direct construction to have the least impact possible, reducing follow-up rehabilitation and corrective actions. Therefore, this rehabilitation document comprises of three plans (Table 1):

1. Mitigation Plan: to focus pre-construction planning and activities on limiting the possible impacts that can arise during construction.
2. Rehabilitation Plan: aimed at rehabilitating the areas temporarily disturbed by the construction. This document recognises that construction will entail three phases.
3. Monitoring Plan: aimed at monitoring the success of rehabilitation as well as recording any impacts that may arise during the operational phase of the pipeline (including maintenance), for which corrective action is needed.

Table 1: Plans in relation to the relevant project phases

Plan	Project Phases
1. Mitigation plan	• Pre-construction planning and activities • Construction • Operation
2. Rehabilitation plan	• Construction • Operation
3. Monitoring and corrective action	• Construction • Operation

3 DESCRIPTION OF ENVIRONMENT AND WATERCOURSES AFFECTED

Historical mining forms and important context of the land use of the site. To the south, the Vlakfontein Gold Mine which was mined from 1942-1977. Mine dumps are also visible to the west of the site. Water from this mine likely leaches into the watercourse directly south of the pipeline. Current land use is dominated by residential infrastructure, roads and associated commercial activities including cemeteries, retail and community centres. The lands traversed by the proposed sewer pipe are clearly ploughed. High

density residential areas have established over several decades and include roads, schools, retail and commercial components.

3.1 Delineated Water Courses

Watercourses in the 500m area of investigation around each section of pipeline discussed in this report lie in two quarternary catchments. In quarternary catchment C21E 2 valley bottom and 3 pan wetlands drain into the Blesbokspruit. In Quarternary catchment C22C 3 valley bottom wetlands drain into a tributary of the Rietspruit. A canalised watercourse extends across both catchments. Figure 8 below shows the delineated watercourses, their associated generic and calculated buffer zones as well as the DWS 500m regulated area around each watercourse. Each wetland is discussed in more detail below

.

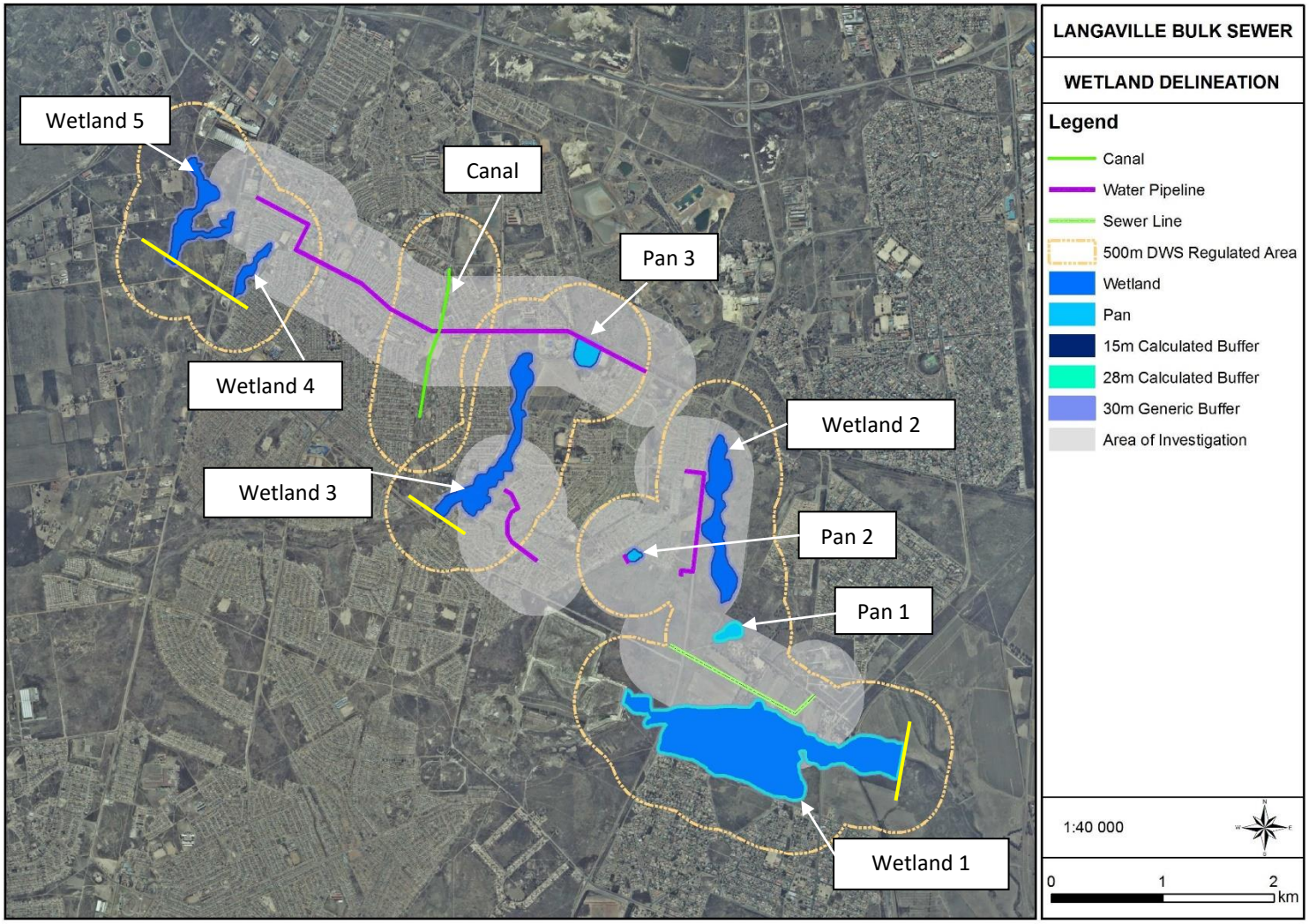


Figure 2: The delineated wetlands and their associated buffer zones as well as the DWS regulated area relative to the proposed pipeline

3.2 Wetland Integrity and Function

The increased hardened surfaces in its catchments due to residential development as well as the intensive changes to the geomorphology and hydrology of the wetland systems have significantly impacted the functionality of wetlands. In many instances hydrology has been significantly impacted mining, roads, and stormwater outlets. Footpaths, dirt roads, dumping and littering also has some impacts on the watercourses.

3.2.1 Scores

Detailed function and integrity scores are presented for each wetland in the accompanying Aquati Biodiversity Assessment.

Table 2 provides a summary of the results recorded for the wetland units potentially affected by the proposed sewage and water pipelines earmarked for repair and replacement.

Table 2: Summary of results for each watercourse unit discussed

Wetland 1	**PES: 48% - EC = D: Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred. **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very Low with Moderate to Moderately High scores for Toxicant and Phosphate Assimilation and Sediment Trapping **Recommended Ecological Management Category: D** **Instream habitat (IHAS):** The IHAS score was calculated to 44.7% for the sample site. This indicates the habitat that not suitable for supporting a diverse macroinvertebrate community. **Aquatic macroinvertebrate assemblages:** The number of taxa observed on site were 8 with a combined SASS score of 18. The Average score per taxon (ASPT) was 2.3- this is low but is mainly driven by the lack of stones habitat and decreased water quality. The taxa observed are all hardy and able to survive in difficult conditions.
Wetland 2	**PES: 53% - EC = D: Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred. **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very Low with Moderate to Moderately High scores for Toxicant and Phosphate Assimilation and Sediment Trapping **Recommended Ecological Management Category: D**
Wetland 3	**PES: 52% - EC = D: Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred. **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and

	sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very Low with Moderate to Moderately High scores for Toxicant and Phosphate Assimilation and Sediment Trapping **Recommended Ecological Management Category: D**
Wetland 4	**PES: 35% - EC = E: Seriously Modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very Low with Moderate to Moderately High scores for Toxicant and Phosphate Assimilation and Sediment Trapping **Recommended Ecological Management Category: D**
Wetland 5	**PES: 57% - EC = D: Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred. **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very High scores are obtained for Toxicant Assimilation and Sediment Trapping. Provisioning and Cultural services score Very Low **Recommended Ecological Management Category: D**
Pan 2 and 3	**PES: 52% - EC = D: Largely modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred. **EIS: Low/Marginal.** Wetlands in this category are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers **ES:** Very Low with Moderate to Moderately High scores for Toxicant and Phosphate Assimilation and Sediment Trapping **Recommended Ecological Management Category: D**
Canal	**PES: 11% - EC = F: Critically Modified**. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.

4 EXPECTED IMPACTS

Impacts and consequently also mitigation and rehabilitation measures specified are relevant to the construction of the sewer pipeline and to the proposed replacement and repair of water pipelines. The proposed sewer pipeline will be located upslope of a channelled valley bottom wetland and a number of impacts can be expected as discussed below. The water pipelines come into close proximity to two pans and are located upslope of several valley bottom wetlands. The water pipelines are confined to existing road servitudes.

Changing the physical structure within a water resource: Trenching activities upslope, including the placement of the drill entry and exit points may result in sediment washing into the downslope wetlands which may affect its structure.

Clearing/removal of natural vegetation: The plants that grow in wetlands are vital for preventing erosion, they play a role in the purification of water, reducing the severity of floods and regulating water, especially during droughts. The moment the vegetation is destroyed, these valuable functions disappear. In addition, vegetation around watercourses, especially upslope, holds soil in place and slows down water runoff during rainy events. The vegetation thus promotes groundwater recharge, while protecting soils from eroding, subsequently causing sedimentation in watercourses.

Compaction of soils: Construction activities may compact soils from heavy equipment access which could inhibit seed germination, reduce water infiltration, inhibit root establishment, and result in bare soil exposure. In particular, soil compaction can lead to an increase in runoff during rainy events, especially in the footprint of the excavated trench. Soil compaction is expected to occur during clearing of the servitude, construction and maintenance (operational phase).

Exposure to erosion: Removal of stream bank vegetation, vegetation against slopes and compaction of soils, expose the resulting bare soils to erosion during rainfall events. Erosion removes the top soil layer, thereby preventing the successful establishment of indigenous vegetation on eroded soils. Eroded areas are likely to be colonised by alien invasive and pioneer plants, or in severe cases, no vegetation will establish causing high velocity runoff during rainfall events and continuous erosion.

Sedimentation of wetlands and rivers: Soil erosion could lead to increased sedimentation and turbidity downstream of the activity, which in turn reduce the water storage capacity thereof, smother vegetation, and decrease oxygen concentration. If sedimentation is allowed to continue, wetlands will lose their function and likely become invaded by alien invasive plant species.

Mobilisation of pollutants: Accidental pollution or illegal disposal and dumping of construction material such as cement or oil, as well as disposal or discharge of human (including partially treated and untreated sewage) into water resources will influence the water quality of watercourses, thereby influencing its functionality and the persistence of vegetation. Water is expected to seep into any area of digging and thus is likely to fill the trenches where the pipeline is to be installed. However it is likely that water could be contaminated within these trenches. Furthermore, the surrounding areas are already exposed to pollution which during high rainfall events could be washed into the wetland and pan – especially if vegetation cover is not sufficient to slow down water and filter pollutants.

Invasion by alien invasive vegetation: During construction, vegetation will be removed and soil disturbed. The seeds of alien invasive species that occur on and in the vicinity of the construction area could spread into the disturbed or stockpiled soils. In addition, the construction vehicles and equipment were likely used on various other sites and could introduce alien invasive plant seeds to the construction sites. From these construction sites, alien invasive plant species can easily spread downstream, likely resulting in offsite impacts.

5 MITIGATION PLAN:

On site mitigation can limit the impact of construction activities and reduce the need for expensive rehabilitation and the need for corrective action. In addition, sedimentation is very difficult and sometimes impossible to rehabilitate without further impacting on watercourses. Therefore, sedimentation should be prevented through mitigation. Table 3 list the mitigation measures that should be implemented during the planning and construction phase in order to limit the need for rehabilitation.

Table 3: Mitigation plan

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Pre-construction planning	Limit the footprint of construction thereby reducing compaction and destruction of natural vegetation.	• The method statement approved by the DWS must be available on site for reference purposes • Ensure that the development footprint remains outside the delineated watercourse and its associated buffer zones • Consider the various methods material and equipment available to install the pipeline and select whichever method(s) that will have the least impact on watercourses. • Demarcate the construction footprint prior to commencement of construction and ensure that all workers and contractors are aware that access beyond the demarcated areas are not allowed Where the pipeline will affect a wetland, the edge / boundary of this wetland must be clearly demarcated in the field with poles, sticks, or any solid structure that will last for the duration of the development. • Ensure that a copy of this and other applicable documents are available on site and that all workers and contractors are aware of it. Implementation thereof should be monitored by the appointed Environmental Officer (EO) or Environmental Control officer (ECO) • Plan construction activities that necessitate water crossings to only cross watercourses at designated points
	Limit the footprint of access roads and constructing camps, thereby reducing compaction and destruction of natural vegetation	• Make use of existing roads in such a way as to minimise impact on the wetlands • Plan construction activities that necessitate water crossings to only cross watercourses at designated points • Plan construction camps to be placed outside of watercourses and their associated buffer zones
	Limit the impact on the hydrology and morphology of the wetland	• The method statement approved by the DWS must be available on site for reference purposes • Activities must be conducted in a manner that does not negatively affect catchment yield, hydrology and hydraulics of local or downstream areas • Plan for necessary erosion protection measures to ensure the sustainability of all structures
Construction	Limit the construction footprint and related impacts	• Topsoil must be stripped and redistributed. Stockpiles' height is restricted to 2.5m in order to preserve the soil's microbiological and nutrient characteristics. Topsoil must be placed immediately after stripping, if possible, but not stockpiled for longer than three months • Only use access roads as designated during the planning phase • Only cross watercourses at designated points • Limit the removal of indigenous vegetation in the construction footprint and do not remove vegetation outside of the construction footprint

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
		• Contractors should refrain from impacting areas beyond the demarcated construction area • Minimise disturbance and loss of soil • The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared
Construction	Prevention of pollution	• The contractors must provide and maintain a method statement for "cement and concrete batching". The method statement must provide information on proposed location, storage, washing & disposal of cement, packaging, tools and plant storage • Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area (outside of the wetland buffer), in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase • The mixing of concrete should only be done at specifically selected sites on mortar boards or similar structures to contain run-off into drainage lines, streams and natural vegetation • Materials such as fuel, oil, paint, herbicide and insecticides must be sealed and stored in bermed areas or under lock and key, as appropriate, in well-ventilated areas • These substances must be confined to specific and secured areas within the contractor's camp, and in a way that does not pose a danger of pollution even during times of high rainfall • Storage of materials as described above may not be within the 1:100 floodline, watercourses or associated buffer areas • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs (DWS) must be informed immediately • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle • Provision of adequate sanitation facilities located outside of the wetland/riparian area or its associated buffer zone • Remove all construction equipment and material on completion of construction • No water should be abstracted from any river / wetland without DWS authorisation • Activities that lead to elevated levels of turbidity in any watercourse must be prevented, reduced, or otherwise remedied

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction		• Any hazardous substances must be handled according to the relevant legislation relating to transport, storage and use of the substance and all storage facilities must be equipped with large, clearly readable material safety data sheets
	Prevent/limit sedimentation	• Increased run-off during construction must be managed using berms and other suitable structures as required to ensure flow velocities are reduced; this must be done in consultation with the ECO • The contractor shall ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Where wetlands are adjacent to the construction areas and these areas slopes toward the wetland, install sediment barriers along the edge of the construction areas as necessary to prevent sediment flow into the wetland • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration of adjacent upland areas is complete • It is important that topsoil should be conserved in areas where bedrock is shallow to avoid sedimentation • Should water need to be pumped around the works area and discharged back into the wetland, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the construction area or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the wetland. The water must be dissipated on re-entry into the wetland, to reduce the changes of erosion • Access roads that cross wetlands should be tarred or concreted along the extent of the watercourse and extend at least 100m beyond the extent of the watercourse to minimise the impact of the watercourse Erosion berms must be implemented for the entire life-of-project to prevent gully formation. The designs and placement of the berms must be done by a registered, professional, independent Civil Engineer and approved in writing by DWS before construction commences • Where any road is within the 100m buffer zone of the watercourse, this portion of the road shall be concreted or tarred • Increased runoff due to vegetation clearance (promoting limiting vegetation clearance at a time) and/or soil compaction must be managed and steps taken to ensure that stormwater does not lead to bank instability and excessive levels of silt entering the watercourse(s)

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
	Stormwater Management	• Stormwater must be diverted from construction works, access roads, linear infrastructure and other areas associated infrastructure and must be managed in such a manner as to disperse runoff and prevent the concentration of stormwater flow • The velocity of stormwater discharges must be attenuated and the banks of the watercourses protected • No other discharges into any watercourse (directly or indirectly) are allowed • Sheet runoff from paved, hardened and compacted surfaces and access roads need to be curtailed
	Maintenance of biodiversity and preventing spread of alien invasive	• The current levels of diversity of biotopes and communities of animals, plants and microorganisms must be maintained • All reasonable steps must be taken to minimise noise and mechanical vibrations in the vicinity of the watercourses • Indigenous vegetation, including dead trees, outside the limits of disturbance indicated on site plans must not be removed from the site • Existing vegetation composition must be maintained or improved by maintaining the natural variability in flow fluctuations. Recruitment and maintaining a range of size classes of dominant wetland species in perennial channels must be stimulated • All reasonable steps must be taken not to disturb the breeding, nesting and/or feeding habitats and natural movement patterns of fauna including aquatic biota • Alien invasive species that where identified within servitudes should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils • Appointment of alien plant working group / assign this duty to specific staff • If herbicide must be used it should be registered for aquatic use • Acquire the necessary equipment for removal and control • Planned sequence of areas to be cleared of invasive plants

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
		• A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage • Ensure that contractors can identify the relevant plants and are aware of the removal procedures • Construction equipment must be cleaned prior to site access. This will prevent alien invasive seed from other sites to spread into disturbed soils

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Operation	Prevention of pollution	• Structures must be inspected regularly for accumulation of debris, blockages, erosion of abutments and overflow areas – debris must be removed and damages must be repaired and reinforced immediately • The contractor shall ensure that a method statement is prepared prior to maintenance work to ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Plan monitoring during the operational phase to ensure that the construction footprint is adequately rehabilitated • During maintenance or emergencies (e.g. burst pipe) in areas that slope toward wetlands, install sediment barriers along the edge of the maintenance activity as necessary to prevent sediment flow into wetlands • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration of adjacent upland areas is complete • Where maintenance work or emergency action must be undertaken and water needs to be pumped around the works area and discharged back into the wetland, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the maintenance activity or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the wetland. The water must be dissipated on re-entry into the wetland, to reduce the changes of erosion
	Alien vegetation management	• Plan an alien invasive plant work group that can carry out follow-up alien plant control for at least three years after construction

6 REHABILITATION PLAN

Rehabilitation in this document refers to the reinstatement of the temporarily disturbed areas affected by the construction or due to construction related activities, to a state that resemble the conditions prior to the disturbances. It therefore does not address the rehabilitation of the wetlands along the proposed pipeline route for example a management category C to a B (Kleynhans, 1996 & Kleynhans, 1999). In order to improve the management category, the current impacts due to urbanisation should be addressed and these fall outside the scope of this document.

This wetland rehabilitation plan recognises two phases of rehabilitation:

- Phase 1: Construction associated with installation of the underground pipeline; and
- Phase 2: Operation, in particular where changed hydrology causes erosion or wetland degradation of any sort as identified during the monitoring phase described below

Phase 1:

The pipeline will be constructed primarily through trenching upslope of the wetland associated with the site. Rehabilitation therefore focuses on reinstatement of soil and vegetation components upslope of the wetland, including the rehabilitation of trenches and drill entry and exit points. The following rehabilitation measures should be implemented (Table 40).

Phase 2:

This phase of rehabilitation is associated with potential impacts of the operational phase of the pipeline as observed during monitoring. An example is the formation of erosion where preferential flow paths are formed. Rehabilitation measures appropriate to this phase will depend on the habitat degradation observed. Detailed rehabilitation measures should be formulated based on the specific conditions at that time. Guidance to decision making in this regard is provided in the monitoring plan in Table 5.

Table 4: Rehabilitation plan

Activity	Rehabilitation	Time frame
Planning	• Rehabilitation should proceed directly after closure of the trench and drill entry and exit points although revegetation may have to be postponed to the onset of the growing season • Plan the access and construction areas for the site. • The rehabilitation plan must be made available to all parties involved. • Plan the areas to be rehabilitated in stages so as to work on one area at a time.	• Duration of rehabilitation activities
Access control	• Access must be restricted to as few people as possible. • No vehicles may access the wetland channel during resloping and infilling activities. • All works should be supervised.	• Duration of rehabilitation activities
Site preparation	• Compacted and disturbed areas must be shaped to natural forms and follow the original contours. In general cut and fill slopes and other shaped areas must not exceed 1:3 (v:h) ratio • Slopes for revegetation must be cleared of alien and invasive plants. • Manual / mechanical removal of alien plants is preferred to chemical control • If herbicide must be used it should be registered for aquatic use • Acquire the necessary equipment for removal and control • Planned sequence of areas to be cleared of invasive plants • A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage • Indigenous vegetation must be cut to just above ground level and stockpiled for use in brush packing and seeding. • Activities must commence in areas that are small enough to be revegetated and stabilised before working on another area. • Areas where indigenous grass clump growth are unaffected by resloping activities should be preserved in order to stabilise the banks. • Soil heaps dumped on the immediate site can be used for filling areas for resloping.	• Commence in early rain season (September to October)

Activity	Rehabilitation	Time frame
	• The use of fertiliser should be avoided. Nutrient deficiencies are not expected to be present on the site. • Soils must be moist for revegetation activities. • Badly damaged areas should be fenced in to allow for rehabilitation to take place without further impacts on these areas • Excavate and backfill trenches on a progressive basis	
Resloping	• Slope reshaping must follow the natural slope and topography of the surrounding undisturbed area • Areas for resloping must be ripped or loosened to a depth of 150mm to prepare soils for revegetation and allow water penetration into the soils. • Ripping must be done manually with hand tools. • No vehicles are permitted in the area in order to prevent further disturbance to the wetland. • Ripping must be done during the late dry season to prevent erosion and collapse of the banks. • The original contours must be established over the pipeline. After the backfill has subsided, the contours must follow the surrounding contours to stop irregular flows, flow into surface cracks to the pipe or blockage of biotic movement	• As soon as possible after closure of the trench or drill entry and exit areas
Revegetation	• A suitable grass mixture must be spread by hand along the extent of the slopes. The proposed grass species list and application rate is indicated in **Table 11** below. • Seeds must be thorough mixed before applying. • The seeds must be applied according to the required rates. • Application rates can be increased in areas that are unfavourable or steep, but no more than double the recommendations. • Seeds can be mixed with a spreading agent such as river sand, bran or finely sifted kraal to ensure even distribution. • Manure or agricultural lime and granular fertiliser mix can be applied prior to reseeding. • Once complete, the seeded area must be watered and patted down gently. • Indigenous vegetation removed from the area must be applied over the seeded area as mulch.	• Directly after resloping and no later than November.

<table>
<tr><th>Activity</th><th>Rehabilitation</th><th>Time frame</th></tr>
<tr><td></td><td>Table 5: Suitable plant species for seeding together with application rates

<table>
<tr><th>Species</th><th>Common name</th><th>Application rate (kg/ha)</th></tr>
<tr><td>Digitaria eriantha</td><td>Finger grass</td><td>8</td></tr>
<tr><td>Eragrotis curvula</td><td>Weeping love grass</td><td>4</td></tr>
<tr><td>Eragrostis tef</td><td>Tef</td><td>8</td></tr>
<tr><td>Imperata cylindrica</td><td>Cottonwool grass</td><td>8</td></tr>
<tr><td>Panicum maximum</td><td>Guinea grass</td><td>4</td></tr>
<tr><td>Total</td><td></td><td>36</td></tr>
</table></td><td></td></tr>
<tr><td>Slope stabilisation</td><td>• The slopes must be covered by jute or hessian geotextiles (soilsaver or GeoJute or similar biodegradable product a mesh through which seedlings can grow).
• The geotextile must be placed vertically on the slopes and overlap at the edges. It can be fastened with wooden stakes every 1m.</td><td>• Directly after revegetation.</td></tr>
</table>

7 MONITORING PLAN

Monitoring refers to the repetitive and continued observation, measurement and evaluation of environmental criteria to follow changes over a period of time and to assess the efficiency of control measures. The monitoring plan aims to establish whether rehabilitation was successful, whether maintenance or related activities have impacts and whether the implementation of the proposed pipeline has detrimental impacts on the wetland after construction (Table 5). Five phases of monitoring is recommended:

Routine Monitoring:

1. Monitoring during construction: during construction, the mitigation measures put in place to limit or negate the construction related impacts on a watercourse must be monitored. Where these mitigation measures are not sufficient or breached, immediate corrective action should be taken.

2. Monitoring post construction phase: it is assumed that the construction will be phased and that rehabilitation is thus an ongoing effort as each phase is completed. For example, once a portion of pipeline is laid the trench is closed and rehabilitated. Monitoring post construction is important to detect any erosion, sedimentation or faulty structures. As each phase is completed the area is monitored for impacts and corrective action taken where needed.

3. Seasonal monitoring: after construction is complete, rehabilitation success, as well as signs of erosion, sedimentation and the presence of alien vegetation should be monitored twice during the summer months: once at the start and once at the end of the rainy season. This should be continued for at least three years after construction was completed.

4. Rapid monitoring: For the first two years, monitoring should take place immediately after heavy rainfall to ensure that rehabilitated areas are intact and that no erosion and subsequent sedimentation took place.

5. Routine monitoring: after three years, provided that all rehabilitation was found to be successful and no additional problems arose, monitoring can take place as part of the routine patrol of the pipeline during which problems may be highlighted.

Problems such as failed re-vegetation and erosion should be remediated as soon as it is recorded in the monitoring process. Corrective action should be taken and can include the re-initiation of rehabilitation in severe cases or by correction of the problem (e.g. mend broken fences). If problems arise due to the implementation of the underground pipeline that was not pre-empted in this plan, an engineer and wetland specialist should be consulted as soon as possible.

It is recommended that fixed point photography is used to monitor vegetation and soil stability. This involves taking pictures of the areas monitored from the same point during each monitoring event. The images can be compared and serves as a record of the success of rehabilitation or the failure thereof.

Table 6: Monitoring plan

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Hydrology of the wetland	• On-site inspection	• After construction and rehabilitation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Water flows though the rehabilitated area, not causing erosion	• Re-landscape the trench area to a state prior to the disturbance • Energy dissipaters if required
Integrity of rehabilitation structures - where utilised	• On-site inspection • Fixed point photography.	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Arresting of erosion/head cut. • Sedimentation behind structure • Elevated (to near normal) water table level behind structure	• Structures should be fixed where possible or new structures should be implemented
Vegetation cover	• On-site inspection • Assess landscape functionality • Monitor species cover abundance and ensure that natural species cover increase(compare to vegetation study results prior to construction) • Fixed point photography	• After re-vegetation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Spreading and distribution of dominant plant species in specified wet zones • During rehabilitation, a vegetation basal cover of at least 15% shall be maintained at all times • Wetland re-vegetation shall be considered successful if the cover of herbaceous and/or woody species is at least 80 percent of the type, density, and distribution of the vegetation in adjacent wetland areas that were not disturbed by	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern • Prevent livestock from entering rehabilitated areas for at least three years • If re-vegetation is not successful at the end of 3 years, develop and implement (in consultation with an ecologist) a remedial re-vegetation plan to actively re-vegetate the disturbed area. Continue re-vegetation efforts until wetland re-vegetation is successful • If wetland rehabilitation is successful at

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
			construction	the end of 3 years, report on the status of the vegetation (e.g. using photographic record) and if maintenance activities might have disturbed the area again
Plant species composition	• Fixed transect to determine the species composition	• Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Presence/absence of species in specified wet areas.	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern. • If exotic plants have colonised the area the exotic plants should be removed.
Erosion	• On-site inspection • Fixed point photography Compare to adjacent land	• During and immediately after construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Areas where vegetation cover is limited or nil and where soil has started to erode • Bare soil patches or ditches • Stabilised head cut and gully erosion • Water table behind structure	• Should erosion occur, soft options such as hay bales, eco-logs and replanting should be considered, if erosion is too great for soft options then a rehabilitation method should be discussed with an engineer and wetland specialist
Sedimentation	• As determined by ECO • Visual observations and site inspections • Fixed point photography	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter during routine inspections	• Excess sediment in wetlands • Sediment behind structure	• Cause of sedimentation should be identified and dealt with appropriately • Should sedimentation be observed to accumulate and smother vegetation, a wetland specialist should be consulted to find a suitable solution for the specific wetland / river and its plant species composition.
Alien Invasive Plant Species	• Monitor the emergence of alien invasive plant species in or around	• After construction • After re-vegetation • Seasonal for the first	• Establishment of alien invasive plant species in rehabilitated areas or in watercourses	• Remove emergent invasive vegetation from the rehabilitated footprint and servitude as soon as it becomes apparent

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
	rehabilitated areas • On-site inspection • Fixed point photography	three years and rapidly after heavy rainfall • Thereafter during routine inspections		• Manual labour is preferred above chemical or manual removal. • Do not use herbicides or pesticides in or within 200 meters of wetland areas

8 REFERENCES

Department of Water Affairs and Forestry (1999). Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0. Pretoria

Department of Water Affairs and Sanitation (2016) Risk-based Water Use Authorisation Approach and Delegation Protocol for Section 21(c) and (i), Edition 02

Dallas, H.F. (2005). Volume 2 – Maps of national RHP monitoring sites – per water management area In: Inventory of national river health programme monitoring sites. Report prepared for Environmentek (CSIR) and Resource Quality Services, Department of Water Affairs and Forestry.

Dallas, H.F. (2007). River Health Programme: South African Scoring System (SASS) data interpretation guidelines. Report prepared for Institute of Natural Resources and Department of Water Affairs and Forestry.

Davies, B. & Day, J. (1998). Vanishing Waters. Cape Town: University of Cape Town Press.

Department of Water Affairs and Forestry. 1996. South African Water Quality Guidelines (second edition). Volume 1: Domestic Use. Volume 4: Agricultural Use: Irrigation. Volume 5: Agricultural Use: Livestock Watering. Volume 7: Aquatic Ecosystems. Pretoria: Department of Water Affairs and Forestry.

Department of Water Affairs (2008): Updated Manual for the Identification and Delineation of Wetlands and Riparian areas.

Kleynhans, C.J. (1999): A procedure for the determination of the for the determination of the ecological reserve for the purpose of the national water balance model for South African Rivers. Institute for Water Quality Studies Department of Water Affairs and Forestry, Pretoria.

Kotze, D., Macfarlane, D. & Edwards, R. (2020). WET-EcoServices (Version 2): A technique for rapidly assessing ecosystem services supplied by wetlands and riparian areas. Final Report. WRC Project K5/2737

Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. (2020). WET-Health (Version 2.0): A Refined suite of tools for assessing the present ecological state of wetland ecosystems – Technical Guide. WRC Report No. TT 820/20.

Macfarlane D.M., Teixeira-Leite A., Goodman P., Bate G and Colvin C. (2015) Report on the Development of a Method and Model for Buffer Zone Determination. Water Research Commission project K5/1789. The Institute of Natural Resources and its Associates

Macmillan, P.H. (1998). An Integrated Habitat Assessment System (IHAS v2) for the Rapid Biological Assessment of Rivers and Streams. A CSIR research project. Number ENV-P-I 98132 for the water resources management programme. CSIR.