FINAL AMENDED ENVIRONMENTAL MANAGEMENT PROGRAMME

Proposed Vulindlela Bulk Water Supply (BWS) Upgrade between Howick West and Reservoir 2, uMngeni Local and Umgungundlovu District Municipalities, KwaZulu-Natal

MAY 2023

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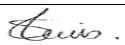
Simone Lewis Assistant author	April 2021	

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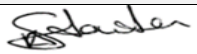
Kerry Stanton Director	May 2023	

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Acronyms

S&EIR	SCOPING AND ENVIRONMENTAL IMPACT REPORT
DEA	DEPARTMENT OF ENVIRONMENTAL AFFAIRS
DWS	DEPARTMENT OF WATER AFFAIRS AND SANITATION
EA	ENVIRONMENTAL AUTHORISATION
EIA	ENVIRONMENTAL IMPACT ASSESSMENT
EIR	ENVIRONMENTAL IMPACT REPORT
ECO	ENVIRONMENTAL CONTROL OFFICER
EDTEA	DEPARTMENT OF ECONOMIC DEVELOPMENT, TOURISM AND ENVIRONMENTAL AFFAIRS
EMPR	ENVIRONMENTAL MANAGEMENT PROGRAMME
IEM	INTEGRATED ENVIRONMENTAL MANAGEMENT
KSEMS	KSEMS ENVIRONMENTAL CONSULTING
KZN	KWAZULU-NATAL
MSDS	MATERIAL SAFETY DATA SHEET
NEMA	NATIONAL ENVIRONMENTAL MANAGEMENT ACT
PCA	POST CONSTRUCTION AUDIT
SHE	SAFETY, HEALTH AND ENVIRONMENT
SWMP	STORM WATER MANAGEMENT PLAN

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

Umgeni Water (UW) is a state-owned business enterprise that operates within the South African legislative parameters of the Water Services Act (Act No. 108 of 1997), Public Finance Management Act (Act No. 1 of 1999) and Public Audit Act (Act No. 25 of 2004). The primary function of UW is to supply bulk potable water to its customers, comprising of seven municipalities in KwaZulu-Natal, namely:

- eThekwini Metropolitan Municipality
- iLembe District Municipality
- Sisonke District Municipality
- uMgungundlovu District Municipality
- Ugu District Municipality
- Msunduzi Local Municipality
- Uthukele District Municipality

Within the uMgungundlovu District Municipality, UW implemented the Vulindlela Water Scheme Supply (VWSS) to meet the increasing demand for water in the area. The VWSS covers approximately 280 square kilometres of area on land belonging predominantly to the Ingonyama Trust in the Msunduzi municipal area. The scheme was one of 12 National Presidential Lead Projects prioritised in 1994 under the Reconstruction and Development Program. The scheme was commissioned on 21 March 1998 by then State President, Nelson Mandela. Umgeni Water has identified the need for increased water supply to ensure that demand does not exceed supply, and so, is proposing to implement the Vulindlela Bulk Water Supply (BWS) upgrade.

The purpose of the proposed upgrade to the Vulindlela Bulk Water Supply is to increase supply to meet increasing water demand in the Vulindlela system and to significantly improve pumping efficiencies with minimal impact on the environment. The proposed upgrade project will be an addition to an existing system and infrastructure currently supplying the Vulindlela area. UW proposes to upgrade the Vulindlela BWS for the route extending between the Howick West Reservoir and Vulindlela Reservoir No.2.

The proposed scope of works for the proposed Vulindlela Bulk Water Supply Upgrade from Howick West to Reservoir 2, will comprise of the following new infrastructure components:

- DN800 rising main from the existing Howick West pump station to the existing Vulindlela Reservoir 2.
- 10Mℓ Reservoir at the midway ridge site.
- Pump Station at the existing Howick West Reservoir Site (48Ml/day).
- New Mpophomeni Booster Pump Station (48Ml/day).
- Improvements to the existing access track (1.3km long and 3m wide) to allow for access to the Midway Ridge site during construction. The track will be improved according the following specifications:
    - Rip and Recompact 150mm in situ material to 95% MOD AASHTO
    - 150mm G5 material to 97% MOD AASHTO
- Concrete Access driveway (0.25km long and 3m wide) required off existing gravel road to access the Mpophomeni pump station.

Preferred Route

The preferred route is the selected route between the Howick West Reservoir and Vulindlela Reservoir No.2 which follows the existing water pipeline to Mpophomeni on the western side of the R617 provincial road as far as the entrance to the airstrip and army shooting range, where it then deviates to alongside the shooting range, over a midway ridge at about 1260m elevation, and on through informal extensions to Mpophomeni to Vulindlela Reservoir 2 at a top inlet elevation of 1414m. The proposed route is 9.3km in length.

The preferred route pipeline on the western side of the R617 is divided into three (3) legs, excluding minor pipe lengths that are part of the two pump stations and the ridge reservoir site. The first leg is a total of 6077.90m in length from Howick West to Midway Ridge Reservoir which has a 10Ml capacity, the second leg is from the Midway Ridge Reservoir to Mpophomeni Booster Pumps which is 2420.70m in length and the third leg is from the Booster Pumps to Reservoir 2 which is the end of the proposed pipeline with a length of 862.09m.

The existing reservoir at Howick West with a capacity of 16Ml will serve as the source of water for the scheme with a new pump station at Howick West site to pump water to Midway Ridge Reservoir. The new booster pump station at Mpophomeni is required to pump water from Midway Ridge Reservoir with a capacity of 10Ml to the inlet at Reservoir 2 where the proposed pipeline ends. The pipe diameter is 800mm and the throughput capacity is 740 l/s.

The existing pump station at Howick West with a capacity of 16Ml will serve as the source of water for the scheme. The new booster pump station at the Midway Ridge Reservoir is required to pump water from Midway Ridge Reservoir with a capacity of 10Ml to the inlet at Reservoir 2 where the proposed pipeline ends. The pipe diameter is 800mm and the throughput capacity is 740 l/s.

An alternative layout was also considered for the pipeline (pink in Figure 1 below) which would travel parallel to the R617 road on the opposite (eastern) side of the road to the preferred route and branch off before the township of Mpophomeni B, running along the flats prior to re-join the preferred route as it traverses upslope to end at Reservoir 2 (Figure 1). The length of the alternative as shown in pink below is 4970m (this is only the deviated portion of the alternative route). Upon conducting an impact assessment with input from various specialists, it was determined that neither the preferred route, nor alternative route will have fatal impacts on the receiving environment. The alternative route would, however, have a greater direct impact on watercourses due to it having a greater construction footprint. The longer alternative route would also prove more costly to implement. As a result of the above findings, the preferred route will have less of an impact on watercourses and will be more economical to implement and is therefore the preferred option that is being applied for.

This EMPr must be adhered to during all phases of development: pre-construction, construction and operational. Specialist input provided during the Environmental Impact Assessment has been incorporated into the EMPr to ensure that the potential impacts of the proposed development are minimized, mitigated against, or prevented.

The pipeline follows the existing R617 provincial road for a portion of the route. Access to the proposed development will therefore be gained from the R617 (Figure 1).

Co-ordinates of the proposed Vulindlela BWS:

Table 1: Co-ordinates of the proposed development

	PREFERRED ROUTE	GEOGRAPHIC CO-ORDINATES	
1	Start at HW Pump Station	29° 31' 8.84" S	30° 13' 13.45" E
2	Midway Reservoir	29° 34' 2.77" S	30° 12' 15.31" E
3	Pump Station 2A	29° 35' 3.38" S	30° 11' 53.68" E
4	Reservoir 2	29° 35' 42.74" S	30° 11' 52.33" E
	ALTERNATIVE ROUTE	**GEOGRAPHIC CO-ORDINATES**	
1	Start adjacent to R617 Road	29º 31' 47.27" S	30º 13' 01.79" E
2	Pump Station 1	29º 33' 54.37" S	30º 11' 39.67" E
3	Re-join Preferred Route	29º 34' 51.29" S	30º 12' 01.08" E

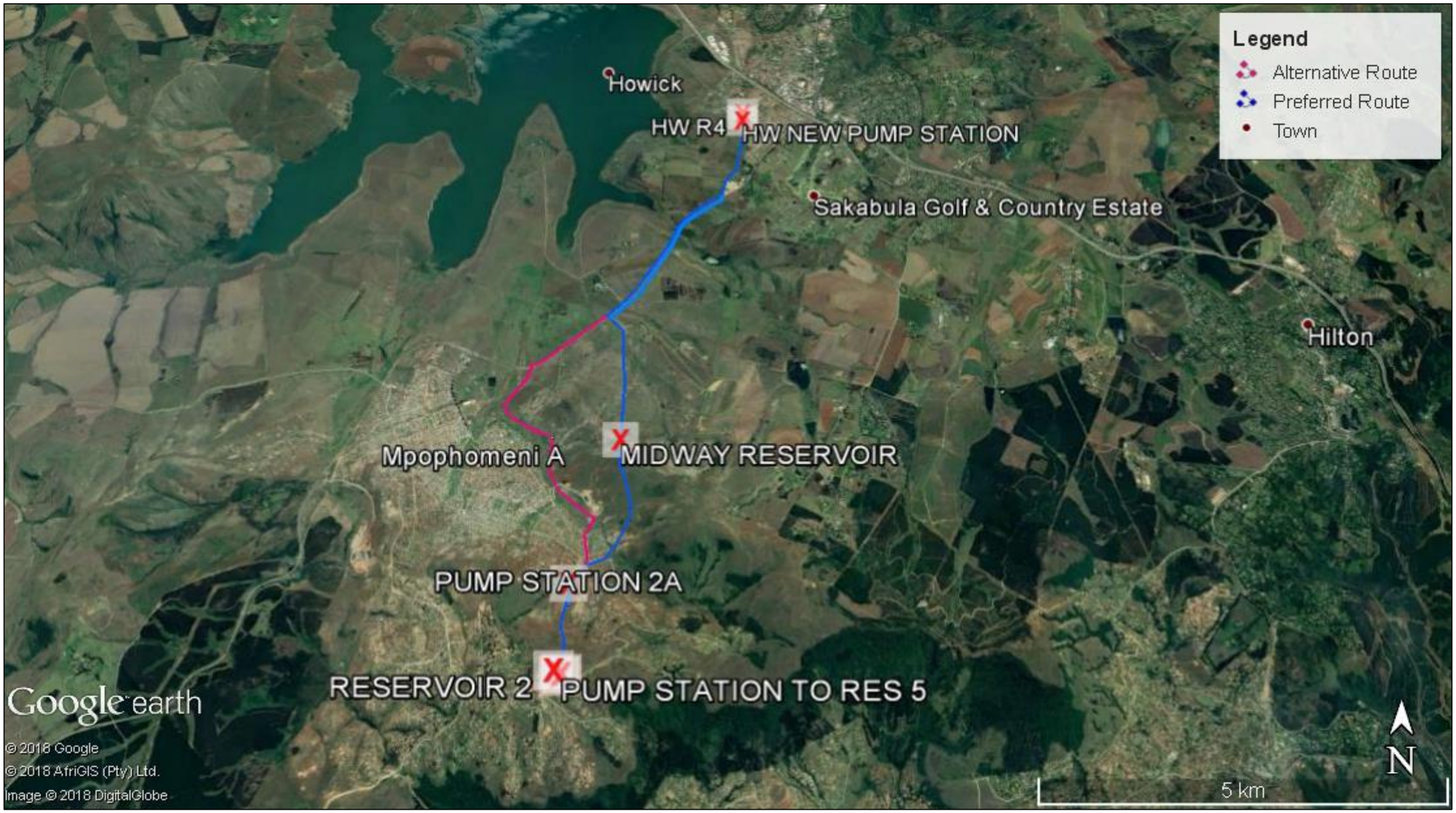


Figure 1: Map illustrating the proposed alternative sites within the Msunduzi and Umngeni Local Municipalities (Source: Google Earth, 2018)

1.2 ASPECTS OF THE ACTIVITY COVERED BY THE ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPR)

In terms of Section 24(2) of the National Environmental Management Act (Act 107 of 1998), the Minister may identify activities which may not commence without prior authorisation. The Minister thus published GNR 327 (Listing Notice 1), 325 (Listing Notice 2) and 324 (Listing Notice 3) (as amended in April 2017) containing activities that may not commence prior to environmental authorisation by the competent authority.

- GNR 326 of April 2017 is the current EIA Regulations which clearly highlights the various processes to follow to obtain environmental authorisation.
- Listing Notice 1 identifies activities subject to a Basic Assessment (BA) process undertaken in terms of the EIA Regulations, prior to commencement of that activity.
- Listing Notice 2 identifies activities that require a Scoping and Environmental Impact Report (S&EIR) process to be undertaken in terms of the EIA Regulations, prior to commencement of that activity.
- Listing Notice 3 identifies activities within specific geographic areas that require a BA process to be undertaken, in terms of the EIA Regulations, prior to commencement of that activity.

This Act places an onus on all levels of government to ensure that risk to the environment is identified and where it cannot be avoided, is minimised and mitigated and offset. Should there be any impact on the environment during or after construction, THD and DTPC, as the responsible party, have a duty to take measures to address these impacts and undertake the necessary clean up and mitigation measures as per this EMPr.

KSEMS undertook a detailed analysis of the listed activities contained in Listing Notice 1, 2 and 3 to ascertain which of the activities are relevant to the proposed project. The activities, potentially applicable to the proposed development as are per the table below, the different phases associated with these activities must be monitored as per this EMPr.

Table 2: Legislation applicable to the proposed development

Government Notice No.	Activity No(s)	Description
Listing Notice 1 GNR327 December 2014, as amended in 7 April 2017	9	The development of infrastructure exceeding 1000 metres in length for the bulk transportation of water or storm water- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; **The proposed pipeline is 9.3km in length and the diameter is approximately 795mm (internal diameter) equating to 0.795m which exceeds the threshold of this activity.**
Listing Notice 1 GNR327 December 2014, as amended in 7 April 2017	12	The development of - (xii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs - (a) within a watercourse (b) if no development setback exists, within 32 metres of a watercourse measured from the edge of a watercourse. **The proposed development will include the development of the following infrastructure:** • **DN800 rising main from the existing Howick West pump station to the existing Vulindlela Reservoir 2.** • **10Mℓ Reservoir at the midway ridge site.** • **Pump Station at the existing Howick West Reservoir Site (48Ml/day).** • **New Mpophomeni Booster Pump Station (48Ml/day).** • **Improvements to the existing access track (1.3km long and 3m wide) to allow for access to the Midway Ridge site during construction. The track will be improved according the following specifications:** **O Rip and Recompact 150mm in situ material to 95% MOD AASHTO** **o 150mm G5 material to 97% MOD AASHTO** • **Concrete Access driveway (0.25km long and 3m wide) required off existing gravel road to access the Mpophomeni pump station.**

		The development will therefore comprise of a pipeline that will be 9.3km in length with an internal diameter up to 800mm, along with the associated infrastructure mentioned above, which exceeds 100 square metres and some portions of the pipeline will traverse several wetlands and watercourses. Refer to Wetland Specialist Report- Appendix D. The crossings can also be viewed on the sensitivity map (Figure 3). The coordinates of the crossing points can be found in Appendix I (6) of the Final BAR.
Listing Notice 1 GNR327 December 2014, as amended in 7 April 2017	19	**Activity 19:** The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from - (i) a watercourse **The proposed 9.3km long pipeline and associated infrastructure will entail the infilling or depositing of material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand or rock of more than 10 cubic metres from a watercourse. As such, this activity will be triggered.**
Listing Notice 3 GNR324 December 2014, as amended in 7 April 2017	2	The development of reservoirs for bulk water supply with a capacity of more than 250 cubic metres. (d) In KwaZulu-Natal: viii. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; xi. Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority (d) In KwaZulu-Natal- v. within a critical biodiversity area as identified in systematic biodiversity plans adopted by the competent authority, or in bioregional plans. xii outside urban areas (aa) areas within 5km of any terrestrial protected area in terms of NEMPAA. **The proposed activity has a combined capacity of more than 250 cubic metres including the 10Ml reservoir at Midway Ridge. According to the KZN terrestrial systematic conservation plan, portions of the area are classified between Biodiversity Areas and Critical Biodiversity Area 1 and will be constructed within 5km of the Midmar Nature Reserve. As such, this activity will be triggered. However, despite being located within these classes, the EAP and specialist have identified numerous alien invasive species during site visits. The Vegetation Specialist has stated that the area has a high density of alien invasive species (McDonald, 2018). Refer to Botanical Vegetation Assessment in Appendix D1.**
Listing Notice 3 GNR324 December 2014, as amended in 7 April 2017	12	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. (b) In KwaZulu-Natal: iv. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; v. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; viii. Within a Protected area. xi. Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose. xii Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority **More than 300 square metres of indigenous vegetation may be cleared. Vegetation will be cleared from a critically endangered ecosystem (Oakland and Townhill Ridge) and endangered ecosystem (Pietermaritzburg South, Karkloof Forest Collective and Loskop Grassland) for the proposed pipeline. Therefore, this activity may be triggered.** **A section of the pipeline (approximately 1.2km in length) will be located along the boundary of the Midmar Nature Reserve and as such, will result in clearing of vegetation in excess of 300 square metres within a protected area. Ezemvelo KZN Wildlife confirmed that the route traverses the sensitive ridge line area which is believed to contain species of conservation importance. The ecological specialist did, however, observe the area to be highly transformed**

		and dominated by alien plant species, whereby potential impacts can be mitigated to acceptable levels.
Listing Notice 3 GNR324 December 2014, as amended in 7 April 2017	14	The development of- (ii) infrastructure or structures with a physical footprint of 10 square metres or more; Where such development occurs (a) within a watercourse and (c) within 32m of a watercourse (d) In KwaZulu-Natal: within iv. A protected area identified in terms of NEMPAA vii. Critical biodiversity areas or ecological support areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans. viii Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority x – outside urban areas (aa) areas within 5km of a protected area **The proposed development will include the development of the following infrastructure:** • **DN800 rising main from the existing Howick West pump station to the existing Vulindlela Reservoir 2.** • **10Mℓ Reservoir at the midway ridge site.** • **Pump Station at the existing Howick West Reservoir Site (48Ml/day).** • **New Mpophomeni Booster Pump Station (48Ml/day).** • **Improvements to the existing access track (1.3km long and 3m wide) to allow for access to the Midway Ridge site during construction. The track will be improved according the following specifications:** **O Rip and Recompact 150mm in situ material to 95% MOD AASHTO** **o 150mm G5 material to 97% MOD AASHTO** • **Concrete Access driveway (0.25km long and 3m wide) required off existing gravel road to access the Mpophomeni pump station.** **The proposed pipeline is 9.3km in length (up to 800mm in diameter) for the preferred alternative and 10.5km for the route alternative and will have a physical footprint that exceeds 10 square metres in size and is within a watercourse with critical biodiversity areas according to the KZN systematic biodiversity plans. Therefore, this activity will be triggered.** **A section of the pipeline (approximately 1.2km in length) will be located along the boundary of the Midmar Nature Reserve and as such, will result in clearing of vegetation in excess of 300 square metres within a protected area. Ezemvelo KZN Wildlife confirmed that the route traverses the sensitive ridge line area (comprising Midlands Mistbelt Grassland vegetation) which is believed to contain species of conservation importance. The ecological specialist did, however, observe the area to be highly transformed and dominated by alien plant species, whereby potential impacts can be mitigated to acceptable levels.**

1.3 SITE SETTING

Site Access:

The pipeline follows the existing R617 provincial road for a portion of the route therefore access will be gained from the R617. Paved and gravel roads branching off the R617 can be used to access most of the pipeline infrastructure. Two new access roads have been proposed to access infrastructure that don't have existing access roads. Figure 6 indicates all paved and dirt roads that have been proposed as the preliminary access routes. The access routes are indicative and will be subject to the appointed contractor. Once construction is completed, all access and haulage routes should be reinstated to the original condition by the appointed contractor.

Gradient:

The topography along the preferred and alternative routes of the proposed development are illustrated in Figures 2 and 3, respectively (Google Earth Pro, 2018). The average slopes along the preferred and alternative routes were calculated to be 8.6 % and 3.6%, respectively, and the elevation ranging from between 1050 m and 1398 m with an average elevation of 1153 m.

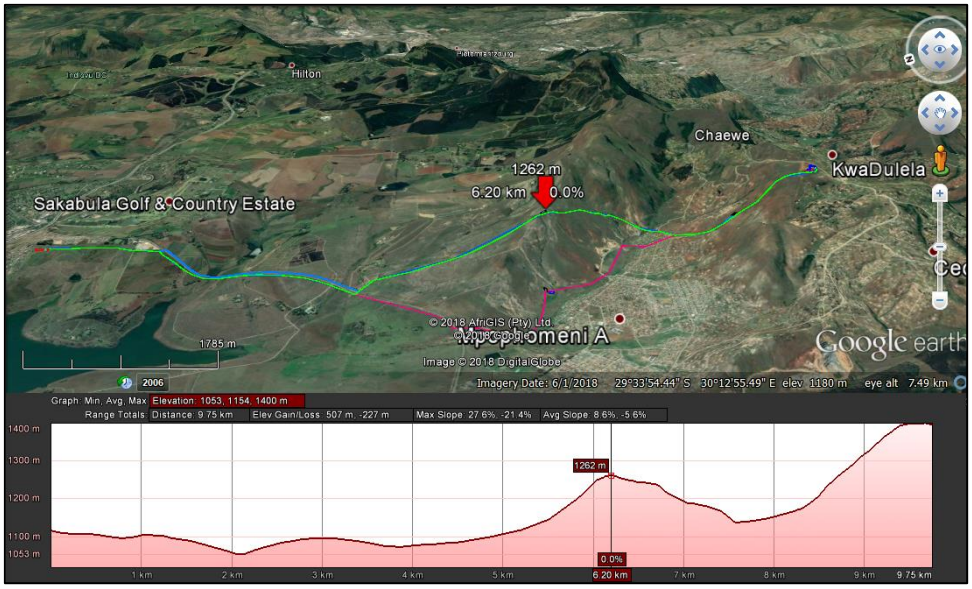


Figure 2: Map illustrating the topography along the preferred Vulindlela Pipeline route (Green line) (Google Earth Pro, 2018).

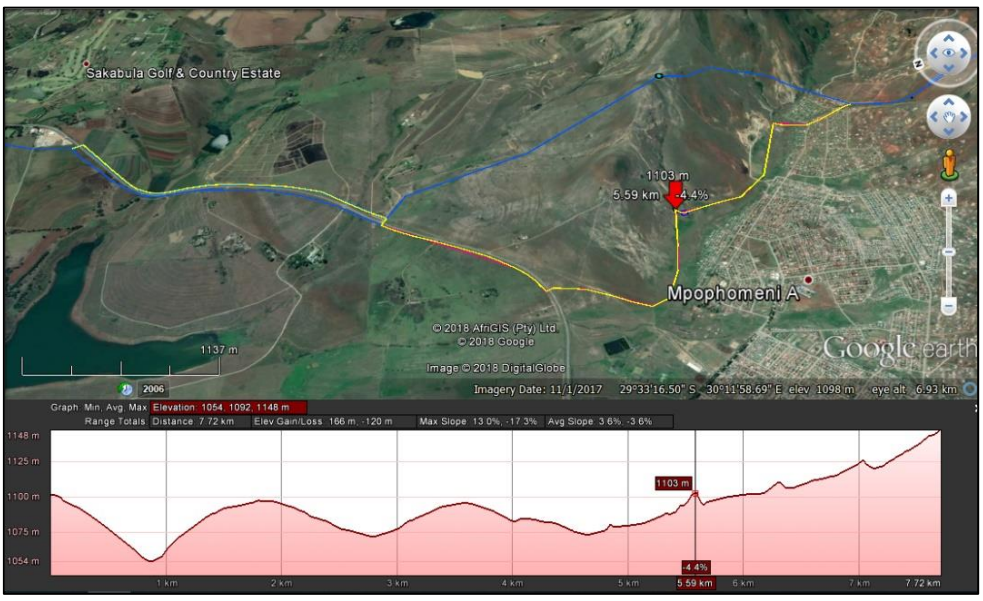


Figure 3: Map illustrating the topography along the alternative Vulindlela Pipeline route (Yellow line) (Google Earth Pro, 2018).

Land use:

The dominant land covers within the study area were recorded to be Urban township (low veg/grass) and Grassland. However, in addition to the aforementioned land cover classes several other classes were recorded to be impacting on the surrounding terrestrial and aquatic environments within the study area (Figure 4).

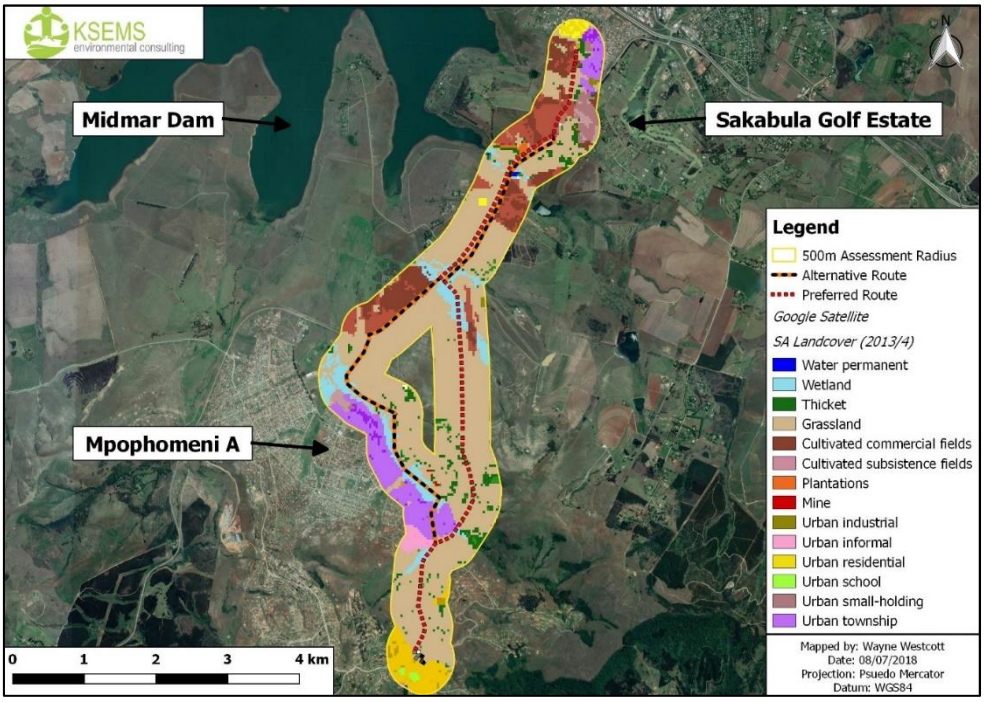


Figure 4: Illustration of the land cover classes recorded within the study area (SANBI, 2013/14).

Vegetation:

The study area is recorded to extend over four (4) vegetation units, namely: Alluvial Wetlands: Temperate Alluvial Vegetation, Freshwater Wetlands: Eastern Temperate Wetlands, Midlands Mistbelt Grassland and Southern KZN Moist Grassland (Scott-Shaw & Escott, 2011) (Figure 5). The conservation status associated with all the aforementioned vegetation units is vulnerable, aside from the Midlands Mistbelt Grassland unit, which is categorised as endangered (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). Although these conservation categories are relevant at a regional (provincial) scale, the on-site floral communities were observed to have been extensively transformed by human activities, specifically urban and rural settlements, commercial and subsistence agricultural practices (i.e. sugarcane crops) and infrastructural developments (e.g. informal and formal roads, bridges and fences). The natural vegetation that was observed on-site, notably the grassland, had undergone significant overgrazing and fire damage which had altered the composition and diversity within the habitat.

Subsequent to consulting the Wetland Vegetation (WetVeg) dataset, the entire study area was determined to fall within the Sub-escarpment Grassland Group 3 Wetveg unit. All wetlands that were delineated within the study area (i.e. Channelled Valley-bottom, Unchannelled Valley-bottom and Hillslope Seepage wetlands), which fall within the aforementioned WetVeg unit are classified to be critically endangered (SANBI, 2011). However, like the terrestrial vegetation cover observed within the study area, the hydrophytic vegetation recorded within the wetland systems was determined to have been largely to substantially modified by various anthropogenic pressures.

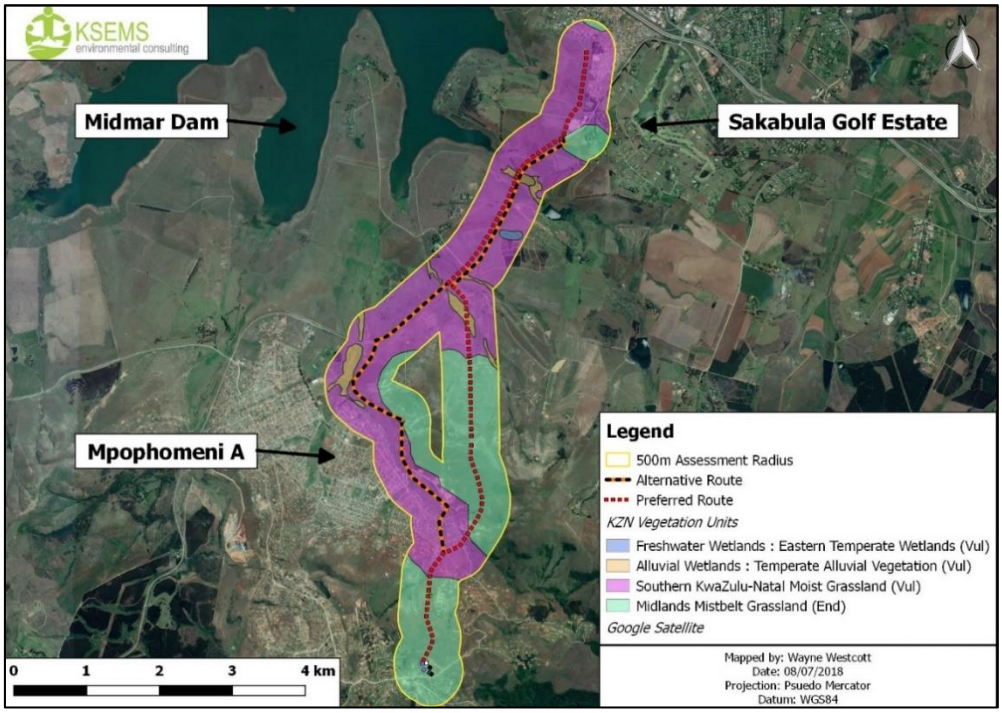


Figure 5: Illustration of the vegetation units relevant to the study area (Mucina & Rutherford, 2006 & 2012; Scott-Shaw & Escott, 2011).

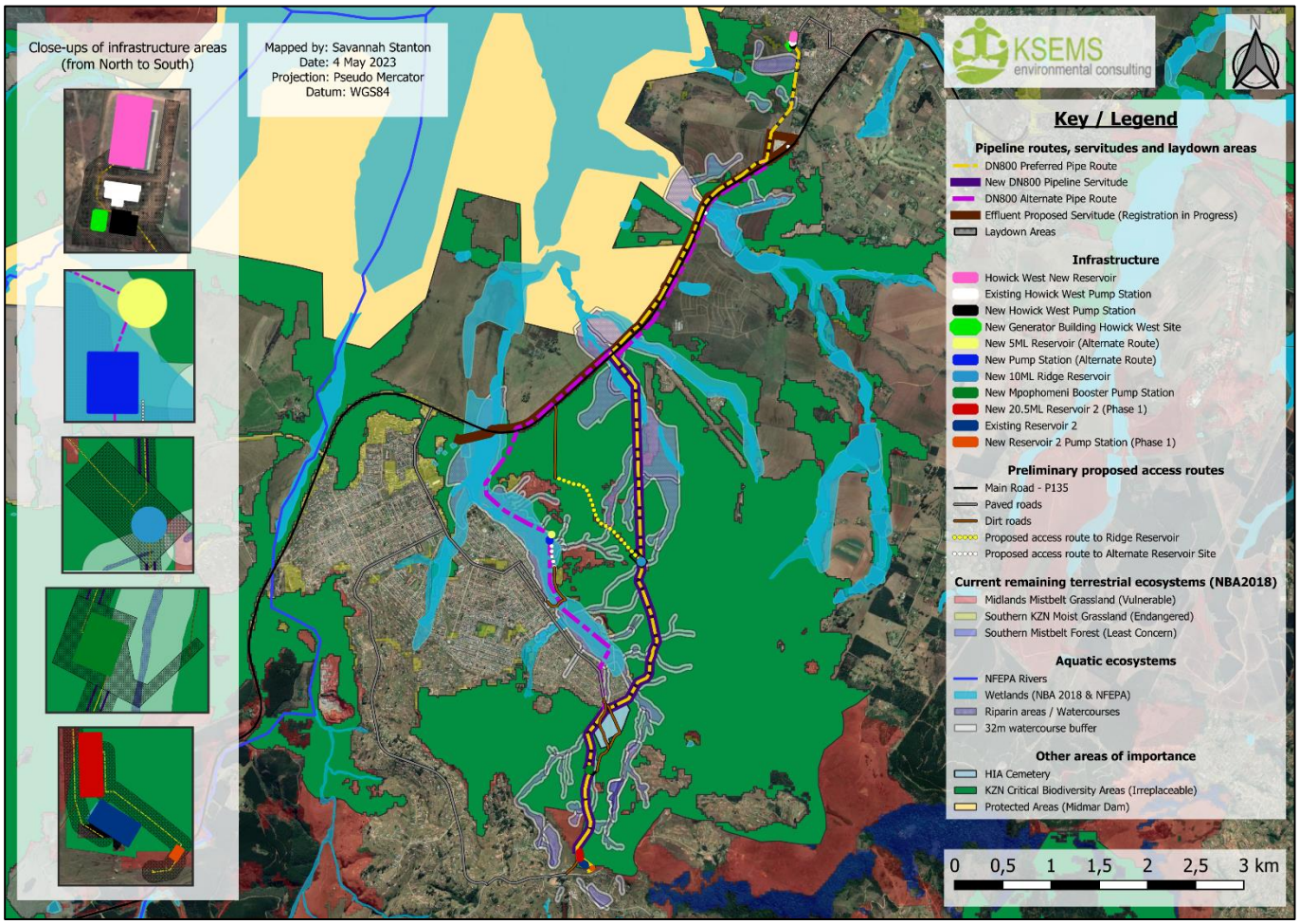


Figure 6: Map illustrating the proposed pipeline and associated infrastructure and environmental sensitivities (KSEMS, 2023).

1.4 PURPOSE OF THE EMPR

The objective of the EMPr is to provide measures to mitigate and manage construction, operation and decommissioning activities in order to minimize potential negative impacts on the surrounding environment. This is achieved by:

- Assigning environmental impact mitigation responsibilities to key personnel,
- Developing specific action plans designed to ensure mitigation,
- Managing and auditing the specified action plans, and
- Managing stakeholder involvement.

Integrated Environmental Management Principles (IEM) have been used as a foundation for the development of this EMPr and must be strictly applied during its implementation. The EMPr serves as a standalone document to be disseminated to and used by the contractors and other stakeholders involved in the construction phase.

2. ROLES AND RESPONSIBILITIES

2.1 ASSIGNED RESPONSIBILITY

In order for the EMPr to be effectively implemented the following professional inputs will be required, the applicant will obtain the services of the following with formal contracts in place:

- **Applicant –Umgeni Water is responsible for the following:**
  - Ensuring that the engineer and contractors comply with the approved EMPr.
  - Ensuring compliance with the provisions for duty of care and remediation of damage in accordance with section 28 of the National Environmental Management Act (NEMA), (No. 107 of 1998) and its obligations regarding the control of emergency incidents in terms of Section 30 of NEMA.
  - Notifying the DEA of any incident as defined in subsection 30(1)(a) of NEMA.

- **Project Manager is responsible for the following:**
  - Appointing the appropriately qualified contractor to co-ordinate, supervise and expedite different action plans.
  - Ensuring adherence to the DEA's conditions of authorization and any other laws and standards relevant to the construction of the facility.
  - Ensuring all elements of the work undertaken are properly and competently directed, guided and executed at appointed stages of the project.
  - Ensuring the adherence to statutory safety, health and environment (SHE) standards and ensuring the construction activities comply with the EMPr.
  - Monitoring the site on a daily basis to ensure compliance.
  - Overall responsibility and accountability for the site during the construction phase.
  - Avoiding and / or mitigating adverse impacts on the environment by the appropriate design and construction.
  - Ensuring transparency in their operation and environmental management of the site.
  - Managing the contractors compliance and ensure documentation management.
  - Ensuring that the contractor has a copy of the EMPr and all agreed Method Statements.

- **Contractors - Responsible for the following:**
  - Managing and operating their activities with due care and diligence.
  - Complying with all elements of the EMPr.
  - Ensuring that stakeholder interest is reported to the ECO.
  - Maintaining relevant documentation for review by the ECO.

- **ECO - (Environmental Control Officer) is responsible for the following:**
  - Determining the conformance of the site with the EMPr criteria and compliance with the conditions of the EMPr.
  - Liaising with the EDTEA and I&APs, if required.
  - Identification of possible areas of improvement during construction.

- Undertaking on-going monitoring of the construction site through regular site visits and record key findings. This includes photographic monitoring of the construction site. The frequency of these visits will be determined by the progress and complexity of the project.
- Advising the Project Manager and the contractors on environmental matters during the construction phase of the development.
- Monitoring implementation of the EMPr by the contractor.
- Advising the project manager on environmental impacts and provide appropriate recommendations to address and rectify these matters.
- Ensuring that the conditions stipulated in the EA and any other laws and standards relevant to the construction are being complied with.

3. IMPACT MANAGEMENT OBJECTIVES, OUTCOMES AND ACTIONS

This section identifies the potential significant impacts associated with all phases of the proposed development, as well as the associated impact management objectives, management outcomes and actions. All impacts that are medium can be mitigated to low provided that all recommended mitigation measures are adhered to. Table 2 below defines each phase of the project.

Table 3: Phases of the proposed development as covered by the EMPr

Phase	Description
Phase 1:	Design and Planning (Pre-construction)
Phase 2:	Construction activities (i.e. construction of the proposed mixed-use development)
Phase 3:	Post Construction (i.e. removal of waste disposal facilities, removal of site camp, site is devoid of any general and hazardous waste utilised during construction, etc.)
Phase 4:	Rehabilitation (removal of alien vegetation, implementation of indigenous species to disturbed landscapes, continued monitoring of established wetlands, etc.)
Phase 5:	Operational phase

Table 4: Identified Impacts, objectives, actions and outcomes associated with the pre-construction phase

Pre-construction Phase - Design and Planning							
Aspect	**Potential Impact**	**Management Objective**	**Management Action**	**Method of Monitoring implementation of the management actions**	**Time period for implementation of the management actions**	**Management Outcome**	**Monitoring Frequency and responsible party**
Identification of the development footprint and associated construction site	Unnecessary construction outside of the project footprint.	To identify the project footprint and propose an appropriate demarcation	Use the available facility illustration during the initial site visit to identify the workable corridor. The proposed design must be adhered to. The pipeline must be made to run as close to the existing servitudes as possible. Clearly demarcate the workable site and ensure that the demarcated area is only that which is necessary for construction. Adhere to the recommended specialist buffers for the sensitive areas.	Visual inspection	Prior to site set up and site camp establishment	To prevent construction activities occurring outside of the construction footprint. To prevent and avoid destruction to sensitive habitats outside of the construction footprint.	The contractor /designated representative must monitor the site on a daily basis and conduct weekly checks. Monthly audits must be conducted by an ECO.
Training and conduct	Inadequate knowledge of environmental aspects can result in destruction to sensitive environments and cause excessive degradation to the receiving environment	To ensure that all contractor personnel are adequately trained prior to commencement of construction. To ensure proper conduct of the site personnel.	A training session to be conducted by the appointed ECO to highlight the sensitivity of the receiving environment as contained within the EMPr. Site personnel must be informed of the *dos* and *donts* when on site, these must be reinforced during weekly toolbox talks by the contractor representative.	Training and toolbox talk registers available for review by the ECO	Prior to the commencement of construction activities and weekly toolbox talks	To prevent unnecessary destruction to the surrounding receiving environment To avoid complaints from surrounding land owners relating to the conduct of the site personnel.	The contractor/ designated representative must conduct weekly toolbox talks and the ECO must conduct an initial environmental awareness training session prior to construction. The registers must be made available for the ECO to review during the audit.

Compliance with the EMPr, EA and other applicable legislation	Contravention of the EMPr, EA and other applicable legislation can result in the halting of construction activities and even shut down of the site.	To ensure that the contractor is adhering to the conditions of all relevant legislation and authorisations applicable to the site.	Ensure that the contractor has a copy of the EMPr and EA onsite at all times. The contractor personnel must be made aware of the location of these	Documents available onsite for review by the ECO.	Documents to be made available prior to construction within the week of site set up	To avoid contravention of the EMPr, EA and other applicable legislation and authorisations.	The contractor/ designated representative must conduct weekly toolbox talks in which these documents are discussed. Monthly audits must be conducted by an ECO and these documents must be made available for review by the ECO.
Setting up construction camp	Unnecessary destruction of the natural environment.	Correct site selection and location of site camp will ensure that time and costs associated with environmental management and rehabilitation are reduced.	The footprint of the construction site camp must be kept to a minimum. The site camp should be situated within degraded areas if possible, and should not be located in areas considered sensitive i.e. the sensitive ridge line, the boundary of the Midmar Nature Reserve, or CBA Irreplaceable areas (Figure 8), or within 50m of any watercourses, if possible. The contractor must submit the proposed location of the site camp to the ECO for approval, prior to site camp establishment. The applicant is required to demarcate the pipeline and 25m working corridor during the construction phase, and the 9m servitude during the operational phase as a no- go area to prevent future informal settlement along the pipeline route. The applicant has confirmed that they will engage with community leadership to further prevent informal dwellings along the pipeline. This is needed to prevent housing along the pipeline route to protect the integrity of the pipeline.	Visual Inspection and Documents available onsite for review by the ECO.	During site set up and ongoing monitoring.	To prevent unnecessary destruction to the surrounding receiving environment	The contractor /designated representative must monitor the site on a daily basis and conduct weekly checks. Monthly audits must be conducted by an ECO.

			Stormwater management must be implemented to avoid standing water and/or sheet erosion. Adequate chemical toilets must be made available for the contractors and these chemical toilets must be place at least 50m away from any water body. Chemical toilets must be emptied by a registered service provider and proof of safe disposal must be kept in the environmental file on site. Long drop toilets and usage of surrounding environment for ablution facilities are strictly forbidden. Vegetation clearance must be limited and any protected plant species to be relocated only after the relevant permits have been obtained from Ezemvelo KZN Wildlife, where applicable.				
Management of sourcing materials	illegal mining or sourcing of materials from unregistered sources.	Ensure that materials are sourced in a legal manner and from a registered source.	Contractor must prepare a source statement indicating sources of all materials and this must be submitted to the Engineers and ECO for approval prior to commencement of construction. Where materials are mined, proof of the authorisation must be obtained and place in the environmental file. Stockpile areas of raw materials and other construction material must be clearly identified and demarcated prior to materials being brought onto site. None of these areas must be on or near slopes or water resources (within 50 m).	Documents available onsite for review by the Engineer and ECO.	Prior to construction	To prevent unlawful mining activities.	ECO to monitor the environmental file on a monthly basis to ensure materials are being sourced legally.
Existing services	Increased pressure on existing stormwater services in the area Damage to existing services (electricity, water, etc.); Potential	To minimise as far as possible the pressure on the existing stormwater services in the area. To prevent destruction to	During the site establishment and preliminary activity phase, all existing drainage systems (streams, channels) are to be maintained by the developer in accordance with normal agricultural soil conservation practices and local authority guidelines. Existing access routes to the construction site must follow the existing access roads as far as possible. Should new access roads be required these must be constructed in a way to minimise	Visual inspection	Prior to construction	To prevent and/or minimise the pressure on the existing stormwater system To maintain the existing services at and around the site	The contractor /designated representative must monitor the site on a daily basis and conduct weekly checks. Monthly audits must be

	impact on power lines due to mechanical damage or obstruction to power line.	existing services and servitudes	concentrated flow runoff and pollution to the existing wetlands. Vegetation clearance must be limited as much as possible and any protected species may only be relocated once the relevant permits have been obtained from Ezemvelo KZN Wildlife, where applicable. The proposed preliminary access routes can be found in Figure 6. The access routes are indicative and will be subject to the appointed contractor. Once construction is completed, all access and haulage routes should be reinstated to the original condition by the appointed contractor. This impact can be fully mitigated against by identifying services prior to construction and avoiding damage to existing services. Alternatively, if service disruption is unavoidable, the parties affected must be notified in advance.				conducted by an ECO.

Table 5: Identified Impacts, objectives, actions and outcomes associated with the construction phase

		Construction Phase					
Aspect	**Potential Impact**	**Management Objective**	**Management Action**	**Method of Monitoring implementation of the management actions**	**Time period for implementation of the management actions**	**Management Outcome**	**Monitoring Frequency and responsible party**
General - Construction Camp	Incorrect disposal of general and hazardous waste	To mitigate the risks of litter and pollution.	The contractor must monitor and manage drainage of the site camp. Chemical toilets are to be maintained and kept in a clean state. A registered chemical waste company is to be used to service the chemical toilets. Proof of this must be kept in the environmental file. The contractor must ensure that surrounding areas are not being used as a toilet facility.	Visual Inspection and Documents available onsite for review by the ECO.	Ongoing	To ensure that construction camp is well maintained at all times.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO

			Bins and / or skips must be present on site for waste to be placed into. The bins and / or skips must be emptied regularly, and the waste must be disposed of a registered landfill site. Proof of disposal must be kept within the environmental file. The contractor must ensure that the site camp and all working areas are kept clean at all times. The applicant is required to demarcate the pipeline and 25m working corridor during the construction phase, and the 9m servitude during the operational phase as a no- go area to prevent future informal settlement along the pipeline route. The applicant has confirmed that they will engage with community leadership to further prevent informal dwellings along the pipeline. This is needed to prevent housing along the pipeline route to protect the integrity of the pipeline.				
Soil	Construction activities expose soil to environmental elements including rain and wind resulting in the removal of topsoil as well as the erosion of stockpiled material.	To minimise exposure of topsoil and erosion of stockpiled material	Contractors must limit vegetation clearing to the demarcated workable corridor/site. The contractor must stabilise cleared areas to prevent and control erosion and/or sedimentation of the watercourses. Berms, sandbags and hessian sheets must be used to contain all sediment whilst energy dissipaters must be constructed at all outflow points to prevent erosion. Stockpiles must not exceed 2m in height and must not be located within 50 metres of any rivers, wetlands and/or riparian channels or within the 1:100 year flood lines. The furthest threshold must be adhered to. Spoil material that will be re-used during construction must be stockpiled on site, in accordance with the above recommendations. Any spoil that will not be used, must be disposed of as general waste at the appropriate landfill.	Visual inspection	Ongoing	To prevent excessive loss of topsoil and soil erosion. Limits sedimentation of the watercourses. Maintaining the quality of top soil that can be reused for rehabilitation.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO

			Stockpiles that remain longer than 6 months must be revegetated to prevent erosion and a netting must be used to confine sediment from water and wind erosion. Topsoil piles must be separated from sub soils. Sandbags must be used where soil becomes unstable to prevent erosion. Backfilled material must be in reverse order.				
Soil	Risk of contamination to soil during concrete mixing.	To prevent contamination of soil from concrete mixing	Concrete mixing will need to take place on a hard surface or concrete mixing trays. Concrete mixing will not be permitted to occur where run off can enter stormwater drains. Construction will be monitored by an ECO who will manage compliance with the construction section of the EMPr.	Visual inspection	Ongoing	To maintain the quality of the soil at the site.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Slopes and soil	Extensive earthworks resulting in the creation of unstable slopes and erosion.	To prevent the creation of unstable slopes.	Stockpiles are to be maintained as flat as possible and not exceed 6m in height or as directed by the SWMP. Precaution must be taken in areas of high erosive potential as identified in the ecological report specifically during the earthworks phase. Given the soil erodibility in and around the proposed site, specific attention must be paid to the soil erosion mitigation measures and topsoil management, and the revegetation measures outlined in this plan. The engineer must compile an erosion control plan for construction of the pipeline along the ride line to ensure impacts on the receiving environment is prevent, or limited as much as possible. This erosion control plan form part of the EMPr and must be placed in the environmental file and implementation thereof of monitored by the ECO.	Visual inspection	Ongoing	Stable slopes and minimal erosion	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

Soil stability and integrity	Potential unstable soil conditions which may compromise the integrity of the pipeline over time. The specialist considers the site stable and suitable for the proposal, but identified that some areas may become unstable over time Areas underlain by weakly cohesive sandy and silty soils are prone to erosion. The pipe trench line may experience erosion if not mitigated.	To ensure soil stability is maintained and to prevent damage to infrastructure and to prevent harm to site staff.	Trenches excavated in loosely consolidated soils Including sandy, fill, alluvium, clayey and clayey colluvial soils may be unstable and so will require lateral support or battering of slopes to stable temporary angles. Trenches deeper than 1.5m must be shored, particularly if left open. See section 10.5 of the geotechnical report for further recommendations in this regard. Excavations must be carried out in the dry season as far as possible and backfilled as soon as practically possible. It is recommended that the geotechnical and contractor carry out regular documented inspections of trenches to detect potentially unstable sidewall conditions. Lateral support must be used in all situations where groundwater is encountered or where instability is observed. Site staff must not enter or work below any excavations deeper than 1.5m that is not shored or battered back. In the event of blasting being required where hard bedrock is encountered, then a blasting programme will need to be proposed which takes into account the safety issues and potential damage to surrounding structures. Where the pipeline runs perpendicular to contours, over gradients steeper than 9 degrees, it is recommended at every intervals of every 3 to 5m, a section of the backfill be stabilised with cement or lime. The section of stabilised soil must be around 1m to 2m in length. It is also recommended that grass cover be reinstated as soon as practically possible.	Visual inspection and documentation	Regular inspections - Weekly	Reduced risk of soil instability and associated damage to infrastructure/ injury to site staff	Weekly inspection by the contractor and geotechnical specialist. The documentation from these inspections must be placed in the environmental file for monthly monitoring by the ECO

			Geotextiles may be used to control erosion along steep trench slopes and along drainage lines. Backfill material in trenches must be compacted over the bedding layer of maximum loose thickness of 200mm and compacted to a minimum of 90% to ensure that settlements over pipes are kept to a minimum. Areas of wet, soft clay may require undercutting when exposed in trenches to improve working conditions. Areas showing signs of erosion must be rehabilitated immediately to prevent long term damage or sedimentation of nearby watercourses. Rehabilitation may include infilling and shaping of banks to stabilise soil.				
Flora	Vegetation clearance resulting in destruction of natural habitat and bare soil susceptible to erosion. The proposed new reservoir and pump station will result in total habitat loss within their respective footprints. Compaction of soil from human and vehicular traffic will result in higher erosion leading to more	To prevent excessive vegetation removal and habitat destruction outside of the project footprint To prevent re-infestation of alien plant species To prevent erosion and loss of top soil	The specialist recommended that the reservoir and pump station structures be re-located to avoid the rock habitats which will present a construction challenge resulting in the potential for impact being high. These rock habitats offer unique features to specialist flora (although not of conservation concern). Vegetation clearance must be limited to proposed pipeline construction buffer to limit habitat destruction. The pipeline must be made to run as close as possible to the existing servitudes and access roads through natural vegetation must be limited. The proposed pipeline must be located outside of the Midmar Nature Reserve boundary. Construction and maintenance activities must be carried out in accordance with environmental best practice.	Visual inspection	Ongoing	To maintain the vegetation outside of the project footprint	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

	runoff and erosion.		Careful management of the trench digging and pipe laying will be required to minimise clearing and to expedite rehabilitation. Existing access must be utilised where possible. The contractor must stabilise cleared areas to prevent and control erosion and/or sedimentation of the watercourses. Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes without erosion protection measures being in place; Berms, sandbags and hessian sheets must be used to contain all sediment whilst energy dissipaters must be constructed at all outflow points to prevent erosion. Vegetation clearing must be undertaken as and when necessary. The entire construction area must not be stripped of vegetation prior to commencing construction activities. Construction vehicles must be restricted to existing roads and access points. Any signs of erosion must immediately be rehabilitated to prevent long term damage. A walk through of the selected corridor must be conducted during the construction phase to minimise loss of sensitive species. The walk-through must identify where species require relocation. Permits must be obtained from EKZNW for disturbance to schedule 12 species translocations.				

			Access roads through vegetation must be restricted to the minimum functional width to reduce impact on vegetation. Pruning of vegetation is preferred to the removal thereof, where possible. Clearing of land must be undertaken in accordance with acceptable best practice standards and must be done under the supervision of the contractor. An alien invasive control plan must be implemented to eradicate alien plant infestation. Ongoing alien plant control must be undertaken after the construction phase and particularly in the disturbed areas. This must be controlled through the EMPr. Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge. Areas cleared of alien invasive plants must be rehabilitated with indigenous plant species. Significant impacts must be offset and/or compensated for, through the implementation of appropriate Biodiversity Offsets. The overarching principle of the Biodiversity Offsets must be to obtain a net benefit for biodiversity conservation and persistence at a landscape level according to the Draft National Policy on Biodiversity offsets. The applicant is required to engage with the Ezemvelo KZM Wildlife regarding offset measures that will permit construction of the preferred route.				
Faunal species of importance	Injury or death to species of importance	To prevent the removal of these species within the proposed	The sensitive floral species confirmed to occur in and around the alternative route option must be translocated prior to construction. The necessary	Visual inspection	Ongoing	To maintain faunal habitats as far as possible and to avoid injury or	The contractor / designated representative must monitor the

	during construction	development footprint or to apply for the necessary permits if removal is inevitable.	permits must be obtained from Ezemvelo's permits office prior to removal. The rocky habitats and termitaria are most likely to harbour invertebrates and herpetofauna and these must be avoided where possible and disturbance kept to a minimum where there is no alternative. Termitaria must be checked for animals before being cleared for construction and any animals found must be released into nearby suitable habitat. As construction proceeds, a concerted effort must be made to ensure that amphibians (near drainage lines and watercourses) and herpetofauna are removed from the working area before and during earthworks. Any animals encountered should be released in nearby suitable habitat. A sweep of the area must be made prior to construction in order to establish the presence or absence of the nests of ground-nesting birds of the Red-Listed species known to be present in the area. Should a nest be found, construction should be halted until the ECO has been advised. A search and rescue operation may be required prior to commencement of construction to identify and rescue any invertebrate or plant species of concern (see Appendix 13). This must form part of the additional rehabilitation/ offset plant to be provided to Ezemvelo KZN Wildlife for review and approval, prior to construction commencing. It is imperative that the biodiversity sensitivities known and predicted to occur in and around this proposed site as well as the MNR are protected and safeguarded from direct and indirect impacts anticipated to arise from the proposed development.			death to fauna as a result of construction activities	site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

			If an offset proposal is provided to Ezemvelo KZN Wildlife for consideration, it must include information and motivation as to why Ezemvelo's alternative option cannot be pursued and why an offset would be viable. It must be noted that pursuing an offset is also risky in that, land-security/ offset receiving sites would need to be secured prior to the commencement of construction, and ongoing management and monitoring would need to implemented. Significant impacts must be offset and/or compensated for, through the implementation of appropriate Biodiversity Offsets. The overarching principle of the Biodiversity Offsets must be to obtain a net benefit for biodiversity conservation and persistence at a landscape level according to the Draft National Policy on Biodiversity offsets. Construction of the pipeline must take place as far away from the Midmar Nature Reserve boundary as possible. Where possible, a sloping end or side to trenches must be constructed to allow animals falling into the trench, to escape. Trenches are to be monitored on a daily basis for animals that may have fallen inside and for such animals to be safely returned to their natural habitat. No open fires are allowed on site under any circumstance. The careful stockpiling of materials and soils for rehabilitation must be ensured so that they do not pill over into natural vegetation or become introduced to wetlands. An ongoing monitoring plan must be implanted to enforce the continual eradication of alien and invasive species during post-construction. An				

			alien control plan must be compiled and implemented for all phases of the development				
Stormwater	Stormwater structures and discharge points resulting in point-source erosion.	To prevent point source erosion as a result of inadequate stormwater management	Stormwater drains must have capacity to accommodate new anticipated flows. The discharge of stormwater runoff into the identified systems will be managed by means of multiple discharge points that are reasonably spread out across the development adjoining the wetland habitat. Accompanying each discharge point will be suitable "baffle structures" (e.g. gabion mattresses) that will dissipate the energy of storm flow and encourage infiltration, thus reducing the likelihood of erosion. Outflow points will incorporate a best management practice approach to trap excess suspended solids and other pollutants originating from the proposed development before entering the freshwater ecosystems. These will need to be regularly serviced and maintained to ensure adequate functioning and efficacy. Stormwater must be directed onto vegetated areas to allow for seepage and to reduce flows feeding into watercourses and to trap excess sediment loads. Areas must be remain vegetated where possible to maintain surface roughness for minimising surface runoff and erosion.	Visual inspection	Ongoing during construction	To effectively implement stormwater control measures	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Wetlands	Sedimentation build up in the surrounding wetlands Potential contamination of watercourses from surrounding construction activities	Increased potential for excessive runoff to transport soils and other sediments into the surrounding wetlands.	Stormwater is required to be closely monitored as per the SWMP to ensure excess sediments are not being washed into the surrounding wetlands. Stormwater must be directed onto vegetated areas to allow for seepage and to reduce flows feeding into watercourses and to trap excess sediment loads. Areas must remain vegetated where possible to prevent surface runoff.	Visual inspection	Ongoing during construction	To effectively implement stormwater control measures	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

	Disturbance may result in a change in wetland habitat and invasion by alien vegetation		Stockpiles may not exceed 2m in height and must be located at least outside of the 1:50 year floodline where applicable. Stockpiles that remain longer than 6 months must be revegetated to prevent erosion and a netting must be used to confine sediment from water and wind erosion. Sandbags must be used where soil becomes unstable to prevent erosion. Backfilled material must be in reverse order. Backfilled material must be tilled and topography to resemble pre-disturbance state. Where necessary, diversion ditches will be created to intercept and slow the speed of runoff. Once areas are excavated, the pump station 2A gradient must be levelled and reshaped to prevent erosion. The ECO must monitor sources of waste and ensure remediation of any polluted areas or drains. Any potential contaminants must be stored in bunded areas. Herbicides must only be applied if deemed necessary by the ECO and must be in consultation with a certified contractor and a vegetation specialist, if necessary. If used, these must be stored in bunded, enclosed areas. No herbicides may be applied in watercourses.				
Wetlands	Direct wetland habitat destruction as a result of the proposed pipeline and associated infrastructure .	To minimise impacts to surrounding wetlands	The footprint of the pipeline construction activities must be kept to a minimum, to ensure there is no unnecessary intrusion into any water resource. Machinery and vehicles must remain outside of the watercourses as far as possible. All areas of increased ecological sensitivity must be designated as “No-Go” areas and prohibited to all unauthorised vehicles and work personnel.	Visual inspection	Ongoing until the offsets are complete.	To effectively offset the loss of wetland habitat	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be

			Pipelines must be designed to cross drainage lines at right angles and be placed outside of the active channels. Diversions must ensure sufficient water is fed through the system and the topography resembles the post disturbance state to avoid erosion and an alteration to the hydrological regime and sediment inputs. Adequate erosion measures must be implemented such as the erection of silt traps. Geotextiles recommended to hold sediment in place in areas with a high topography or gradient. Once areas are excavated, the pump station 2A gradient must be levelled and reshaped to prevent erosion. Flow continuity and connectivity of the freshwater features must be reinstated post- construction activities. Vegetation must be maintained where possible and must be cleared in a phased approach. No protected species are to be cleared without the necessary permits. Whilst excavation may occur within watercourses, areas that fall outside of the development area must be classified as prohibited areas and personnel informed. Diversions must ensure sufficient water is fed through the system and the topography resembles the pre-disturbance state to avoid erosion and an alteration to the hydrological regime and sediment inputs. Adequate erosion measures must be implemented such as the erection of silt traps to prevent sedimentation of watercourses.				conducted by an ECO. A wetland specialist may also be appointed for the monitoring of the implementation of the offset strategy.

			Machinery and vehicles must remain outside of the watercourses as far as possible. Once areas are excavated, the pump station 2A gradient must be levelled and reshaped to prevent erosion. No construction of infrastructure may take place within riparian and wetland areas and associated buffer zones unless authorisation is granted by the DWS. Where a proposed pipe is placed directly on alluvial or similar sediments, it is recommended that reno- mattresses be used as a base. The disturbed sediment beneath the reno- mattress must be well compacted to prevent settlement occurring. The buried pipeline under larger streams may be prone to erosion and this must be considered during the design of the pipeline.				
Surrounding water bodies	Reduced water quality due to to hydrocarbons washed in from road network	To prevent and/or minimise the hydrocarbons that are washed into the surrounding wetlands and river.	Attenuation features and constant monitoring will reduce the potential of this impact occurring. The use of grass swales to trap sediments and hydrocarbons will be effective as well as bio-retention ponds. Stormwater drains must accommodate new anticipated flows. Areas must remain vegetated where possible. Previously disturbed area must be used where feasible.	Visual inspection	Ongoing during construction	To maintain the water quality of surrounding water bodies.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Stormwater	High flow rates, peak flows and increased bank full events resulting in increased erosion (gully scour) within the wetland channels	To reduce high flow rates thereby preventing gully erosion.	Attenuation and bio-retention ponds will function to decrease the flow rates as well as reducing peak flows and therefore erosion. Erosion will also be controlled through the grass swales network. During construction, constant erosion monitoring will be required.	Visual inspection	Ongoing during construction	To maintain the flow rates of stormwater	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be

							conducted by an ECO.
Waste *Any substance, material or object that is not wanted, or intended for use by the holder of that substance.* Hazardous waste *As per Schedule 3 of the National Environmental Management Waste Act, 2008 (Act No. 59 of 2008), means waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.*	Improper storage of hazardous waste i.e., used oils from vehicles; old cement bags etc. resulting in possible contamination to the surrounding environment.	To prevent improper handling and storage of hazardous waste.	Hazardous waste must be stored on a hard surface within a bunded area and must not be allowed to enter storm water drains and the surrounding environment. Waste must be disposed of regularly by a reputable contractor. Hazardous waste such as oils, contaminated rags etc. must be disposed of at a hazardous class landfill/ waste disposal facility. Safe disposal certificates must be provided. The ECO must monitor sources of waste and ensure remediation of any polluted areas or drains. Spill kits must be made available and any leakages or spillages reported to the ECO and remediated immediately. Any potential contaminants must be stored in a bunded area.	Visual inspection	Ongoing during construction	Management of hazardous waste on site.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
General Waste *Waste that does not pose an immediate hazard or threat to health or to the environment.*	Potential for improper storage and disposal of waste materials generated during construction resulting in	To prevent improper storage and handling of waste	A waste management plan is recommended. Waste must be stored in the bins within the waste collection area in the construction camp and must not be allowed to blow around the site, be accessible by animals, or be placed in piles adjacent to the skips / bins. Separate waste bins	Visual inspection	Ongoing during construction	Management of general waste on site.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists.

General waste includes non-hazardous substances, materials, inert and building/ demolition waste. Building and Demolition waste *means waste (excluding hazardous waste) produced during the construction, alteration, repair or demolition of any structure and includes rubble, earth, rock and wood displaced during construction/ demolition. Such waste includes:* - *Discarded concrete and bricks,* - *Discarded wood glass and plastic,* - *Discarded metals* - *Discarded soil, stones and spoil* - *Other discarded building waste*	possible contamination to the surrounding environment.		for each of the waste streams generated must be provided. The waste containers must be appropriate to the waste type contained therein and where necessary will be lined and covered. Waste must not be allowed to accumulate on site but will be disposed of regularly by a reputable contractor and must be disposed of at an appropriate landfill site. Separate bins must be provided for different types of waste and recycling must be encouraged. No dumping of waste is permitted on site. No littering is permitted. The ECO must monitor sources of waste and ensure remediation of any polluted areas or drains.				Monthly audits must be conducted by an ECO.

Waste Disposal	Potential for construction waste to be disposed of at incorrect landfill resulting in contamination at the landfill site.	To prevent improper disposal of waste	Recycling will be undertaken where possible to limit waste added to the landfill site. Waste to be sent to registered landfills and safe disposal certificates must be retained for hazardous waste.	Visual inspection	Ongoing during construction	Management of general waste on site.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Storage of hazardous materials	Spillage of diesel during construction potential contaminating groundwater and surrounding environment	To prevent spills on site thereby preventing and/or minimising contamination to groundwater	Cement mixing will need to take place on a hard surface or cement mixing trays will need to be used. If the creation of a permanent bunded area is not feasible, these materials must be stored on drip trays capable of holding at least 110% of the spilled volume. Any construction equipment that could leak oil must be placed on a drip tray. All equipment must be in good working order to reduce the likelihood of oil leaks occurring. Any re-fueling of equipment must occur on a hardened surface, within a designated re-fueling area where any spills can be contained. A designated hazardous store will be set up which must be located within a bunded area on a hardened surface and under cover. Drip trays must be placed under all machinery, servicing of vehicles must be avoided on site unless absolutely necessary and then this must take place in a bunded area. Spill kits must be kept on site and any accidental spillages reported immediately to the ECO. Water quality testing must take place in instance of leak and parameters remedied to reflect natural conditions.	Visual inspection	Ongoing during construction	Management of hazardous waste storage on site.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Noise	Noise generated by construction workers,	To minimise excessive noise	It is noted that the site is directly adjacent to the airport and in the flight path however excessive noise must be controlled on site. Workers will be	Monitoring	Ongoing during construction	Control of noise levels during construction	The contractor / designated representative

	machinery and construction vehicles disturbing surrounding residents	during construction.	trained regarding noise on site and construction hours will be kept to working hours (07h00 to 18h00). All precautions must be taken to ensure that noise generation is kept to a minimum. If excessive noise is expected during certain stages of the construction, residents must be notified prior to the event.				must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Air Quality	Increased emissions generated from construction vehicles	To minimise air emissions from construction vehicles	The only emissions that will be generated will be from construction vehicles which are expected to be minimal and are not expected to significantly affect the surrounding communities or the environment.	Monitoring	Ongoing during construction	Control of air emissions during construction	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Air Quality	Dust generated from construction vehicles and other on-site activities impacting on-site workers as well as surrounding communities and road networks.	To minimise dust on site.	Dust control measures (the use of water cart/ truck) must be used to wet exposed soil thereby maintaining low dust levels. The dust levels must be kept below the required SANS Standards to ensure minimal impact on the surrounding community and environment.	Monitoring	Ongoing during construction	Control of air emissions during construction	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Traffic	Increase in traffic disruptions on surrounding access roads during construction.	To minimise traffic disruptions during construction	Pointsmen in attendance to control traffic where road disruption is most likely. Alert traffic department if road closure is required, conduct road closures during off peak hours and place notices of intent in advance. Construction vehicles to comply with the speed limits.	Visual inspection	Ongoing during construction	Traffic control during construction	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

Existing services	Potential damage to the existing water pipeline that runs east to west across the site.	To prevent damage to the existing water pipeline	The water pipeline and servitude has already been identified by the developers and engineers. Care will be taken not to impact the water pipeline during construction. Alternatively, if service disruption is unavoidable, the parties affected must be notified in advance.	Visual inspection	Ongoing during construction	To avoid impacts on the existing water pipeline	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Access	Unauthorised access to property.	To prevent unauthorised access to the site during construction	The applicants are the landowners will authorize access to the property. The areas under construction must however be fenced so ensure workers do not cross boundary lines particularly where the development footprint runs adjacent to nearby communities.	Visual inspection	Ongoing during construction	Access control during construction	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Cultural and Heritage	Potential unearthing and damage to items of cultural or historical significance and destruction to the cemetery along the route.	To prevent damage and destruction to potential resources of cultural and heritage importance.	Heritage Impact Assessments have been conducted and are included in the BAR. The heritage assessment revealed that the only heritage site which may be at risk by the development, is the Mpophomeni Cemetery. The Heritage specialist recommended that the applicant maintain a buffer of at least 8 metres from the border of the cemetery. This buffer zone must be clearly demarcated as a no-go area. The specialist further suggested that the developer erect a study fence with an entrance gate at the northeastern side of the cemetery prior to any excavation being undertaken. Should this not be feasible, then the applicant may need to consider a Phase 2 Heritage Impact Assessment. During the construction phase, should any culturally significance artifacts be discovered, construction is to cease immediately and the	Visual inspection	Ongoing during construction	Maintain the cultural and heritage importance of the site and surroundings.	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO. Upon discovery of any such resource an AMAFA official is to conduct a site visit.

			heritage authority contacted (AMAFA). Construction may only recommence once the identified resources have been evaluated by the relevant authority. A palaeontological assessment was conducted, during which no fossils were identified. The specialist recommended that a Fossil Chance Find Protocol to be included in the EMPr (Appendix 10) for when excavation commences, as follows: 1. The following procedure is only required if fossils are seen on the surface and when excavations commence. 2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the mining activities will not be interrupted. 3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figures 4, 5). This information will be built into the EMP's training and awareness plan and procedures. 4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment. 5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible. 6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.				

			7. If no good fossil material is recovered then the site inspections by the palaeontologist will not be necessary. 8. If no fossils are found and the excavations have finished then no further monitoring is required.				
Health and Safety	Speeding construction vehicles resulting in safety issues for surrounding residents.	To prevent speeding of construction related vehicles	Speeding will be prohibited. Speed warning signs of 30kph speed limits to be set.	Visual inspection	Ongoing during construction	Management of the construction vehicles and control of speed during construction	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Health and Safety	Lack of toilet facilities resulting in unsanitary conditions.	To prevent the use of the surrounding environment as toilets	Adequate toilet facilities will be provided for all staff members as standard construction practice.	Visual inspection	Ongoing during construction	to promote sanitary conditions at the site	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.
Health and Safety	Improper disposal of toilet waste from chemical toilets resulting in contamination of the surrounding environment.	To prevent dumping of toilet waste into the surrounding natural environment	The chemical toilets to be provided must be from a registered company and all sewage must be disposed of at an appropriate facility. Safe disposal certificates must be kept on record.	Visual inspection	Ongoing during construction	To promote sanitary conditions at the site and to maintain the state of the surrounding natural environment	The contractor / designated representative must monitor the site on a daily basis and conduct weekly checklists. Monthly audits must be conducted by an ECO.

Table 6: Identified Impacts, objectives, actions and outcomes associated with the post-construction phase

		Post-Construction/Rehabilitation Phase					
Aspect	**Potential Impact**	**Management Objective**	**Management Action**	**Method of Monitoring implementation of the management actions**	**Time period for implementation of the management actions**	**Management Outcome**	**Monitoring Frequency and responsible party**
Construction Site Camp	Substances containing Hydrocarbons polluting the soils.	Ensure correct rehabilitation of site camp area.	All structures comprising the construction site camp are to be removed from site. The construction site camp area is to be inspected for any spills of hydrocarbon substances. Should spills be present on site, these spills need to be cleaned and the contaminated material needs to be correctly disposed of. All hardened surfaces within the construction site camp must be ripped and all imported materials are to be removed off site. The area must be top soiled and re-grassed. All fences and barriers that are associated with construction must be removed from site. All residual stockpiles must be removed from site or disposed of in an appropriate manner. Spoil (excavated earthen material) that is able to be re-used during construction (i.e. for backfilling of trenches) is encouraged. Spoil may also be used to spread around the site for landscaping, as directed by the ECO. Construction rubble/ Building and Demolition waste means waste (excluding hazardous waste) produced during the construction, alteration, repair or demolition of any structure and includes rubble, earth, rock and wood displaced during construction/ demolition. Such waste thus includes: - Discarded concrete and bricks, - Discarded wood glass and plastic, - Discarded metals - Discarded soil, stones and spoil - Other discarded building waste	Visual Inspection	Post-Construction	To ensure site camp is decommissioned correctly with and spills being cleaned up and rehabilitation is conducted.	The contractor / designated representative must monitor the site when decommission of site camp takes place. A Post-Construction audit must be undertaken by the ECO.

			As spoil refers to excavated materials, it falls in the same category as construction waste mentioned above, and will be treated and disposed of in the same manner. However, contaminated spoil, or spoil that will not be suitable for re-use, must be disposed of in an appropriate manner at the designated landfill/ waste disposal facility. All leftover building materials must be returned to the depot or removed from site.				
Rehabilitation	Exposed surfaces promoting runoff and gully erosion	To minimise exposed surfaces post-construction	The implementation of the rehabilitation plan contained within the ecological report and Appendix 11 of the EMPr, combined with recommendations from the wetland specialist. The ecological rehabilitation plan must be implemented and strictly adhered to. Significant impacts must be offset and/or compensated for, through the implementation of appropriate Biodiversity Offsets. The overarching principle of the Biodiversity Offsets must be to obtain a net benefit for biodiversity conservation and persistence at a landscape level according to the Draft National Policy on Biodiversity offsets. If an offset proposal is provided to Ezemvelo KZN Wildlife for consideration, it must include information and motivation as to why Ezemvelo's alternative option cannot be pursued and why an offset would be viable. It must be noted that pursuing an offset is also risky in that, land-security/ offset receiving sites would need to be secured prior to the commencement of construction, and ongoing management and monitoring would need to implemented. The applicant is required to obtain approval of a biodiversity offset plan for construction of the pipeline along the boundary of the Midmar nature reserve and along the sensitive ridge line.	Visual Inspection	Post-Construction	To ensure rehabilitation is completed sufficiently.	The contractor / designated representative must monitor the site when decommission of site camp takes place. A Post-Construction audit must be undertaken by the ECO.

			An alien control plan must be compiled and implemented for all phases of the development. Topsoil removed during excavation must be stockpiled to a maximum height of 1.5m and is to be covered to prevent loss due to erosion. Only sufficient trench must be opened at a time to allow work to proceed smoothly. Trenches must be closed as soon as practically possible. Topsoil must be replaced after pipe laying and weeds and alien vegetation removed on a monthly basis for the first year, and then six-monthly for a further year. For the first year, a high intensity control programme (monthly) must be implemented to remove competition with indigenous vegetation and then routine follow-up (6 monthly) until rehabilitation is complete. Follow up assessments by the ECO, for six months' post construction, must be undertaken to determine the success of the re-vegetation process. Tillage of areas of bare-soil and revegetation using a mixture of indigenous grass species. Reshape areas to natural topography where possible and if necessary. If fertile topsoil not deemed suitable for use, it is the Contractors responsibility to replace soil. Soil used must be free from IAPS seeds. Soil water quality tests must be undertaken prior to backfill/infill. All permits are to be obtained from EKZNW prior to removal or protected species/ construction.				

Table 7: Identified Impacts, objectives, actions and outcomes associated with the operational phase

		Operational Phase					
Aspect	**Potential Impact**	**Management Objective**	**Management Action**	**Method of Monitoring implementation of the management actions**	**Time period for implementation of the management actions**	**Management Outcome**	**Monitoring Frequency and responsible party**
Soil Stability	Possible instability problems associated with siltstone/ mudstone horizons in western portion of site	To monitor, identify and prevent potential instability on site	The geotechnical specialist has identified areas which have a high collapse potential and high erosion potential, these areas will also be monitored during operation where possible. The site must be monitored for any creation of erosion features such as rills. The trench area must remain vegetated and re-shaping may be required if the landscape slope begins to worsen. The banks must be monitored to ensure they are stable and the sediment is not lose and able to support the infrastructure.	Visual Inspection	Ongoing	To maintain the stability of the site particularly the western portions	The designated representative must monitor on a ad hoc basis.
Stormwater	Stormwater structures and discharge points resulting in point-source erosion.	To prevent erosion by stormwater	The discharge of stormwater runoff into the identified systems will be managed by means of multiple discharge points that are reasonably spread out across the development adjoining the wetland habitat. Accompanying each discharge point will be suitable “baffle structures” (e.g. gabion mattresses) that will dissipate the energy of storm flow and encourage infiltration, thus reducing the likelihood of erosion. Outflow points will incorporate a best management practice approach to trap excess suspended solids and other pollutants originating from the proposed development before entering the freshwater ecosystems. These will need to be regularly serviced and maintained to ensure adequate functioning and efficacy.	Visual Inspection	Ongoing	To effectively manage the operational stormwater management system	The designated representative must monitor on an ad hoc basis.
Stormwater	Stormwater features accumulating litter/excess vegetation.	To prevent the accumulation of excess litter and vegetation in stormwater features.	Mitigation measures include frequent inspection and maintenance of the stormwater facilities. A checklist is included in the Operational SWMP to ensure this is not overlooked. Storm water drains must be in alignment with the storm water management plan.	Visual Inspection	Ongoing	To effectively manage the operational stormwater management system	The designated representative must monitor on an ad hoc basis.

Alien Invasive Species	Risk of further alien invasive encroachment on site and in the Hlawe River riparian zone.	To prevent the growth and spread of alien plant species during operation	An alien control plan must be compiled and implemented for all phases of the development. All exposed soils on site requiring rehabilitation will be re-vegetated with indigenous vegetation typical of KZN's coastal riparian zone that should naturally be occurring there. Disturbance outside of the immediate project footprint must be limited. For the first year, a high intensity control programme (monthly) must be implemented to remove competition with indigenous vegetation and then routine follow-up (6 monthly) until rehabilitation is complete.	Visual Inspection	Ongoing	To maintain indigenous vegetation during operation and to remove alien species.	The designated representative must monitor on an ad hoc basis.
Wetlands	General loss of wetland area	To minimise wetland loss	To implement mitigation measures as per the wetland study in Appendix D of the Draft BAR. Routine (every 3 months) water quality measurements must be undertaken to determine if the quality has changed from the baseline condition.	Visual Inspection	Ongoing	To avoid excessive infilling and destruction to wetlands	A suitably qualified ECO to conduct monitoring of the rehabilitation
Incidents / Spills	Pollution of stormwater.	Correct procedures followed and records to be compiled.	A spill response procedure must be designed to manage spills during operation. Employees of the development must be made aware of the spill response procedure. All spills must be immediately cleaned. Spill kits must be readily available. Spills must not be allowed to enter stormwater drains and contaminate stormwater. In the event of a spill, the following procedure is to be followed: • Stop the source of the spill; • Contain the spill; • All significant spills must be reported to this Department and other relevant authorities; • Remove the spilled product for treatment or authorised disposal;	Visual Inspection	Ongoing	To contain any spills that may occur.	The designated representatives must monitor spills as and when the incidents happen.

			• Determine if there is any soil, groundwater or other environmental impact; • If necessary, remedial action must be taken in consultation with the Department of Economic Development, Tourism and Environmental Affairs; • Incident must be documented. The emergency protocol as per Appendix C of Notice 509 of 2016 must be implemented in the case of emergency incidents. The pipeline structure should contain manholes to inspect and detect any leakages or damages to the infrastructure over time, as applicable. A monitoring programme should be implemented to ensure the pipeline is stable at all times and to ensure leakages are identified and repaired timeously.				
Waste Management	Hazardous and general waste overflowing.	Recycling to be encouraged during all phases of the development. Bins must be located at adequate intervals.	All solid waste generated during operation (including packets, plastic, rubble, cut plant material, solid waste etc.) must be placed in a waste collection area and must not be allowed to blow around the site, be accessible to animals, or be placed in piles adjacent the skips / bins. Dispose of solid paint waste with other solid waste. Refuse will be separated at source and disposed in the appropriate bins, which will be emptied regularly. Littering is prohibited and the site must be cleaned daily. Recycling will be done where possible. Recycling bins must be placed at timeous intervals to separate recyclable materials and to encourage waste recycling. Hazardous waste during operation (e.g. oily rags, used motor oils, paint tins, paint, solvents) will be stored in separate designated hazardous waste stores which will be on a hard-surfaced bunded	Visual Inspection	Ongoing	Ensure waste is handled and disposed of correctly.	The designated representative must monitor waste.

			area that is undercover. A separate drum must be available for storage of contaminated soil. Grease traps will be regularly serviced and sludge removed must be disposed of at an approved hazardous landfill site. Safe disposal certificates must be obtained. A single and central storage point must be set up for used lubrication oil. The used oil must be collected and recycled by an approved oil recycler.				
Hazardous Substances	Hazardous substances polluting the soil.	Hazardous materials must always be stored in a separately bunded area.	Hazardous substances / materials are to be transported in sealed containers or bags. Store paints, chemicals and oils in a bunded storage area which will be roofed to prevent entry of water and locked to prevent illegal entry. Hazardous materials that require disposal (paints, solvents) must be disposed of to a registered hazardous landfill site. These materials may be removed by an appropriate hazardous waste contractor. Proof of appropriate disposal must be available to the ECO. A single and central storage point must be set up for used lubrication oil. The used oil must be collected and recycled by an approved oil recycler. All hazardous waste must be stored in a designated hazardous waste area and must be disposed of at a hazardous approved landfill site. Store paints, chemicals and oils in a bunded storage area which must be roofed to prevent entry of water and locked to prevent illegal entry. Appropriate signage must be fixed for all hazardous materials or materials requiring special management.	Visual Inspection	Ongoing	To ensure the hazardous waste is stored and handled correctly.	The designated representative must monitor the hazardous materials storage area.

			Storage must not exceed the minimum allowable limits as per the eThekwini bylaws. Firefighting equipment to be kept near store for materials.				
Occupational Health and Safety		Occupational health and safety risk during operation, i.e. handling of hazardous chemicals and used oils, inhalation of dangerous vapours	Staff handling hazardous substances/materials must be aware of their potential impacts and follow appropriate safety measures. Firefighting equipment must be present on site at all times as per the Occupational Health and Safety Act (85 of 1993). During filling of the underground tanks, the area must be appropriately demarcated to avoid impact on staff and patrons of the service station.	Visual Inspection	Ongoing	To ensure the hazardous waste is stored and handled correctly and that everyone is aware of the correct methods for handling of hazardous substances.	The designated representative must monitor the hazardous materials storage area.

4. MONITORING AND COMPLIANCE

4.1 MECHANISM FOR MONITORING COMPLIANCE WITH THE IMPACT MANAGEMENT ACTIONS

The key to a successful EMPr is appropriate monitoring and review to ensure effective functioning of the EMPr and to identify and implement corrective measures in a timely manner. Monitoring for non-compliance against the EMPr, EA and other applicable legislation must be done on a daily basis by the contractors under the guidance of the Project Manager / Environmental Officer / Engineer and a monthly or bi-monthly basis by the ECO (or as prescribed by the EA).

4.2 REPORTING ON COMPLIANCE

An appropriately timed audit report will be compiled by the independent ECO which must include recommendations and a timeframe for the implementation of corrective measures. Paramount to the reporting of non-conformance and incidents is that appropriate corrective and preventative action plans are developed and adhered to. Photographic records of all incidents and non-conformances must be retained.

According to Appendix of the EIA Regulations, 2014 reporting on compliance is imperative. The environmental audit report must detail the level of compliance with the conditions of the EA, EMPr and where applicable the closure plan. The report must further identify and assess any new impacts and risks as a result of the proposed development, evaluate the effectiveness and shortcomings of the EMPr and the need for any changes to the management actions provided in the EMPr.

4.3 PROCEDURES FOR ENVIRONMENTAL RELATED EMERGENCIES AND REMEDIATION

The purpose of this section is to anticipate a potential impact resulting in an environmental crisis which may occur due to unforeseen circumstances. Such events cannot be predicted and as such a procedure has been prepared. This procedure must be followed in the event of such an incident to prevent degradation to the surrounding environment and to contribute to the safety of the workers and I & APs.

4.3.1 Potential environmental incidences / emergencies

The National Environmental Management Act (NEMA) defines an 'incident' as an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed. The following hazards have the potential to occur within the proposed site:

- Hazardous chemical spillage
- Leakage of fuel or oil from equipment
- Potential contamination of water resources (ground and surface).
- Damage to surrounding infrastructure
- Erosion of areas stripped of groundcover

4.3.2 Response to environmental emergencies

The emergency response plan (Appendix 4) must be used to update the onsite emergency response plans. A record of all incidents must be recorded as defined in NEMA and NWA (Appendix 5). Incidents will be reported and recorded the relevant authority as soon as reasonably practicable after knowledge of the incident.

An emergency incident report (Appendix 6) must be completed in terms of section 30(5) of the National Environmental Management Act (Act No. 107 of 1998).

"The responsible person or, where the incident occurred in the course of that person´s employment, his or her employer, must, within 14 days of the incident, report to the Director General, provincial head of department and municipality such information as is available to enable an initial evaluation of the incident, including:
(a) the nature of the incident;

(b) the substances involved and an estimation of the quantity released and their possible acute effect on persons and the environment and data needed to assess these effects;
(c) initial measures taken to minimise impacts;
(d) causes of the incident, whether direct or indirect, including equipment, technology, system, or management failure; and

(e) measures taken and to be taken to avoid a recurrence of such incident."

5. ENVIRONMENTAL AWARENESS PLAN

5.1 ENVIRONMENTAL AWARENESS PLAN (APPENDIX 7)

In accordance with NEMA EIA (2014) regulations, an environmental awareness plan is required. As part of the environmental awareness plan 'Toolbox Talks' posters have been developed and can be used for training purposes.

- **Objectives of the plan**

The objective of the environmental awareness plan is to inform employees and contractors of any environmental risks which may result from their work and the manner in which the identified possible risks must be dealt with in order to prevent degradation of the environment.

- **Content of the plan**

The environmental awareness plan includes:

- The definition of environment (people + air + soil + water +business);
- Reasons for conserving and protecting the environment;
- How the following activities can impact the environment: - Not using assigned ablutions, hazardous materials, uncleaned spills, mixing of cement or paint on soil or grass surfaces, waste management i.e. use of waste receptacles and waste separation for recycling, vehicle washing polluting soil & ground water; litter;
- What to do to prevent the above impacting the environment i.e. assign impermeable mixing areas, no vehicle washing on site, use of waste receptacles and separation of waste to allow for recycling, how to respond in an emergency and deal with a spill; and
- Consideration of neighbours.

The environmental awareness plan that will be presented to employees is attached in Appendix 7. A training record of all staff that has undergone environmental training must be kept on record (Appendix 8).

APPENDICES

APPENDIX 1: LETTER OF ACCEPTANCE OF EMPR

RE: Proposed Vulindlela Pipeline between Howick West Reservoir and Reservoir 2

To whom it may concern

This is to state that the undersigned have received a copy of the Environmental Management Programme (EMPr) developed for this site by *KSEMS* dated November 2020. The undersigned do hereby agree to abide by the strictures of the Environmental Management Programme (EMPr). Any contravention of the EMPr will be recorded and corrective action will be carried out.

Any changes to the EMPr must be approved by the *Environmental Control Officer (ECO)*, the consultant *Kerry Seppings Environmental Management Specialists (KSEMS)* and the relevant authority. Such changes are to be made in writing and a record must be maintained.

As Agreed on this day _____ of _____(Month) _____(Year)

Environmental Control Officer (ECO)

Name _____

Signed _____

Contractor

Name _____

Company _____

Signed _____

Engineer

Name _____

Company _____

Signed _____

APPENDIX 2: COMPLAINTS REGISTER

This a register for recording all complaints received from neighbours i.e. Complaints about noise, odours, dust etc.

Date of complaint	Complainant's name	Contact Details (phone)	Nature of complaint	Corrective action taken	Date action completed

APPENDIX 3: NON-CONFORMANCE RECORD AND AUDIT TEMPLATE

This is record of non-compliances with the EMPr i.e. any action taken that is in violation of the EMPr must be recorded e.g. mixing concrete directly on soil, site staff using neighbouring properties as toilet facilities, dumping of material over fence etc.

Date of Non-conformance	Details of non-conformance	Party / ies responsible	Corrective action taken	Date action completed

APPENDIX 4: BASIC EMERGENCY RESPONSE PLAN

1. AIM

1) The effective response to emergency incidents.
2) The control of emergency incidents.
3) Recording incidents and ensuring that where possible, all measures are taken to prevent them from re-occurring

2. DEFINITION OF AN "INCIDENT"

As defined by NEMA, section 30 "Control of emergency incidents"

(1) In this section—

(a) "incident" means an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed;

(b) "responsible person" includes any person who—

(i) is responsible for the incident;

(ii) owns any hazardous substance involved in the incident; or

(iii) was in control of any hazardous substance involved in the incident at the time of the incident;

(c) "relevant authority" means—

(i) a municipality with jurisdiction over the area in which an incident occurs;

(ii) a provincial head of department or any other provincial official designated for that purpose by the MEC in a province in which an incident occurs;

(iii) the Director General;

(iv) any other Director General of a national department.

As defined by the National Water Act section 20 "Control of emergency incidents"

(1) In this section "incident" includes any incident or accident in which a substance -

(a) pollutes or has the potential to pollute a water resource; or

(b) has, or is likely to have, a detrimental effect on a water resource.

Definition of an Incident on Site

Spills, contamination of soil and or stormwater, fires, explosions.

3 CONTENTS OF REPORT TO AUTHORITIES

As taken from NEMA, Section 30 :Control of Emergency Incidents"

(3) The responsible person or, where the incident occurred in the course of that person´s employment, his or her employer must forthwith after knowledge of the incident, report through the most effective means reasonably available—

(a) the nature of the incident;

(b) any risks posed by the incident to public health, safety and property;

(c) the toxicity of substances or byproducts released by the incident; and

(d) any steps that should be taken in order to avoid or minimise the effects of the incident on public health and the environment to—

(i) the DirectorGeneral;

(ii) the South African Police Services and the relevant fire prevention service;

(iii) the relevant provincial head of department or municipality; and

(iv) all persons whose health may be affected by the incident.

(4) The responsible person or, where the incident occurred in the course of that person´s employment, his or her employer, must, as soon as reasonably practicable after knowledge of the incident—

(a) take all reasonable measures to contain and minimise the effects of the incident, including its effects on the environment and any risks posed by the incident to the health, safety and property of persons;

(b) undertake cleanup procedures;

(c) remedy the effects of the incident;

(d) assess the immediate and longterm effects of the incident on the environment and public health.

(5) The responsible person or, where the incident occurred in the course of that person´s employment, his or her employer, must, within 14 days of the incident, report to the DirectorGeneral, provincial head of department and municipality such information as is available to enable an initial evaluation of the incident, including—

(a) the nature of the incident;

(b) the substances involved and an estimation of the quantity released and their possible acute effect on persons and the environment and data needed to assess these effects;

(c) initial measures taken to minimise impacts;

(d) causes of the incident, whether direct or indirect, including equipment, technology, system, or management failure; and

(e) measures taken and to be taken to avoid a recurrence of such incident.

(6) A relevant authority may direct the responsible person to undertake specific measures within a specific time to fulfil his or her obligations under subsections (4) and (5): Provided that the relevant authority must, when considering any such measure or time period, have regard to the following:

(a) the principles set out in section 2;

(b) the severity of any impact on the environment as a result of the incident and the costs of the measures being considered;

(c) any measures already taken or proposed by the person on whom measures are to be imposed, if applicable;

(d) the desirability of the State fulfilling its role as custodian holding the environment in public trust for the people;

(e) any other relevant factors.

(7) A verbal directive must be confirmed in writing at the earliest opportunity, which must be within seven days.

(8) Should—

(a) the responsible person fail to comply, or inadequately comply with a directive under subsection (6);

(b) there be uncertainty as to who the responsible person is; or

(c) there be an immediate risk of serious danger to the public or potentially serious detriment to the environment,

a relevant authority may take the measures it considers necessary to—

(i) contain and minimise the effects of the incident;

(ii) undertake cleanup procedures; and
(iii) remedy the effects of the incident.

As taken from the National Water Act section 20 "Control of emergency incidents"

(2) In this section, ``responsible person'' includes any person who -
(a) is responsible for the incident;
(b) owns the substance involved in the incident; or
(c) was in control of the substance involved in the incident at the time of the incident.
(3) The responsible person, any other person involved in the incident or any other person with knowledge of the incident must, as soon as reasonably practicable after obtaining knowledge of the incident, report to -
(a) the Department;
(b) the South African Police Service or the relevant fire department; or
(c) the relevant catchment management agency.
(4) A responsible person must -
(a) take all reasonable measures to contain and minimise the effects of the incident;
(b) undertake clean-up procedures;
(c) remedy the effects of the incident; and
(d) take such measures as the catchment management agency may either verbally or in writing direct within the time specified by such institution.

The following emergency procedures are guidelines only and should be used in conjunction with the emergency response plan provide by the contractor.

4. ON SITE EMERGENCY PROCEDURES

4.1 SPILL RESPONSE

4.1.1 RESPONSIBLE PERSON/S

- The spill is reported to the Foreman who must report to his superior who must report to the ECO.
- All employees must be made aware of the procedure in case of a spill.
- The ECO must report to relevant authorities if contamination occurs and if spill falls within the definition of a spill

4.1.2 PROCEDURE

- Identify nature and size of spill e.g. oil 20L. Consult MSDS for safety precautions
- Protect exposed stormwater drains, prevent entry of substance to stormwater drains and drainage line.
- For a small spill (less than a litre, locate spill kit, contain spill according to the training from the spill kit suppliers
- For large spill (unable to deal with on site), contact external spill control contractors
- Determine appropriate method for disposal of material based on information provided in MSDS

- Determine if any contamination has occurred i.e. entry to stormwater, soil contamination
- If contamination has occurred, consult with authorities on need for on-going monitoring and or rehabilitation requirements. Determine medium and long term effects. Stormwater incidents must be reported to Waste water
- If no contamination has occurred, determine if spill falls under definition of an "incident" and if so, report to relevant authorities.
- Record in Incidents register
    - Nature of incident
    - Cause of incident
    - Contamination if any
    - Measures taken to control spill and handle contamination
    - If spill falls under definition of an incident
    - Mitigation measures taken to prevent re-occurrence
- Record in non-compliance register and incident (if defined as incident)
- The ECO must review all spill reports
- Adjustments will be made, if necessary, to the operational and emergency procedures to prevent future occurrences

4.2 FIRE

4.2.1 RESPONSIBLE PERSON/S

- The spill is reported to the Foreman who must report to his superior who must report to the ECO.
- All employees must be made aware of the procedure in case of a spill.
- The ECO must report to relevant authorities if contamination occurs and if spill falls within the definition of a spill

4.2.2 PROCEDURE

- Identify source and nature of fire
- In case of small fire extinguish with material appropriate to the nature of the fire. Consult MSDS.
- Immediately contact the ECO. In case of a large fire contact Fire Department
- Seal off exposed stormwater drains to ensure spill does not cause any external contamination
- Determine whether any contamination has occurred
- If contamination has occurred, consult with authorities to determine appropriate rehabilitation and monitoring
- Record in incident register:
    - Nature of incident
    - Cause of incident
    - Clean up measures
    - Mitigation measures taken
- Record in non-compliance register and record as incident if applicable.
- The ECO must review all fire reports
- Adjustments will be made, if necessary, to the operational and emergency procedures.

APPENDIX 5: INCIDENT RECORD

This is record of incidents as defined in NEMA and the NWA. Incidents must be recorded and reported to the applicable authorities.

Date of incident	Details of incident	Party / ies responsible	Corrective action taken	Date action completed

APPENDIX 6: EXAMPLE OF AN EMERGENCY INCIDENT REPORT FORM (SOURCE: DEA WEBSITE)

environmental affairs Department: Environmental Affairs REPUBLIC OF SOUTH AFRICA	**Document Type:**	Emergency Incident Report	
	Title for the Incident:		
	Date of the incident:		
Reference:	[A reference that may be used in future correspondence]	**Initial Submission Date:**	[Date of initial submission of the report to the Department: Environmental Affair, Tourism]
Revision No.:	example	**Compiled by:**	[Full name and contact details of the person submitting the report]

This form provides a template for the emergency incident report required in terms of section 30(5) of the National Environmental Management Act (Act No. 107 of 1998) (hereinafter "NEMA") in which the responsible person or, where the incident occurred in the course of that person´s employment, his or her employer, must, within 14 days of the incident, report to the Director General, provincial head of department and municipality such information as is available to enable an initial evaluation of the incident, including: (a) the nature of the incident; (b) the substances involved and an estimation of the quantity released and their possible acute effect on persons and the environment and data needed to assess these effects; (c) initial measures taken to minimise impacts; (d) causes of the incident, whether direct or indirect, including equipment, technology, system, or management failure; and (e) measures taken and to be taken to avoid a recurrence of such incident.
In terms of section 30(1)(a) of NEMA, an "incident" means an unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed.
In line with section 24 of the Constitution of the Republic of South Africa (Act No. 108 of 1996), "serious" is taken to be a measure of the impact of an incident where such an incident has had, could have had, is having, or will have a negative impact on human health or well-being.

1. RESPONSIBLE PERSON			
In terms of section 30(1)(b) of NEMA, the "responsible person" includes any person who: (i) is responsible for the incident; (ii) owns any hazardous substance involved in the incident; or (iii) was in control of any hazardous substance involved in the incident at the time of the incident			
Name:	[Full name of person, company, etc.]	**Designation:**	[designation of responsible person (n/a for companies, etc.)]
Postal Address:	[Full postal address including postal code]	**Physical Address:**	[Full physical address]
Telephone (B/H)	[Business hours contact telephone number and area code]	**Telephone (A/H)**	[After hours contact telephone number and area code]
Fax:		**Email:**	
Nature of Business:	[Brief summary of the nature of the business]		

2. Emergency Incident Summary Information							
Mark the appropriate boxes							
2.1 Fire:		**2.2 Spill:**		**2.3 Explosion:**		**2.4 Gaseous Emission:**	
2.5 Injuries		**2.6 Reportable injuries:**		**2.7 Hospitalisation:**		**2.8 Fatalities:**	
2.9 Open water impacts:		**2.10 Ground water impacts:**		**2.11 Atmospheric impacts:**		**2.12 Soil impacts:**	
2.13 Own emergency response involved		**2.14 Fire prevention services involved**		**2.15 Government hazardous materials emergency response involved**		**2.16 More than 1 governmental emergency response service involved**	
2.17 Emission of non-toxic substances at low concentrations		**2.18 Emission of non-toxic substances at high concentrations**		**2.19 Emission of toxic substances at low concentrations**		**2.20 Emission of toxic substances at high concentrations**	
2.21 No evacuation required		**2.22 Immediate area evacuated**		**2.23 Immediate surrounds evacuated**		**2.24 Evacuation of the general public**	
2.25 Others							

3. Initial Emergency Incident Report				
In terms of section 30(3) of NEMA, the responsible person or, where the incident occurred in the course of that person´s employment, his or her employer must forthwith after knowledge of the incident, report through the most effective means reasonably available: (a) the nature of the incident; (b) any risks posed by the incident to public health, safety and property; (c) the toxicity of substances or byproducts released by the incident; and (d) any steps that must be taken in order to avoid or minimise the effects of the incident on public health and the environment to: (i) the Director General; (ii) the South African Police Services and the relevant fire prevention service; (iii) the relevant provincial head of department or municipality; and (iv) all persons whose health may be affected by the incident.				
Description	**Date:**	**Time:**	**Medium:**	**Contact Details:**
Relevant fire prevention services: (in case of fire)	[submission date]	[submission time]	[Fax, phone, SMS, letter, etc.)	[who was the report made to?]
Local:				
Provincial: (Those deal with Environmental issues)				
Director General: (DEA)				
Any other Director General of National Department eg DWA				

4. Incident Details			
In terms of NEMA section 30(5)(a) and (d), the responsible person must report on the nature of the incident as well as the causes of the incident, whether direct or indirect, including equipment, technology, system, or management failure			
4.1 Location of the incident	[Provide physical address of the location where the incident happened including the GPS co-ordinates]		
Incident start date and time:	[The exact time that the unexpected event started]	**Incident duration:**	[the duration of the unexpected event]
Duration of exposure:	[The duration of conditions that had a direct impact anyone's health or well-being]		
Incident description			
Background of the incident: Operation: Incident type: Root Cause of the incident: Contributing factors to the incident: Conclusion:			
Wind speed and direction	[The wind speed and direction at the point of the incident at the time of the incident]	**Ambient air temperature**	[ambient air temperature at the time of the incident]
Weather conditions	[Sunny, light rain, mist, heavy rain, etc.]	**Other relevant meteorological conditions**	[Temperature inversion, floods, etc]

5. POLLUTANTS RELEASED DURING INCIDENT					
In terms of NEMA section 30(5)(b), the responsible person must report on the substances involved and an estimation of the quantity.					
List all the pollutants directly released during the incident (i.e. exclude those pollutants that resulted from mitigation measures, e.g. flaring, treatment, dilution etc.)					
5.1 Substance or mixture of substances	**5.2 Reference Number**	**5.3 Phase**	**5.4 Total Quantity emitted**	**5.5 Unit**	**5.6 Nature of emission**
[The name recognised by any national or internationally recognised chemical referencing system]	[Reference to any national or internationally recognised chemical referencing system]	[solid, semi-solid, liquid or gas]	[the total measured or estimated quantity released into the environment]	[the unit of measure in respect to the quantity]	[emitted from truck, underground pipe, stack, etc.]

6. SECONDARY POLLUTANTS RESULTING FROM INCIDENT					
In terms of NEMA section 30(5)(b), the responsible person must report on the substances involved and an estimation of the quantity released.					
List all the pollutants that resulted from mitigation measures, e.g. flaring, treatment, dilution etc.					
6.1 Substance or mixture of substances	**6.2 Reference Number**	**5.3 Phase**	**5.4 Total Quantity emitted**	**5.5 Unit**	**5.6 Nature of emission**
[The name recognised by any national or internationally recognised chemical referencing system]	[Reference to any national or internationally recognised chemical referencing system]	[solid, semi-solid, liquid or gas]	[the total measured or estimated quantity released into the environment]	[the unit of measure in respect to the quantity]	[emitted from truck, underground pipe, stack, etc.]

7. POLLUTANT CONCENTRATIONS					
In terms of NEMA section 30(5)(b), the responsible person must report on the substances involved and an estimation of the quantity released.					
List all the pollutants detailed above.					
7.1. Substance or mixture of substances	**7.2. Reference Number**	**7.3. Estimated pollutant concentration**			
		7.3.1. 10m	**7.3.2. 100m**	**7.3.3. 500m**	**7.3.4. >2000m**
[The name recognised by any national or internationally recognised chemical referencing system]	[Reference to any national or internationally recognised chemical referencing system]	[estimate the concentration of the pollutant in water, soil and/or air within a 10m radius of the epicentre of the incident] [provide the units used in a case of estimating concentrations eg ppm]	[estimate the concentration of the pollutant in water, soil and/or air within a 100m radius of the epicentre of the incident] [provide the units used in a case of estimating concentrations eg ppm]	[estimate the concentration of the pollutant in water, soil and/or air within a 500m radius of the epicentre of the incident] [provide the units used in a case of estimating concentrations eg ppm]	[estimate the concentration of the pollutant in water, soil and/or air within a >2000m radius of the epicentre of the incident][provide the units used in a case of estimating concentrations eg ppm]

8. INCIDENT IMPACT	
In terms of NEMA section 30(5)(b), the responsible person must report on possible acute effect on persons and the environment and data needed to assess these effects;	
8.1 Minor injuries	[Describe the number and types of any minor injuries that resulted from the incident or efforts to manage the incident or the impacts thereof]
8.2 Reportable injuries	[Describe the number and types of any injuries requiring statutory reporting that resulted from the incident or efforts to manage the incident or the impacts thereof]
8.3 Hospitalisation	[Describe the number and types of any injuries that required professional medical care that resulted from the incident or efforts to manage the incident or the impacts thereof]
8.4 Fatalities	[Describe the number and cause of any fatalities that resulted from the incident or efforts to manage the incident or the impacts thereof]
8.5 Biological impacts	[Describe any impacts on biological life, other than human life, e.g. fish kills, plant mortality, etc.]
8.6 Impact area	[Describe the area possibly affected by the incident or the impacts thereof including: (i) size of the area; (ii) socio-economic context; (iii) population density; (iv) sensitive environments (if any), etc.]

8.7 Data	Attach relevant impact reports, medical reports, death certificates, post mortem reports, environmental monitoring data, etc. as Annexes C1, C2,… to this report

9. EXISTING PREVENTION PROCEDURES AND/OR SYSTEMS	
9.1 Foresight	[Briefly describe whether the incident could have, or had, been foreseen, e.g. was it included in any environmental impact assessment, risk assessment, health and safety plan, etc.]
9.2 Procedures and/or systems	Attach any relevant safety, health and environmental plans (including any statutory planning requirements) that detail what actions must be taken in the event of the incident that is the subject of this report
9.3 Procedure and/or systems failures	[Describe any failures or shortfalls in procedures and/or systems that may have contributed to the incident]
9.4 Technical measures	[Describe any technical measures, equipment, 'fail-safe' devices, etc. that are in place to prevent the occurance of the incident]
9.5 Technical failure	[Describe any failures of technical measures, equipment, 'fail-safe' devices, etc. that are in place to prevent the occurance of the incident]

10. INITIAL INCIDENT MANAGEMENT	
In terms of NEMA section 30(5)(c), the responsible person must report on initial measures taken to minimise impacts.	
10.1 Evacuation	[Describe any evacuation activities including information on the number of people evacuated and whether these people were staff or otherwise]
10.2 Technical measures	[Describe all technical measures taken to address the incident]
10.3 Mitigation measures	[Describe all measures taken to minimise the impact]
10.4 Emergency Services	[Describe any governmental emergency services involvement]

11. CLEANUP AND/OR DECONTAMINATION			
In terms of NEMA section 30(5)(c), the responsible person must report on initial measures taken to minimise impacts.			
11.1 Cleanup and/or decontamination	[Provide a detailed description of all cleanup and/or decontamination activities and the environmental quality and impacts resulting from these activities as well as contact details for any contracted service providers in an annex.]		
11.2 Permissions and Instructions			
Provide details of any permissions and/or instructions received from any organ of state during initial incident management, cleanup and/or decontamination			
11.3 Type	**11.4 Statute**	**11.5 Issued By**	**11.6 Name and contact details**
[Describe the nature or type of permission or instruction]	[Provide a reference to the legal mandate for the permission or instruction]	[Provide contact details for the permitting or instructing authority]	[provide a summary of the activities carried out in terms of the permission or instruction]

12. MITIGATION MEASURES			
In terms of NEMA section 30(5)(e), the responsible person must report on measures taken and to be taken to avoid a recurrence of such incident.			
12.1 Measure	**12.2 Objective**	**12.3 Cost**	**12.4 Timing**
[Briefly describe each of the measures taken, and to be taken, to avoid a recurrence of such incident]	[Briefly describe the objective of the measure, i.e. the desired outcome of the measure]	[Estimate the cost of the measure in terms of capital costs and/or recurrent costs]	[Provide information on the timing for the full implementation of the measure]

13. AUTHORISATIONS			
Provide detail on all authorisations (including permits, licenses, certificates, etc.) in respect of the activity to which the incident relates.			
13.1 Type	**13.2 Statute**	**13.3 Issued By**	**13.4 Issue & Expiry Date**
[Describe the nature or type of authorisation, e.g. Registration Certificate]	[Provide the reference for the authorisation, e.g. section X of the National Environmental Management Act (Act No. 107 of 1989)]	[Provide contact details for the issuing authority]	[provide the date of issue and expiry]

14. History			
Provide details on any and every similar incident involving the responsible person in the last 24 months. Similar incidents include those that: (i) involved similar circumstances; (ii) involved similar emissions; (iii) involved similar personal; and/or (iv) involved similar impacts.			
14.1 Incident title	**14.2 Report reference**	**14.3 Date of incident**	**14.4 Summary of event**
[Provide the title used in the relevant emergency incident report]	[Provide the reference in respect of the relevant emergency incident report]	[Date of incident]	[Provide a summary of the event]

Signed by, or as a mandated signatory for, the responsible person:		Date:	

APPENDIX A List of affected people as results of the incident				
NAME	**ADDRESS**	**PHONE**	**FAULT**	**REMARKS**

APPENDIX B Layout map of the area likely to be affected or affected as a result of the incident

Disclaimer: Any other information not covered in the reporting template must be included.

CAUTION: In terms of section 30 (11) of NEMA as amended, it is an offence not to report an incident and liable on conviction to a fine not exceeding R 1 million or imprisonment for a period not exceeding 1 year, or to both such a fine and such imprisonment.

APPENDIX 7: ENVIRONMENTAL AWARENESS PLAN

SITE ENVIRONMENTAL RULES

TOOLBOX TALK 1:	Definitions, EMPr, and Site Environmental Rules.
ISSUE:	Do's and Don'ts of the Construction Site.
PRESENTER:	

What is the Environment?

Environment (NEMA, 1998) - means the surroundings within which humans exist and that are made up of:

- the land, water and atmosphere of the earth;
- microorganisms, plant and animal life;
- any part or combination of (i) and (ii) and the interrelationships among and between them; and
- the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing;

What is the Pollution?

Pollution (NEMA, 1998) - means any change in the environment caused by -

- substances;
- radioactive or other waves; or
- noise, odours, dust or heat, emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or wellbeing or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future;

What is an EMPr?

Environmental Management Programme – refers to a document that is used to investigate, assess and evaluate the impacts that a development is likely to have on the environment during the construction, operation and decommission phases.

Why should we protect the Environment?

- It is our right to live in a clean and healthy environment.
- To ensure that future generations live in a clean environment.
- To prevent the loss of species diversity.
- To prevent loss of ecological goods and services

Environmental Site Rules:

- *No urinating or defecating on site. Toilet facilities provided at the construction site must be used at all times*
- *Do not waste water*
- *No littering*
- *No washing of cars or other vehicles on site*
- *Do not use spill kits for disposal of waste*
- *Do not dispose of any waste / waste water in watercourses or D'MOSS areas.*

DISPENSING, STORAGE AND DISPOSAL OF HYDROCARBONS/MINERAL OILS

DISCUSSION:

What is a Hydrocarbon (mineral oil)?

Diesel/hydraulic oil etc. are hydrocarbons and therefore classified as hazardous substances. A hazardous substance is any material that poses an unreasonable risk to people, property and the environment. The environment is our surroundings, soil, air and water.

What is the risk?

- Regular dispensing and offloading of diesel increases the risk of a spillage occurring.
- Changing hydraulic lines/ greasing parts / basic maintenance of vehicles
- Leaks from vehicles and equipment

Hydrocarbons are toxic if swallowed by humans or animals. The presence of hydrocarbons in water can also prevent aquatic organisms from breathing and may result in aquatic kills depending on the extent of the spill. Hydrocarbons must therefore be prevented from contaminating ground or surface water.

Note:
Only 1 litre of oil can contaminate a soccer field size of water. It is therefore essential to prevent spillages as far as possible and to ensure that if they do occur that they are properly cleaned up and that the resulting material is disposed of correctly.

What is a spillage?

All situations involving the spilling of a hydrocarbon on to the floor or ground or water.

How do we manage this?

1 **Correct Storage:**
   a. Refer to issues around the bunded area.
   b. Must be contained in waterproof and leak proof containers. Any containers or points that are leaking to be addressed immediately.
   c. Must be stored in a dedicated area on site.

2 **Correct Dispensing:**
   a. Must check lines for leaks before starting with dispensing.
   b. Place drip tray so as to catch any drips. How would you and into what would you empty the drip tray?
   c. Ensure all residual diesel/oil is drained from pipe before disconnecting.

3 Maintenance of vehicles and equipment
   a. Check equipment and vehicles for leaks daily. Report leaks to supervisor immediately. Contain slow drips using a drip tray.

<table>
<tr><td colspan="3">b. Do not use excessive grease when greasing vehicle or equipment parts.
4 Correct Spillage Handling and Disposal:
a. Clean all spillages immediately. This means treat and remove spillage.
b. Dispose in hazardous waste drum or skip.
c. Report spillage to supervisor.</td></tr>
<tr><td>DATE:</td><td>TIME:</td><td>LOCATION:</td></tr>
<tr><td>TOPIC:</td><td colspan="2">Dispensing, storage and disposal of hydrocarbons/ mineral oils</td></tr>
<tr><td>ISSUE:</td><td colspan="2">Spillage</td></tr>
</table>

USE AND MAINTENANCE OF DRIP TRAYS

What is a Drip Tray?

A drip tray is a plastic or metal container that can be used to contain a liquid. A container is suitable to be used as a drip tray, if

- It is heavy enough not to be blown away;
- Has no holes in the base or side from which a liquid could leak; and
- The sides are high enough that the liquid will not overflow.

The drip tray must be sized according to the amount of liquid that needs to be captured and contained.

What is the risk?

There is a risk of spillage of hydrocarbons or other chemicals under the following circumstance:

- Various equipment and vehicles may develop slow hydrocarbon leaks (oils);
- During maintenance of vehicles and equipment, there is a risk that hydrocarbons, grease, diesel/petrol may be spilt;
- Refueling of equipment and vehicles;
- During decanting of chemicals such as paint and curing compound etc, some of the chemicals may be spilt on the ground; and/or
- While applying paint or grease you need something to put the tin, paint brush or roller into.
- Temporary storage of chemicals at point of use

Under all these circumstances the correct use of a drip tray could prevent a spillage on to the ground or into water.

What is correct use of a drip tray?

Note that the use of a drip tray must be an additional precaution to other controls. For example:

- Decanting of chemicals must be done within a bunded area as far as possible. A funnel must be used when discharging liquids into a container with a small opening. Spillage of chemicals must always be avoided. A drip tray must be used only as a precaution in case there is a spill.
- Vehicles and equipment must be checked daily and maintained correctly to prevent leaks. Drip trays must be placed underneath equipment and vehicles when stationary as a precaution in case there is a leak.
- Temporary storage of chemicals at point of use. Chemicals must always be returned to chemical store at the end of the shift.
- When refueling vehicles or equipment a drip tray must be used to capture any excess or spillages from the nozzle of the hose. There must be no overfilling of vehicles and equipment.
- Drip trays may be used for the placing of paint brushes and rollers while applying curing compound.

Correct maintenance?

Drip trays must be maintained empty. Drip trays are to be checked daily, cleaned and emptied into the hazardous waste skip. Drip trays that are not being used must be stored under cover to prevent them filling with rain water.

TOPIC:	Use and maintenance of Drip trays
ISSUE:	Drips trays not being used when they should be
	Incorrect maintenance of drip trays resulting in spillages

USE, HANDLING AND STORAGE OF HAZARDOUS CHEMICALS

What is a Hazardous Chemical?

These are substances that may be dangerous to humans and or the environment if not handled, stored and disposed of correctly. The definition of a hazardous chemical is based on the amount, concentration or inherent properties of the waste.

e.g. Consumption of Alcohol,

Amount – the effect of 1 glass versus 5 litres. It is the same with a chemical. One drop may not be harmful but continuous dripping over a period of a week could be very harmful

Concentration – Beer as opposed to wine, there is alcohol in both but there is more alcohol in the wine than in the beer. It is the same with some chemicals

Inherent properties – Methylated spirits versus Beer, one bottle of methylated spirits could kill you but one beer won't because of the type of alcohol in the beer versus that in methylated spirits. It is the same with some chemicals

What is the risk?

There is a risk of spillage of chemicals under the following circumstance:

- During decanting of chemicals such as paint and curing compound etc, some of the chemicals may be spilt on the ground; and/or
- While applying paint or grease you need something to put the tin, paint brush or roller into.
- Temporary storage of chemicals at point of use

What are the correct use, handling and storage of hazardous chemicals?

- Hazardous chemicals must be stored in a roofed, bunded area that is kept locked. Entry of rain water into the bunded area must be prevented.
- All chemicals or chemical contaminated items must be stored within the bunded area. NOT on the wall of the bunded area or outside the bunded area on a concrete slab.
- Empty chemical containers and drums must be stored in the bunded area until removed or smaller containers thrown in the hazardous waste skip e.g. paint tins, paint brushes or rollers.
- Decanting of chemicals must be done within a bunded area as far as possible. A funnel must be used when discharging liquids into a container with a small opening. Spillage of chemicals must always be avoided.
- All chemical containers must be labelled. No food related containers are to be used for the storage of chemicals e.g. cool drink bottles.
- Temporary storage of chemicals at point of use. Chemicals must always be returned to chemical store at the end of the shift.
- Drip trays may be used for the placing of paint brushes and rollers while applying curing compound or shutter oil.
- All these chemicals must have an MSDS (material safety data sheet). This information is required to ensure that all chemicals are stored, handled and disposed of in the best possible way to ensure the safety of staff and the environment.

Correct maintenance of bunded area

Any cracks in the walls or floors and holes in the roof are to be repaired as soon as possible. Bunded area is to be kept free of spillages. Any spillages are to be cleaned up and disposed of as hazardous waste.

TOPIC:	Use, handling and storage of hazardous chemicals

ISSUE:	Incorrect storage of chemicals
	Spillage of chemicals

WASTE SEGREGATION AND SEPARATION

What is waste separation?
This is the separation of hazardous and general waste

Some examples of hazardous wastes generated on site:
Used oils (hydrocarbons), contaminated spill absorbent or sand, paints, batteries (acid), and fluorescent tubes (mercury), concrete.

Some examples of general waste generated on site:
Cool drink bottles, chip packets, plastic, leftover food, paper etc.

Correct handling, storage and disposal
- General waste must be disposed of in the green wheelie bins or marked skips provided
- Hazardous waste to be thrown in marked skips provided or 210L marked drums provided in certain areas
- The two must not be mixed!
- If hazardous waste is found in general waste, all must be disposed of as hazardous waste.

Why?
- The two waste types are disposed of at different waste dumps. The general waste dump is built only to deal with general waste. Hazardous waste accidentally disposed of here, could pollute the water and harm the people in the area.
- Disposal of general waste at a hazardous waste site results in an unnecessary cost to the company, as it is a lot more expensive to dispose of hazardous waste than general waste.

What is an incident?
- Mixed waste in any of the skips or bins.

TOPIC:	Waste segregation
ISSUE:	Mixing of wastes
	Incorrect disposal of mixed wastes

WASTING DRINKING WATER

What are examples of wasting of drinking water?

- Not turning a tap off properly after use.
- Poor maintenance of water fittings resulting in continuous leaking or dripping.
- Overfilling and / or overflowing of water containers.

Why should we not waste drinking water?

- Good, clean water is scarce in South Africa and expensive to produce and must therefore be used sparingly. Remember anything we put into the water (river, lake or dam) has to be removed before we can drink the water. The more we pollute the water the more expensive it becomes to clean it.

Ways to save water:

- Don't drink directly from the tape, rather fill a glass with water, switch the tape off and drink from the glass.
- Report any maintenance issues with water fittings or lines, as soon as possible.

What is an incident?

- Dripping or leaking tapes or water connections.
- Overflowing of containers that contain water.

TOPIC:	Wasting drinking water
ISSUE:	Scarcity of drinking water
	Expense to produce drinking water

APPENDIX 8: TRAINING RECORD

This is record of training carried out on site.

Training Topic:_____ **Date:**_____

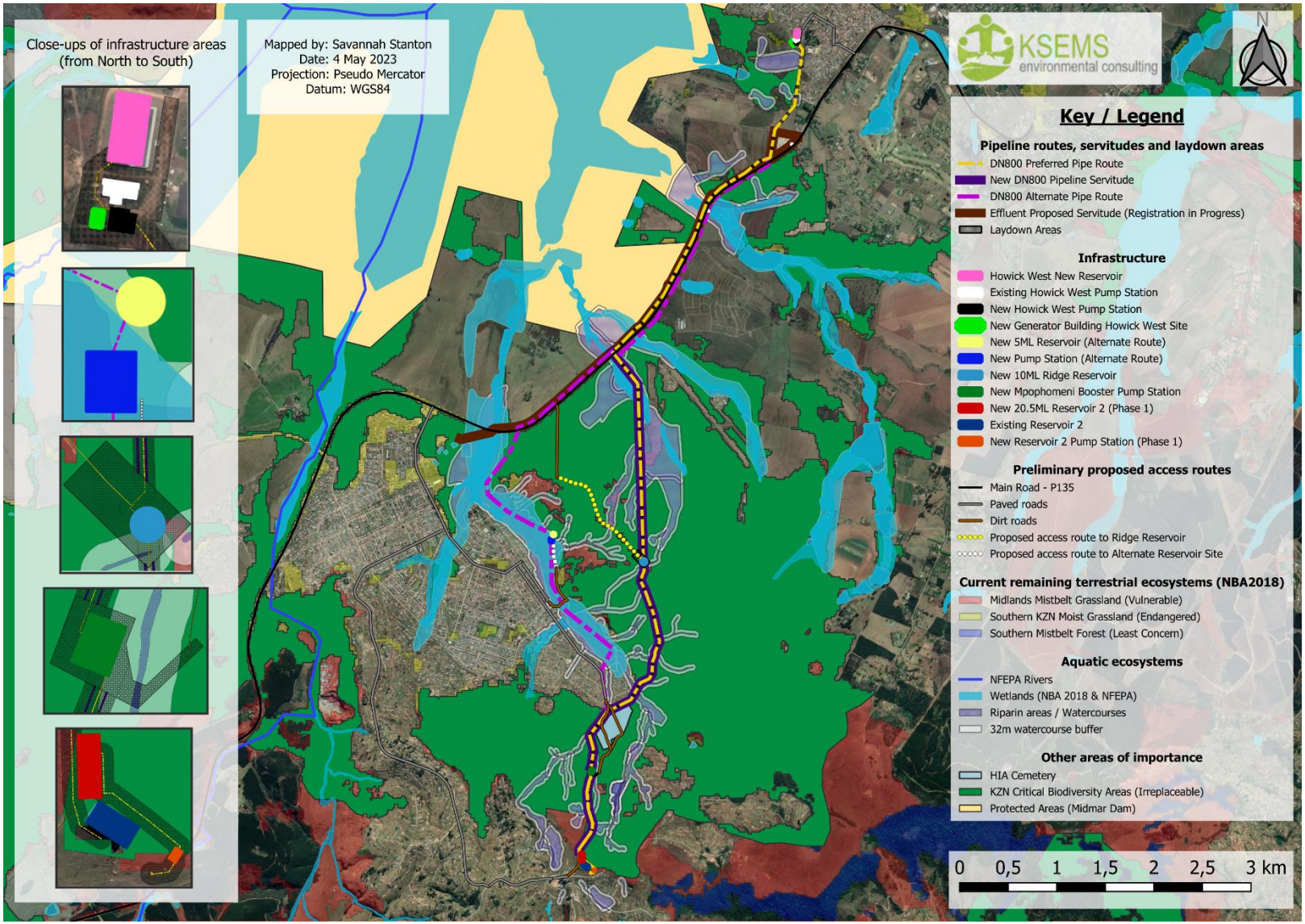
Training Topic Details

Training Attendance	
Name	**Signature**

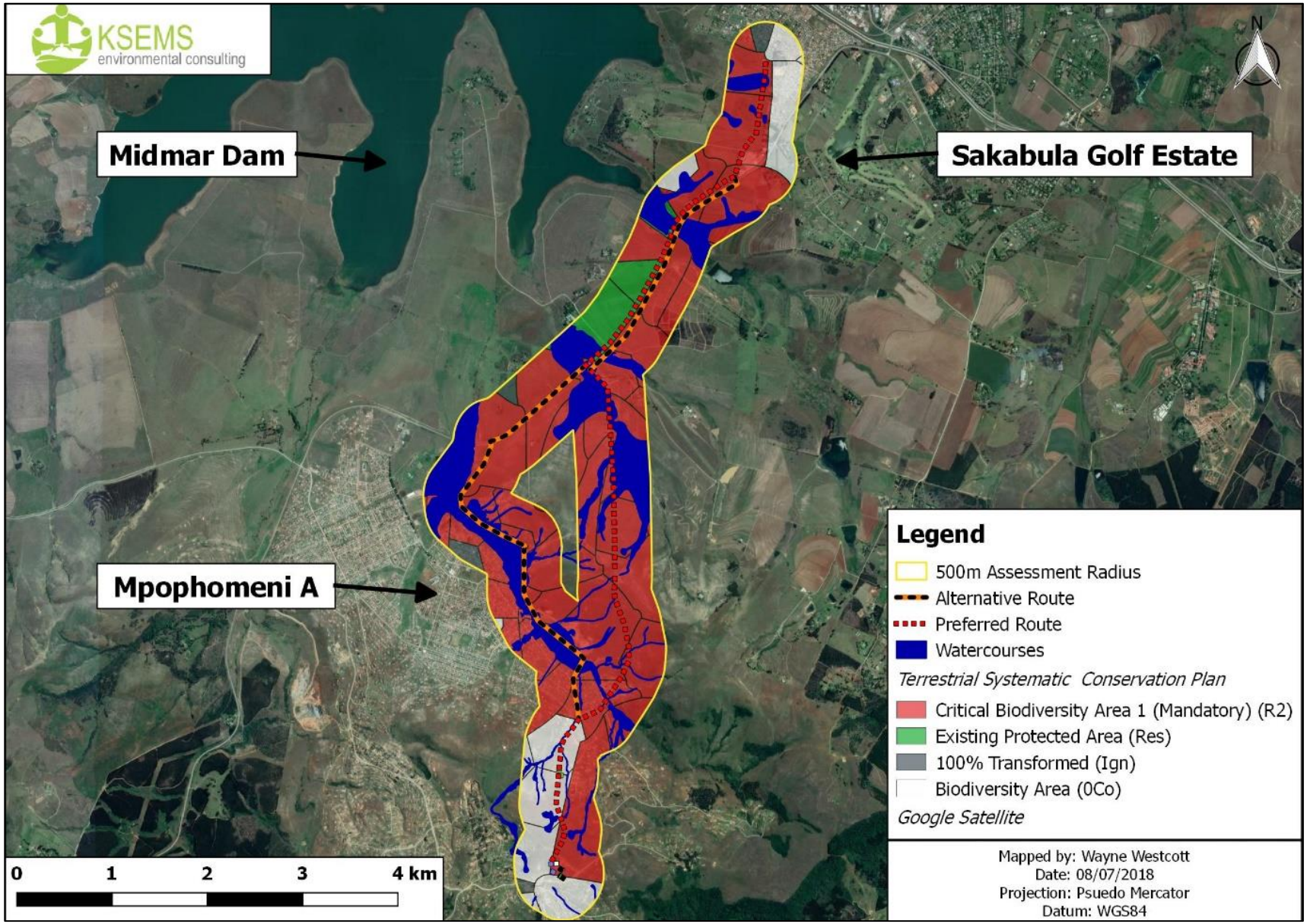
Training Provider: _____ _____

Name Signature

APPENDIX 9: SENSITIVITY MAPS



Map illustrating the proposed pipeline and associated infrastructure and environmental sensitivities (KSEMS, 2023).



Overview of the sensitive wetland and biodiversity habitats associated with the proposed Vulindlela BWS (KSEMS, 2018)

APPENDIX 10: FOSSIL CHANCE FIND PROTOCOL

FOSSIL CHANCE FIND PROTOCOL

(Taken from Palaeontological Impact Assessment, Prof Marion Bamford, September 2019)

Monitoring Programme for Palaeontology – to commence once the excavations for foundations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figures 4, 5). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then the site inspections by the palaeontologist will not be necessary.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

EXAMPLES OF FOSSIL PLANTS FROM THE VRYHEID FORMATION

Figure A: Examples of *Glossopteris* flora plants from the Normandien Formation (from Claassen. 2008. fig 4a).

Figure B: Example of fossil plants from the Normandien Fm, the reproductive structure *Rigbya arberiode*s (From Claassen, 2008, fig 6g).

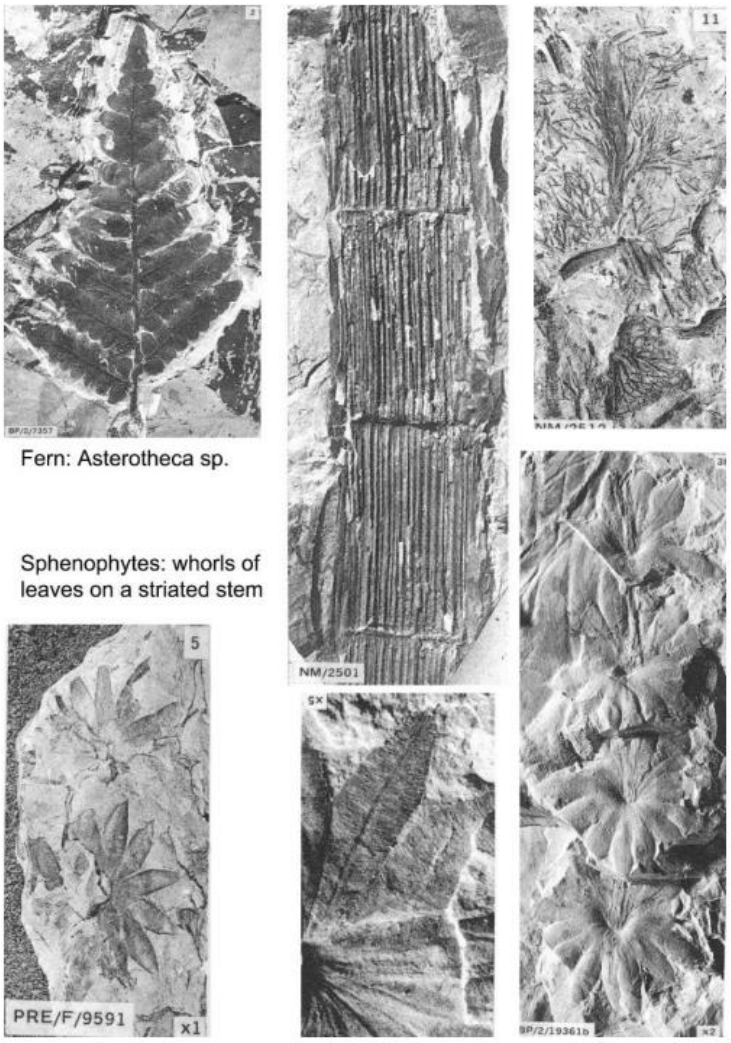


Figure C: More plant impression from the Vryheid Formation.

APPENDIX 11: ECOLOGICAL REHABILITATION PLAN

APPENDIX A:

REHABILITATION PLAN

Rehabilitation principles and goals

The need for rehabilitation

The digging of trenches for the laying of pipes, the clearing of vegetation for new reservoirs and pump stations and the associated earthworks makes the need for rehabilitation obvious. This level of disturbance is always associated with alien plant invasion and the potential for soil erosion. If these two impacts can be successfully managed, rehabilitation will be successful.

Restoration versus rehabilitation

Restoration is envisaged as an effort to reinstate ecosystems as they once would have occurred on this now much transformed site and would involve the re-introduction of species. Rehabilitation involves management methods, but not the introduction of species and allows natural recruitment and reversion to an original state. The following are broad rehabilitation objectives:

- Control of alien vegetation;
- Maintaining indigenous vegetation types and habitats as found on the site in order for natural processes to result in slow diversification of species over time.

Goals

The goals of the Rehabilitation Plan are:

- To successfully restore or rehabilitate habitats which will be impacted by the proposed activity;
- To manage the naturally occurring habitats in a manner which retains or enhances their ecosystem functioning and includes alien plant control and the prevention and control/remediation of soil loss.

Proposed interventions

Although most of a primary grassland's biomass is represented in its grass cover (i.e. above-ground biomass), most of its species diversity is represented by 'non-grass' species in the form of forbs (herbaceous plants) and geophytes (fire-adapted plants with extensive underground organs). This is not the case for Secondary Grassland which tends to be dominated by a small number of grass species and those forb species present will be mainly common, pioneer and ruderal species (i.e. species that flourish in conditions of disturbance). There will also be some presence of alien plants, either because already present or because there will be some subsequent establishment in the newly created secondary grassland, which will need to be the focus of alien control efforts.

The predominant focus of the rehabilitation should be the prevention and remediation of soil loss and alien plant control while natural regeneration of vegetation cover takes place from the seed-bank and plants in the topsoil which was removed, stored and replaced after the pipes have been laid.

Given the Red List status of Least Concern for the geophytes encountered such as *Ledebouria, Gladiolus, Satyrium, Crocosmia, Aristea* and *Freesia* it does not seem practical to specifically remove these species ahead of the construction. Provided the principle of progressive re-instatement is

followed, they can re-planted as encountered when re-topsoiling occurs.

1. *Fix any erosion points created and attend to potential problem areas (eg. slopes)*

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- Any erosion features created during the construction process /associated with the construction zone need to be stabilized using earthen berms or plugs, rock packs or gabions (for the purpose of plugging erosion gullies). For earthen structures used to fill erosion points, the soil used needs to be properly compacted to ensure this is not vulnerable to erosion.

During rehabilitation it may be necessary to address potential erosion sensitive areas by utilizing Vetiver grass, Soil Saver geotextile in association with grass seeding, or grass sods (instant turf).

2. *Reinstate soils and prepare planting area*

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- Stockpiled topsoil which was appropriately removed and set aside for use in back-filling shall be replaced.
- Reinstated soil is not to be compacted too heavily, as this will prevent water saturation and proper plant growth during rehabilitation. Where significant soil compaction has occurred, the soil may need to be ripped in order to reduce the bulk density of the soil such that vegetation can become established at the site.
- An average depth of 30-50cm topsoil should be maintained across the disturbed area where possible to provide sufficient depth for rooting of plants.

During rehabilitation it may be necessary to use additional topsoil to augment areas where trimming is still required after the construction contractor has completed. Soils will need to be prepared for planting by the addition of compost.

3. *Remove any waste products*

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- All waste products (spoil, construction materials, hazardous substances and general litter) need to be removed from the site of the proposed activity and disposed of in proper local waste facilities.
- Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations.

During rehabilitation it may be necessary to remove construction waste products (such as concrete) which have been disposed of inappropriately and which will hamper the rehabilitation efforts. The removal of such items should be for the construction contractor's account.

4. *Reinstate vegetation*

- Once the soil and topography have been returned to their pre-construction state, and waste

products removed, the success of re-planting and grass seeding (along with natural regeneration) should then be monitored. The success of this process will depend on the careful stockpiling of topsoil, the control of alien plant species and the weather conditions. The process has the best chance of success if it is implemented at the start of the rainy season to allow for germination of sown seed and seed stored in the topsoil. This lack of vegetation cover will render the soils susceptible to erosion and the process will require very careful monitoring and erosion control measure. This will be especially true of slopes, which may require geotextile and seeding or turf as assessed by the EO/ECO.

- In areas flagged as requiring further intervention, a suitable replanting / re-vegetation programme should be implemented. This should comprise a mix wild collected seed of rapidly germinating indigenous species naturally occurring in the affected habitat and adapted to stabilizing areas. Locally occurring, indigenous runner grasses may be harvested and planted to help provide cover and stabilise soils, instant turf or sods broken up to provide plugs or runners can be used.
- All collection of any propagules, whether of fruit, seeds or live material must comply with the eKZN-Wildlife Conservation Ordinances.

Central to successful rehabilitation is the re-vegetation of the cleared areas with indigenous plants. The aims of this process are:

- To stabilise bare, exposed soil once alien plants have been removed, preventing erosion and compaction; and
- To re-establish a natural ecosystem, encouraging increased biodiversity and ecosystem functioning.

Successful re-vegetation is likely to be composed of three steps, namely:

1) Over-sowing bare soil with appropriate indigenous grass seed as required

This will have the following effects:

- Covering the soil surface and binding the soil, preventing erosion through raindrop action and human and cattle traffic;
- Stimulate nutrient cycling through increased organic matter inputs to the soil; and
- Providing a competitive influence on alien plant seedlings, thus reducing their recruitment.

The creeping perennial species *Cynodon dactylon* is an effective ground cover and will achieve the above effects, but can have undesirable long-term biodiversity impacts as it out-competes forbs and geophytes, especially when grazed as it can form a thick lawn. Other options are *Dactyloctenium australe* and commercial seed mixes of *Panicum maximum, Digitaria eriantha* and/or *Eragrostis tef*.

2) Periodic removal of alien plant seedlings

This will ensure that indigenous plants maintain dominance within the system. Both operations (clearing of alien vegetation and re-vegetation) lend themselves to poverty relief and community upliftment through the creation of employment opportunities and skills enhancement.

Alien plants:

General principles in alien plant control include the following:

- Contractors must ensure that workers know that all and not some alien species in target areas must be destroyed, and that handover of work areas requires that this be accomplished.
- They must, therefore, be able to identify all the alien plant species that will potentially be encountered along the routes, especially the dominant species and be capable of distinguishing alien from indigenous species to prevent loss of (or damage to) the latter.
- A high level of supervision is needed, therefore.
- Standard methods of control should be implemented and would mostly consist of chemical control and manual pulling as most of the alien species that will re-colonise the servitude will be herbaceous/forbs.
- Follow-ups, if carried out at the correct frequency, will allow for some hand-pulling of emergent seedling alien plants, particularly if done after rain when the soil is still soft and provided this does not disrupt newly germinated indigenous species.
- At the early stages of rehabilitation it is not always possible to be sufficiently selective when using chemical control and newly establishing indigenous species may be lost to over-spray if a high degree of selectivity is not displayed.
- Provided the controlled species are not in fruit or seed, the remaining material can be mulched to improve soil cover and organic matter in the soil, both of which will have the effect of preventing soil erosion and enhancing plant growth.

3. Re-vegetation

This usually has a positive effect in reducing alien species which are often poor at competing.

- Grassing, if required, should only occur during the spring to summer months. It should not occur during hot, dry periods unless sufficient water can be applied artificially;
- Grassing should occur on the basis that lands are exposed to forces of soil erosion for the minimum time.

Grassing should aim for the following results:

- Watercourses, drainage lines and slopes with a gradient greater than 1:3 – good germination of grass cover over at **least 60% of the treated area within two weeks**;
- All other areas – good germination of grass cover over at **least 60% of the treated area within four weeks.**

Re-vegetation will be considered successful when a **final cover of 80 - 85% is reached**.

Broadcasting using a simple hand spinner is useful mainly for very small areas such as the servitude, or for areas that are more inaccessible to conventional implements. Generally, broadcasting should be limited to slopes no steeper than 1:3 and should not occur in high wind conditions.

An even cover can be best achieved by applying half of the total mix in one direction and the second half of mix in direction perpendicular to first half. Sand can be added to the mix to assist with even spread. Soil should be harrowed after seed has been applied.

Turfing should be applied where immediate cover is required for stabilisation. Particular candidates are drainage channels and very steep banks.

Turf should be:

- Placed on a bed of fertilised topsoil of a minimum depth of 75 mm;
- Laid parallel to the contour on sites with steep slope gradients;
- Under or over a pegged artificial mesh in areas of very high water velocity;
- Tamped immediately as laid;
- Where necessary, pegged to the soil at 1 to 2 metre centres;
- Watered immediately to enhance establishment; and
- Watered regularly for the first seven days or as required to effect establishment.

Geotextiles (also referred to as erosion control blankets or mats) are any permeable textile material that is used to holding seed, fertilizers and/or topsoil in place, or holding disturbed soil on steep slopes and graded sites, in order to prevent erosion.

Good surface preparation is critical, as the soil surface should be relatively smooth and without projections. The blanket or mat should extend beyond the edge of the area to be covered, with the top end buried in a trench at least 10 cm deep by 20 cm wide. The mat or blanket will need to be further secured with staples. There must be maximum soil contact to prevent erosion underneath.

Although geotextiles have historically been made of natural plant materials, geotextiles are increasingly made from a synthetic polymer or a composite of natural and synthetic material. Plant fibre-based geotextiles are subject to decomposition and have a limited durability. However they may be left in place to form an organic mulch to help in establishment of vegetation. Different fibres will degrade at different rates. Coir geotextiles degrade in 2-3 years while jute degrades in 1-2 years. Coir is therefore useful in situations where vegetation will take longer to establish, and jute is useful in low rainfall areas because it absorbs more moisture.

Ideally, vegetation is the best form of erosion control, with geotextiles only used for temporary stabilisation purposes until this can establish. Geotextiles are only superior to hydromulching in the following situations:
When the growing season is short or unfavourable and plants cannot stabilise a slope quickly;
When surfaces are so unstable or contours so channelled that a heavy rain could result in significant and costly erosion damage.

Geotextiles can be ineffective when flows can get beneath the blanket/mat, and they may also mask slope failures until erosion is too far advanced to effectively and cheaply remediate the slope. In contrast where hydraulic applications fail damage is visible early.

Biotic resources

It may be necessary in the context of the rehabilitation plan to collect propagules (seed and/or plants) of certain grass/grassland species in order to re-introduce them into areas that will be disturbed and in need of rehabilitation. In most instances, it will suffice to broadcast commercially

available grass seed and allow natural re-generation, but should monitoring show that this has been unsuccessful then it may be necessary to cultivate seed under nursery conditions before re-introducing seedlings to these areas.

Additional topsoil may be collected from the sites where reservoir and pump station construction are anticipated, since the species composition varies very little along the proposed routes.

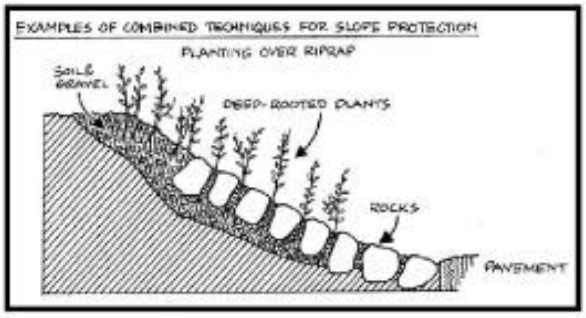
It might also be possible at times to obtain plants through rescue operations from grassland to be destroyed or reduced by other development in the zone. Where these opportunities present themselves, resources should be made available to obtain benefits for the restoration area.

Planting

Grassland plants

Steep Slopes Planting Guide

Steep slopes should be planted along the contour, with rows being closer together the steeper the slope is. Mat-forming grasses and groundcovers are best for slope stabilisation. Shrubs can be planted in between contours at random intervals if required from an aesthetic point of view. Vetiver grass is a good vegetative solution to slope stabilisation. Once indigenous species are established it should be possible to remove the Vetiver in a phased approach. The use of Vetiver as a primary stabiliser should be explored before resorting to engineered structures such as gabions. Geotextile and grass sowing can be utilised.



Source: Nichols (2002)

Use of groundcovers

A mixture of grass and groundcover is better than just one of these, as higher biodiversity levels are achieved and the combination makes for better binding of the soil. Groundcovers chosen should occur locally, be vigorous-growing and easily propagated plants that can be used on disturbed habitats. They should be suitable for slopes of any gradient and should be watered every day for the first 2 weeks after planting. Thereafter, they should be watered every 3 days until they become established. Plant these groundcovers at 7 -15 plants per square metre. The steeper the slope, the greater the number of plants/square metre.

Grasses

Wherever possible grass cover should be cultivated parallel to contours and ground should, where

possible, be prepared for seeding. Plants with small seeds such as grasses establish best on a fine seedbed. However, a rougher seedbed should be prepared where the risk of soil dispersion or erosion is high by scarifying to a depth of about 50mm to 75mm. Compacted soils require ripping to a depth of 300mm. In all cases, if seeding is not followed by regular rain, follow-up watering will be needed to aid germination and quick establishment. There should be hand pulling or spot-herbicide treatment of recalcitrant alien plants and failure replacement should occur. Whatever the method used, treated areas must be inspected and monitored afterwards and periodically thereafter. Areas which fail to establish cover adequate to prevent erosion must be re-seeded and re-mulched as soon as they are identified.

There is a limited range of indigenous species available commercially in the form of seed or plugs. The particular grass species available may also create risk for the longer term differentiation of grassland to a more species-diverse state, as these mainly comprise taller-growing, aggressive species which out-compete other grass species, and quickly overtop forbs and geophytes. Although the list below may not be exhaustive the following are typically available commercially, some of which may be erratically available or, if available, then only as plugs:

- *Aristida junciformis*
- *Chloris gayana*
- *Cynodon dactylon*
- *Digitaria eriantha*
- *Eragrostis tef*
- *Hyparrhenia* species (not recommended for seeding)
- *Panicum maximum*
- *Setaria sphacelata*
- *Sporobolus africanus*
- *Sporobolus pyramidalis*
- *Themeda triandra*

If other indigenous species are found to be available commercially, they should not be introduced on the site without consulting with a vegetation specialist, as these could be inappropriate or create longer-term biodiversity issues.

- *Eragrostis tef* is the only non-indigenous species in this list. It establishes a quick cover within which slower-growing species can emerge, but is very short lived and does not result in any persistent presence. As a result it should only be used as a minority component of any mix, with more long-lived species predominating.
- *Aristida junciformis*, if available, is a desirable species in any seed mix or as plugs. The species is regarded as an undesirable species by grassland specialists with a pasture management background because it is unpalatable to livestock and tends to over-express and becomes dominant under poor management regimes. However, it already occurs on the site and is an important component of this grassland where it is a common, but not overwhelmingly dominant grass and is also compatible with high forb and geophyte diversity.
- *Hyparrhenia* species should be used with caution in any mix as this is a taller, aggressive grass that may cause longer-term biodiversity issues. For similar reasons *Digitaria eriantha* should be used, if at all, only sparingly at **no more than 15%** of any mix.

- On no basis should invasive alien grasses often used in lawns such as *Pennisetum clandestinum* (Kikuyu) be used in grassing.

Mat-Forming Grasses

When planting these grass runners, they need to be watered every day for the first 2 weeks and then 3 times a week until established which often makes the use of mat-forming grasses impractical. Furthermore, certain species that are generally used may become invasive later.

Grass Type	Gradient	Best Form	Spacing for planting on slope	Spacing for planting along contour
Annual Panicum - *Panicum laticomum* This is an annual species that is only suited to shade. Not good for high traffic areas.	<25º	runners/ seed	300mm between rows	150 mm between runners in the rows.
Berea Grass - *Dactyloctenium australe* Will take some shade	<25º	sods	1m between rows	Continuous sod along the contour line
	>25º	runners	0.5 m between rows	150 mm between runners in the rows.
Bermuda Grass - *Cynodon dactylon* Likes full sun	<25º	sods	1m between rows	Continuous sod along the contour line
	>25º	runners	0.5 m between rows	150 mm between runners in the rows.
Buffalo Turf Grass – *Stenotaphrum secundatum* Likes full sun	<25º	sods	1m between rows	Continuous sod along the contour line
	>25º	runners	0.5 m between rows	150 mm between runners in the rows.

Source: Nichols (2002)

Clump-Forming Grasses

Note: Clump-forming grasses can be grown from seed or planted as individual clumps (which are sometimes referred to as "plugs"). If clumps or plugs are used, they should be planted in a quantity of at least 7 clumps per square metre. Clump-forming grasses are mostly grown from seed for best results.

Summer mix:

GRASS SPECIES	COMMON NAME	APPLICATION RATE (kg/ha)
Eragrostis tef	Teff	4
Heterepogon contortus and/or *Tristachya leucothrix* and/or *Alloteropsis semialata*	Spear grass Hairy trident grass Black-seed grass	10
Chloris gayana	Rhodes grass	10
Digitaria eriantha	Smutsfinger grass	2
Cynodon dactylon	Couch grass	2
Paspalum notatum	Lawn paspalum	2
TOTAL		30

Winter mix:

GRASS SPECIES	COMMON NAME	APPLICATION RATE (kg/ha)
Lolium multiflorum	Italian rye grass	10
Heterepogon contortus and/or *Tristachya leucothrix* and/or *Alloteropsis semialata*	Spear grass Hairy trident grass Black-seed grass	10
Chloris gayana	Rhodes grass	5
Paspalum notatum	Lawn paspalum	2,5
TOTAL		27,5

Sedges

Sedges are good for use in extremely wet areas, in waterways and seepage lines. All these species are to be used in wetlands or areas where there is a constant supply or water. All need to be in full sun for best results.

Sedge Type	Best Form
Basket Sedge - *Cyperus textilis*	clumps
Broad-leaved Sedge - *Cyperus latifolius*	clumps or seed
Bulrush - *Typha capensis*	clumps or seed
Common Reed - *Phragmites australis*	clumps or seed
Dwarf Papyrus - *Cyperus prolifer*	clumps or seed
Giant Sedge - *Cyperus dives*	clumps or seed
Matting Rush - *Juncus kraussii*	clumps or seed
Six angled Sedge - *Cyperus sexangularis*	clumps

Source: Nichols (2002)

Vetiver Grass

A hedge-forming, sterile grass that:

- Prefers full sun
- Is tolerant to sandy and/or dry conditions
- Is good for erosion control as the roots penetrate up to 3m in depth
- Has a high transpiration rate so can help with waterlogged soil
- Thrives in waterways or wet conditions
- Is tolerant of grazing, fire and poor soil conditions

Differentiation of rehabilitated grassland to a more species-diverse state

The existing grassland is in a retrograde state and dominated by early seral species as a result of grazing and burning pressure. It is dominated by a small number of grass species and those forb species present are mainly common, pioneer and ruderal species (i.e. species that flourish in conditions of disturbance). There is also the presence of alien species which will need to be the focus of eradication efforts.

Once a uniform grass cover establishes, the planting of forbs and geophytes can occur where necessary (ie. if they have not returned naturally). This can occur through two methods, both of which will require a considerable, ongoing effort to obtain seeds and fruits for propagation.

Some seeds which are easier to germinate, such as legumes, can also be sown directly into the ground after necessary preparation, into small plots which are demarcated, managed and maintained including through watering. Others will need to be produced by a commercial nursery.

Given the large area of grassland that must be restored or rehabilitated, it is not feasible to produce sufficient cultivated material to uniformly plant up the entire area. Instead, smaller focus areas should be identified and planted up through these methods.

Care after planting (modified after Nichols 2002)

***Mulching*:**

Mulch is important for retaining moisture in the soil and for protecting plants from harsh wind, sun, and rain during the time that they take to become established. It may also be used to slow the growth of weeds. There are a range of materials that can be used successfully as mulch, and can be sourced from whatever is easily available on a particular site, including non- seeding/fruiting mechanically controlled alien species (no chemical contaminants).

Brush Cut Material

- This is made up of small branches and twigs and can be harvested from areas of the site that need to be cleared for construction.
- The Contractor should try to leave as much seed as possible on mulch material that is made up of **indigenous vegetation**.
- Should it be necessary to harvest brush-cut material for mulch from areas other than those that need to be cleared for construction, the EO/ECO's approval must be obtained beforehand.

Straw / Hay

- Straw or hay makes excellent mulching material. Buy or harvest locally occurring wheat straw or thatch grass.
- The straw or hay must be checked for alien plant material as well as pests and diseases before it is brought onto the site.
- Should it be necessary to harvest straw or thatch grass for mulch from areas other than those that need to be cleared for construction, the EO/ECO's approval must be obtained beforehand.

Wood Chips

- Wood chips can be obtained from wood or paper mills and makes good mulching material.

The principles, practice and specifications for rehabilitation

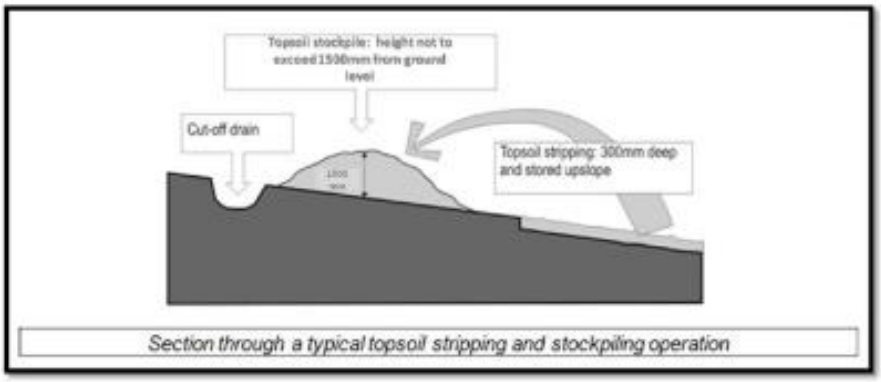
What follows below should be read in conjunction with the Bill of Quantities (Appendix C) as it informs the practices expected of the construction Contractor and Rehabilitator as expressed by DWAF (2005) and Umgeni Water (2002) and from which it is cited with modification.

The management of topsoil

The construction Contractor is required to strip topsoil (as defined in this specification) together with grass, groundcover and sedges from all areas where permanent or temporary structures are located, construction related activities occur, and access roads are to be constructed, etc. The depth to which topsoil will be stripped shall be 300 mm.

- Topsoil is to be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify.
- Topsoil is to be replaced along the contour.
- Topsoil is to be replaced by direct return (i.e. replaced immediately on the area where construction is complete), rather than stockpiling it for extended periods. This is feasible for progressive construction (e.g. pipelines), but not necessarily so for reservoirs, site establishments, dams, etc.
- Topsoil stockpiles are not to exceed 1.5 metre in height.
- Topsoil stockpiles are to be maintained in a weed free condition (i.e. no 'broad-leafed' plants regarded as weeds in terms of the Conservation of Agricultural Resources Act No 43 of 1989, or those plants regarded as a 'general nuisance in the area' are to be growing on the stockpiles). The ECO will provide guidance as to which plants are weeds and require removal.

- The stockpiles are not to be contaminated with sub-soil, or any other waste material. Topsoil may not be compacted in any way, nor may any object be placed or stockpiled on it.
- Topsoil which is to be stockpiled for periods exceeding 4 months is to be vegetated. In summer (September-February inclusive) use *Eragrotis tef* (Teff) to be applied at an application rate of 6 kg/ha, unless otherwise instructed in the project specification.
- In winter (March-August inclusive), use *Lolium multiflorum* (Annual/Italian Rye grass) to applied at an application rate of 6kg/ha unless otherwise instructed in the project specification. Fertiliser (standard 2:3:2 (NPK)) to be applied at 300kg/ha.



Section through a typical topsoil stripping and stockpiling operation

Source: modified after DWAF 2005

Topsoil conservation

- Ahead of all construction, borrowing and quarrying, strip the entire available topsoil layer. Stockpile separately from overburden (subsoil and rocky material).
- In the absence of a recognizable topsoil layer, strip the upper-most 300mm of soil.
- Co-ordinate Works to limit unnecessarily prolonged exposure of stripped areas and stockpiles. Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area.
- Strip and stockpile herbaceous vegetation, overlying grass and other fine organic matter along with the topsoil.
- Do not strip topsoil when it is wet.
- Store stripped topsoil in an approved location and in an approved manner for later re-use in the rehabilitation process.
- Stockpile topsoil stripped from different sites separately, as re-application during restoration must preferably be site-specific. If necessary keep a stockpile register.
- Do not mix topsoil obtained from different sites.

Spoil

- Position spoil (excavated subsoil) as indicated on the approved Plan.
- Any additional spoil storage area required by the contractor must be approved by the EO / ECO, in the form of an amended ESM&R Plan at least 30 days prior to initiating the activity. The following information is required for approval:
  - The location, description of and access to proposed sites
  - The quantity of material to be stored as spoil
  - The type of material to be stored as spoil (i.e. blast rock, excavated rock, subsoil etc.)
  - The proposed method of storing spoil
  - A proposal for the re-instatement and rehabilitation plan, including the final profile

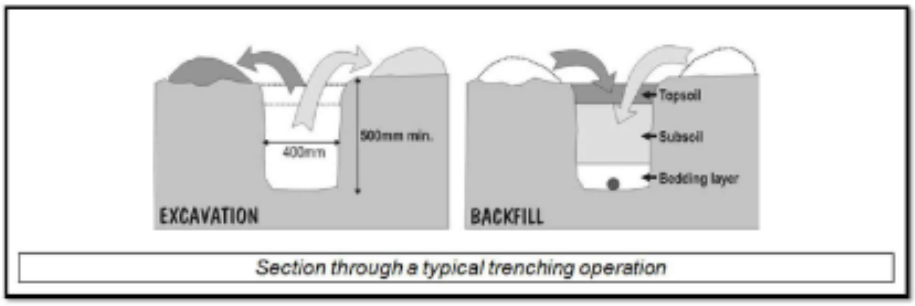
- Written approval from the landowner / relevant authority that material may be stored on the land in question, subject to conditions
- In linear projects, spoil must be positioned in windrows parallel to the excavation.
- Position spoil on the higher side of a disturbed area, and above a 1:20 year flood line wherever possible.
- Ensure that all spoil is stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself.
- Store spoil in low heaps, not exceeding 1.5m in height.
- Do not store spoil in drainage lines.
- Properly rehabilitate any permanent spoil dumps as soon as work in that area is complete.
- In general, no slopes steeper than 1(V]:3(H) will be allowed.
- Bury the coarser material beneath the finer material, and overlay all permanent spoil heaps with a layer of topsoil at least 200mm thick.

Backfill material

No material stripped or excavated which is classed, in terms of this specification, as topsoil, may be used as backfill in any excavation.

Excavation and backfilling

During excavation 'conservation of topsoil', as specified above will apply. Excavated material is to be stockpiled along a pipeline trench within the working servitude, unless otherwise authorised. A conceptual layout for working within a pipeline trench servitude is indicated below.



Section through a typical trenching operation

Source: DWAF 2005

Surplus excavated soft, intermediate and hard rock material shall not be disposed of along the pipeline trench, but shall be removed to a spoil site.

In certain cases, for example to help stabilise the disturbed area or to reinstate the natural aesthetics of an area, excess excavated intermediate and hard material may be disposed of in a designated manner along a pipeline trench.

Deficiency of backfill material shall not be made up by excavation within the free haul distance of 0.5 km of site, without the prior approval of the Engineer of the source of the material. Where backfill material is deficient, it should ideally be made up by importation from an approved borrow pit (i.e. one which operates within the ambient of an EMPR.)

Shaping and trimming

- Execute bulk (shaping) and fine (trimming) earthworks according to design (aimed at the prevention of soil erosion, of efficient storm water control, of the eventual re-establishment of vegetation and of ultimately achieving aesthetically acceptable landscapes).
- Shape areas to correct contours to within a tolerance of 300mm. This tolerance applies to areas where the final contours are shown on the drawings.
- Trim areas already shaped to within a tolerance of 50mm, with all undulations following a smooth curve. This tolerance applies to areas where the final contours are shown on the drawings.
- Plan shaping and trimming operations to allow for topsoil application: final trimmed levels must make provision for the specified depth of re-applied topsoil.
- Leave trimmed surfaces slightly rough to facilitate topsoil binding for the natural establishment of vegetation.
- Trim areas requiring grassing so that the finished surface of the area is approximately 25mm below the top of adjacent kerbing, channelling or pavement.
- Where machine operations are not practicable, trimming must be carried out using hand tools.
- Trimming of rock outcrops or koppies will not be required.

Control of Erosion

Surface erosion protection measures will be required to prevent erosion where slopes are steeper than 1:8 on all soil types. Erosion protection measures required may include all or some of the below, as specified in the project specification or upon instruction of the Engineer in conjunction with the Environmental (Control) Officer:

- construction of cut off berms (earth and/or rockpack) - these are to be angled across the contour and normally would approximate an angle of 30^{o} from the bisector of the contour.
- placing of brush wood on bare surface
- pegging of wattle trunks or branches along the contour
- hard landscaping, e.g. use of Loffelstein walls, ground anchors, gabions etc.

After re-instatement and during rehabilitation, the use of geotextiles, turf and/or Vetiver grass can be utilised for susceptible areas.

Conservation of Topsoil

The aim of the construction procedure should be to open as short a trench as practical and to immediately back-fill after the pipe has been laid. Although not forming part of the rehabilitation (and , therefore, not reflected in that Bill of Quantities), should the process of pipe laying be stalled for more than 4 months for any reason, then the grassing of topsoil as indicated above will apply.

REINSTATEMENT AND REHABILITATION

It is anticipated that the Rehabilitator will work closely in conjunction with the construction Contractor since, for effective rehabilitation to take place, the processes should work in tandem. As the Contractor completes the reinstatement process, the Rehabilitator will start the rehabilitation process thus ensuring soils remain exposed without grass/plant cover for the shortest possible time and plants which were excavated during pipe-laying are re-planted as soon as practical.

Scope: The intention of this section is to ensure that the condition of the areas disturbed by the project are returned to a state that approximates what they were before the project or better, within reason. The concept of progressive reinstatement is fundamental to cost effective (both financial and environmental) rehabilitation of a site. This concept must be followed at all times. Where landscaping is utilised, the concept is to utilise and restore plants indigenous to the site.

Reinstatement will be required for all areas disturbed by the project. For pipeline projects, this will include the full working servitude and buffer. Reinstatement and rehabilitation will ensure that all areas disturbed by the project are returned, within reason, to a state not worse than before the project commenced.

The construction Contractor will reinstate and rehabilitate all disturbed areas outside of the demarcated servitude (working area and buffer) at his own cost and to the satisfaction of the Environmental Control Officer and Project Manager.

Housekeeping:

All areas are to be cleared of rubble associated with construction. This includes the removal of surplus materials, excavation and disposal of consolidated waste concrete and concrete wash water, litter, etc.

All soil contaminated by hydrocarbons, for example from leaking machines, re-fuelling spills etc., is to be excavated to the depth of contaminant penetration, placed in 200 litre drums and removed to an appropriate landfill site.

Finishing

Final Shaping

Final levels of all disturbed areas are, where feasible in terms of the project requirement, to be consistent with the natural topography of the area.

In certain instances, it will be acceptable to reinstate rock onto a works area (e.g. pipeline servitude), provided that that rock does not exceed 250 mm in maximum dimension and is placed in a manner consistent with the natural surrounds as indicated by the ECO and Project Manager.

All drainage lines affected by construction are to be reinstated to approximate their original profile. Where this is not feasible due to technical constraints, the profile is to be agreed upon by the ECO and Project Manager.

All compacted (disturbed) areas (including stockpile areas) are to be ripped (along contour) to a depth of 150 mm prior to the replacement of topsoil.

Topsoiling

Topsoil is to be replaced to a minimum depth of 100 mm, unless otherwise specified in the project specification (e.g. in the case of agricultural lands). Topsoil is not to be compacted, but once replaced is to be scarified (to a depth of 50mm consistent with the natural contour). If insufficient topsoil is available, subsoil or similar material may be used that may be a suitable substrate after addition of soil improving substances e.g. compost, pH rectifiers (lime or gypsum) etc. Soil testing may be required at an approved facility.

Reinstatement of water courses and wetland areas

- The Contractor will ensure that water course banks are returned to their original profile unless the project specification states otherwise.
- The surface re-instatement of wetland areas should ensure that no depressions remain which could act as channels for preferential water flow thereby affecting the hydrological regime of the wetland.
- *The construction Contractor will preserve all riparian and wetland vegetation for use by the Rehabilitator of those environments. This vegetation is to be kept moist at all times. It is to be placed in the shade and covered with moistened hessian cloth until replanting, which is to be undertaken immediately surface re-instatement is complete.*
- *Plants are to be, as nearly as possible, replanted in areas from which they were removed.*

Vegetation Re-establishment

- The Rehabilitator will ensure that all areas disturbed by construction activities are re-vegetated to a specified standard deemed to be an 80 - 85 % cover with no areas in excess of 0.04 m^2/m^2 remaining un-vegetated.
- Re-vegetation shall match the vegetation type which previously existed (e.g. lawned pavements are to be returned to lawned pavements; 'veld' grass to 'veld' grass, etc.), unless stated otherwise in the project specification.
- Prior to re-grassing, and if required:
    - the area is to be scarified or ripped (along contour, to a depth of 50 mm to loosen compaction) by the construction Contractor as part of the withdrawal from the area.
    - weeds present on site are to be removed (contingency based on a delay in rehabilitation which should normally occur as the construction Contractor withdraws from a section of the pipeline after laying).
- Re-grassing, where required, will be either by means of seeding, instant turf (sods), runners or plugs as specified in the project specification or as specified by the ECO.

Where runners or plugs are utilised, they are to be planted at 150 mm centres. Prior to grassing, compost to a depth of 5mm shall be applied to the area. Sufficient irrigation shall be applied each week until reasonable (60%) ground cover has been obtained. This will be dependent on the time of year and the amount of irrigation to be applied will make up the difference between rainfall recorded on site and minimum requirement.

Where instant turf is utilised, it shall be laid as specified in the project specification.

Grassing shall be undertaken by a specialist grassing Sub-contractor, unless permission is granted otherwise by the Engineer/ ECO upon receipt of a written motivation from the Rehabilitator who shall state in writing when the re-grassing operation will commence and its expected duration (dates). Grassing in 'veld' areas is to be undertaken as per below. *Cynodon dactylon* and *Eragrostis tef* are likely to make up the seed bulk because of availability, but the following may apply.

Grass Seed Selection and Application Rates

The specific seed selection and application rates for each of the defined areas are covered separately, as follows.

Summer mix (1 September - 28 February)

GRASS SPECIES	COMMON NAME	APPLICATION RATE (kg/ha)
Eragrostis tef	Teff	4
Heterepogon contortus and/or *Tristachya leucothrix* and/or *Alloteropsis semialata*	Spear grass Hairy trident grass Black-seed grass	10
Chloris gayana	Rhodes grass	10
Digitaria eriantha	Smutsfinger grass	2
Cynodon dactylon	Couch grass	2
Paspalum notatum	Lawn paspalum	2
TOTAL		30

Winter mix (1 March - 31 August)

GRASS SPECIES	COMMON NAME	APPLICATION RATE (kg/ha)
Lolium multiflorum	Italian rye grass	10
Heterepogon contortus and/or *Tristachya leucothrix* and/or *Alloteropsis semialata*	Spear grass Hairy trident grass Black-seed grass	10
Chloris gayana	Rhodes grass	5
Paspalum notatum	Lawn paspalum	2,5
TOTAL		27,5

Seeding methods

The recommended method is hand-broadcasting. The required method shall be as specified in the project specification.

All seed supplied should be labeled in accordance with the Government Seed Act No. 20 of 1961 and the Rehabilitator shall be required to produce such certification, if requested by the Engineer.

Hand-broadcasting

Fertiliser, at the appropriate rate, is to be distributed by hand in a manner to ensure that there is an even spread of fertiliser over the site. This is to be done prior to seeding.

The seed mix is to be weighed and made up in an appropriately large container which shall be stirred to ensure no settling out of the grass seed, and a uniform distribution of the different types of seed. The seed is to be distributed by hand in a regular grid broadcasting manner to ensure that there is an even spread of grass over the entire site.

Performance specifications

The Rehabilitation Phase refers to the period of the project after the completion of the actual Works and the withdrawal of the Contractor from an area.

The following should be read in conjunction with Appendix C: Environmental Bill of Quantities for full specifications.

1. **Final shaping** (Contractor)

- Backfill all prospecting boreholes, excavations and test pits with *in situ* material.
- In general, no slopes steeper than 1(V):3(H) are permitted, unless otherwise specified by the EO / ECO. Steeper slopes require protection. The rationale is that the new slopes must mimic the natural slopes and topography.
- Where possible, programme the backfill of excavations so that subsoil is deposited first, followed by the topsoil. Compact in layers for best results. Do not compact topsoil.
- Deficiency of backfill may not be made up by excavating haphazardly within the Work Site. Additional fill may only be imported from approved borrow areas as indicated by the EO / ECO.
- Monitor backfilled areas for subsidence (as the backfill settles) and fill depressions using available material.
- Dismantle and flatten temporary drifts and river crossings, reinstating all drainage lines to approximate their original profile.
- Shape all disturbed areas to blend in with the surrounding landscape.
- Ensure that no excavated material or stockpiles are left on site and that all material remaining after backfill is smoothed over to blend in with the surrounding landscape.

2. **Topsoil replacement and soil amelioration** (Contractor)

- The principle of Progressive Reinstatement must be followed wherever possible. This includes the reinstatement of disturbed areas on an ongoing basis, immediately after the specified construction activities for that area are concluded.
- Execute top soiling activity prior to the rainy season or any expected wet weather conditions.
- Execute topsoil placement concurrently with construction where possible, or as soon as construction in an area has ceased.
- Replace and re-distribute topsoil to the original depth (i.e. as much as was removed prior to construction). These areas will be quantified by the EO / ECO.
- Place topsoil in the same area from where it was stripped. If there is insufficient topsoil available from a particular soil zone to produce the minimum specified depth, topsoil of similar quality may be brought from other areas of similar quality. The EO / ECO will advise.
- The suitability of substitute material will be determined by means of a soil analysis addressing soil fraction, fertility, pH and drainage, and approved by the EO / ECO.
- Do not use topsoil suspected to be contaminated with the seed of alien vegetation (i.e. black wattle). Alternatively, the soil is to be sprayed with specified herbicides (ECO to specify).
- Shape and mound topsoil to 200m from the top of manholes and valve chambers which protrude above ground and over pipelines to facilitate subsequent consolidation of the backfill. Ensure that storm water run-off is not channelled alongside the gentle mounding, but that it is taken diagonally across it.
- Shape remaining stockpiled topsoil not utilised elsewhere in an acceptable manner so as to blend in with the local surrounding area.
- After topsoil placement is complete, spread available stripped vegetation randomly by hand over the top-soiled area.

- In the event that no topsoil is available on site prior to construction, and thus no topsoil is available for rehabilitation, undertake the following ameliorative action:
  - Sample the soil to a depth of 200mm in all areas allocated for grass planting and send the sample for soils analysis to determine the type of fertiliser and rate thereof to be applied.
  - The necessary soil amendments as indicated by soil tests must be added to and worked into the soil.
  - After the application of fertilisers such as superphosphate, a waiting period of six to eight weeks is required prior to the execution of planting and or grassing.

3. Ripping and scarifying (Contractor)

- Rip (to a depth of 300mm) and / or scarify (to 50mm) all areas following the application of topsoil to facilitate mixing of the upper most layers. The EO / ECO will specify whether ripping and / or scarifying is necessary, based on the site conditions immediately before these works begin.
- Rip and / or scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works eg. Buffer zone.
- Rip and / or scarify along the contour to prevent the creation of down-slope channels.
- Rip and / or scarify all areas at 300mm intervals (but not more than 400mm intervals), ensuring that the lines overlap.
- Do not rip and / or scarify areas under wet conditions, as the soil will not break up.

4. Erosion control (Contractor)

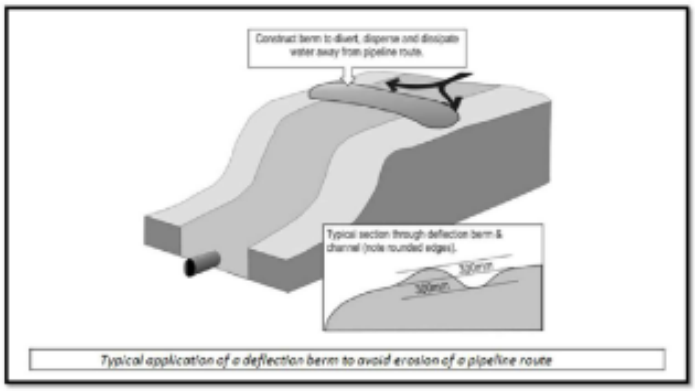
- Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes or along pipeline routes without erosion protection measures being in place.
- Over-flow and scour channels should be lined with stone pitching along their length and at their points of discharge to prevent soil erosion. The point of discharge must be at a point where there is dense natural grass cover.
- Ensure that channels do not discharge straight down the contours. These must be aligned at such an angle to the contours that they have the least possible gradient.
- Locate any point of overland discharge at least 50m away from any river, stream or drainage way. Ensure that overland discharge occurs over areas that have a minimum cover of 90% grass cover at a minimum height of 150mm. This applies to areas down-slope of the discharge point as well.

Erosion protection

- Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas.
- Retain natural trees, shrubbery and grass species wherever possible.
- Do not permit vehicular or pedestrian access into natural areas beyond the demarcated boundary of the Work Area.
- Avoid access into seasonally wet areas and / or turf soils during and immediately after rainy periods, until such a time that the soil has dried out.
- Utilise only light equipment for access and deliveries into areas of unstable soils, in areas where erosion is evident, and at stream and river embankments.
- Limit vehicular access into rocky outcrops and ridges.
- Institute adequate sedimentation control measures at river crossings and when excavation or disturbance within riverbanks, or the riverbed takes place.
- Address erosion donga crossings as river crossings, applying soil erosion control and bank

stabilisation procedures as specified by the EO / ECO.

- Do not allow erosion to develop on a large scale before effecting repairs. When in doubt, seek advice from the EO / ECO.
- Repair all erosion damage as soon as possible to allow for sufficient rehabilitation growth.
- In general, slopes steeper than 1(V):3(H) or slopes where the soils are by nature dispersive or sandy, must be stabilised. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:
  - Topsoil covered with a geotextiles (preferably made of sisal, with openings of at least be 225mm^2 and guaranteed to last at least 24 months), plus a specified grass seed mixture.
  - A 50:50 by volume rock:topsoil mix 200mm thick, plus specified grass seed mixture
  - Logging or stepping (logs placed in continuous lines following the contours)
  - Earth or rock-pack cut-off berms
  - Benches (sand bags)
  - Packed branches
  - Ripping and / or scarifying along the contours
  - Stormwater berms
- Near vertical slopes of 1(V):1(H) or 1(V):2(H) must be stabilised using hard structures, preferably with a natural look, and with facilities allowing for plant growth. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:
  - Retaining walls (loffel or otherwise)
  - Stone pitching
  - Gabions
  - Shotcrete
- Protect the slopes of all river diversions. One or more of the following methods may be used, as specified by the EO / ECO:
  - Sandbags
  - Reno mattresses
  - Plastic liners and / or coarse rock (undersize rip-rap)
- During the course of construction, the EO / ECO may identify additional slopes in need of stabilisation and will specify actions in terms of the most appropriate approved method and technology.



Source: DWAF 2005

1. Topsoil shaping, replacement and soil amelioration (Rehabilitator)

- Final hand-trimming of soil profile.
- Local augmentation (small scale) of topsoil as required for planting.
- Composting of servitude with 5mm of compost throughout (or as required).

2. Planting (Rehabilitator)

Transplanted plants

- Randomly re-distribute any herbaceous vegetation, overlying grass and other fine organic matter in all disturbed areas of the construction site, including temporary access routes.
- Plant bulbs (and aloes if present) in similar soil conditions and to the same depth as in their original position.
- Water once directly after transplanting to settle the soil.

3. Grassing (Rehabilitator)

- Grass areas using the method specified on the planting plan.
- Prepare an even surface for grassing (trim) areas to be grassed to the required level.
- Sodding may be done at any time of the year, but seeding must be done during the summer when the germination rate is better.

Sods

Sodding is defined as the laying of grass sods (instant turf/lawn).

- The soil should be uniformly wet to a depth of at least 150mm before planting of grass sods.
- Protect sods against drying out: keep these moist from the time of harvesting until final placement.
- Rake or spike the area to give a loose surface to a depth of 100mm.
- Lay the first row of sods in a straight line, starting at the bottom of a slope, where possible.
- Place the next row of sods in the same way, tightly against the bottom row with the joints staggered, until the full area is covered with sods.
- Tightly butt sods together, taking care not to stretch or overlap sods.
- Where a good fit cannot be obtained, the intervening spaces may be filled with parts of sods or topsoil.
- On steep slopes the sods must be secured using timber stakes of at least 300 mm in length.
- After planting, water sods to prevent drying out.
- Irrigate as required until the grass is able to survive independently (i.e. depending on the rainfall).

Runners and plugs

- Plant evenly by hand at a rate of at least 400 runners per hectare (i.e. at 250mm centres).
- Use only fresh runners, avoiding grass runners that have been allowed to dry out.
- Rake or spike the area to give a loose surface to a depth of 100mm.
- The soil should be uniformly wet to a depth of at least 150mm before planting of grass runners.
- After planting, runners must be given copious amounts of water and, when sufficiently dry, must be rolled with a light agricultural roller and re-watered.
- Irrigate as required until the grass is able to survive independently (i.e. depending on the rainfall).

Hand seeding

- All seed supplied should be labelled in accordance with the Government Seed Act (Act No. 20 of 1961).
- The soil should be loose and uniformly wet to a depth specified by the EO / ECO, before any seeding commences.
- Halve the seed and fertiliser mixture as specified and apply evenly in two immediate successive applications perpendicular to each other.
- The seeded area must be raked over after seed application and watered well.
- Irrigate as required until the grass is able to survive independently (i.e. depending on the rainfall).

4. Erosion control (Rehabilitator)

After withdrawal of the Contractor, it may still be necessary for the Rehabilitator to institute erosion control measures as required in order to stabilise soils including:

- Geotextiles and grass seeding.
- Laying of sods/ instant turf.
- Planting of Vetiver grass.

5. Control of alien plants (Rehabilitator)

All sites disturbed by construction activities will be monitored for colonisation by invasive alien plant species. The ECO will identify those plants which require removal during both the construction and maintenance period, for the Rehabilitator's action and will provide advice as to effective methods of removal and control of alien plant species. Alien plant control should take place monthly for the first year and then 6 monthly for a further year. Activities include:

- Identify, locate and map all exotics and invasive plants to be eradicated.
- Control exotics and invasive plants to be eradicated. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion.
- Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge.
- Follow manufacturer's instruction when using chemical methods, especially in terms of quantities, time of application etc., although hand-pulling may also be a mode of control.
- Ensure that only properly trained people handle and make use of chemicals.
- Dispose of the eradicated plant material at an approved solid waste disposal site. If no toxic sprays or persistent poisons were used during eradication and material is not fruiting or seeding then utilise as mulch.
- Sprayed herbaceous seedlings can remain as their roots will help stabilise the soil.
- Rehabilitate all identified areas as soon as practically possible, utilising specified methods and species.

6. Maintenance (Rehabilitator)

- Allow for a maintenance period of one year following practical completion, unless otherwise specified (eg. alien plant control for a two year period).
- Landscape maintenance is to be undertaken by suitably qualified persons, making use of the appropriate equipment.
- Cordon off sensitive areas that are under rehabilitation as no-go areas using danger tape and steel droppers where required. If necessary, these areas should be fenced off to prevent

vehicular, pedestrian and livestock access.

- Delay the re-introduction of stock to all rehabilitation areas until an acceptable level of re-vegetation has been reached. Fencing using 5 strands of barbed- wire may be used, or the area may be covered by branches.
- Re-vegetation must match the vegetation type which previously existed, unless otherwise indicated in the Contract or specified by the EO / ECO.
- Water all transplanted, planted and grassed areas as specified. Ideally, the amount of irrigation required will make up the difference between rainfall recorded on site and the minimum requirement.
- Mow lawn (sodded areas) regularly to a height of 50 mm above ground level. This promotes adequate coverage.
- Control weeds by means of extraction, cutting or other approved methods.
- For planted areas that have failed to establish, replace plants with the same species as originally specified. The same species as originally specified must be used unless otherwise specified by the EO / ECO.
- A minimum grass cover of 80% is required, and individual plants must be strong and healthy growers at the end of the Maintenance Period.
- In the case of sodding, acceptable cover entails that 100% cover is attained by the specified vegetation.
- Bare areas that show no specified vegetation growth after three months of the Rehabilitation Work are to be spread with additional topsoil, ripped to a depth of 100mm and re-planted, re-sodded or re-hand sown as appropriate.

APPENDIX B

MEASUREMENT AND PAYMENT

Measurement and payment for compliance with clauses of the specification will be made as follows. All other costs of compliance are deemed to be included in the Rehabilitator's rates.

ITEM **UNIT**

Topsoil shaping, replacement and soil amelioration

- Final hand trimming of soil profile and composting (5mm) of servitude (20m working area and 25m buffer either side):
  - Augmentation of topsoil..... m^3
  - Compost (supplied, placed and mixed into the soil)..... m^3
  - Aqua Matrix..... kg

Vegetation re-establishment/planting

- ***Transplanting***

Aloes and bulbs present in topsoil and randomly spread stripped vegetation .. km

- ***Grassing***

Deemed to be inclusive of soil preparation and improvements, materials and labour

Procure and hand seed with appropriate grass seed mix as per planting plan... m^2

Erosion control

- Slopes steeper than 1(V):3(H) or dispersive or sandy soils to be stabilised using appropriate and approved method and technology:
  - Geotextile..... m^2
  - Vetiver..... m^3
  - Sods..... m^2

Control of alien plants

- Control exotic and invasive plants, both present and which emerge, and establish indigenous plant cover to limit re-invasion..... ha
- Monitor rehabilitated sites for colonisation by invasive plants and control..... ha

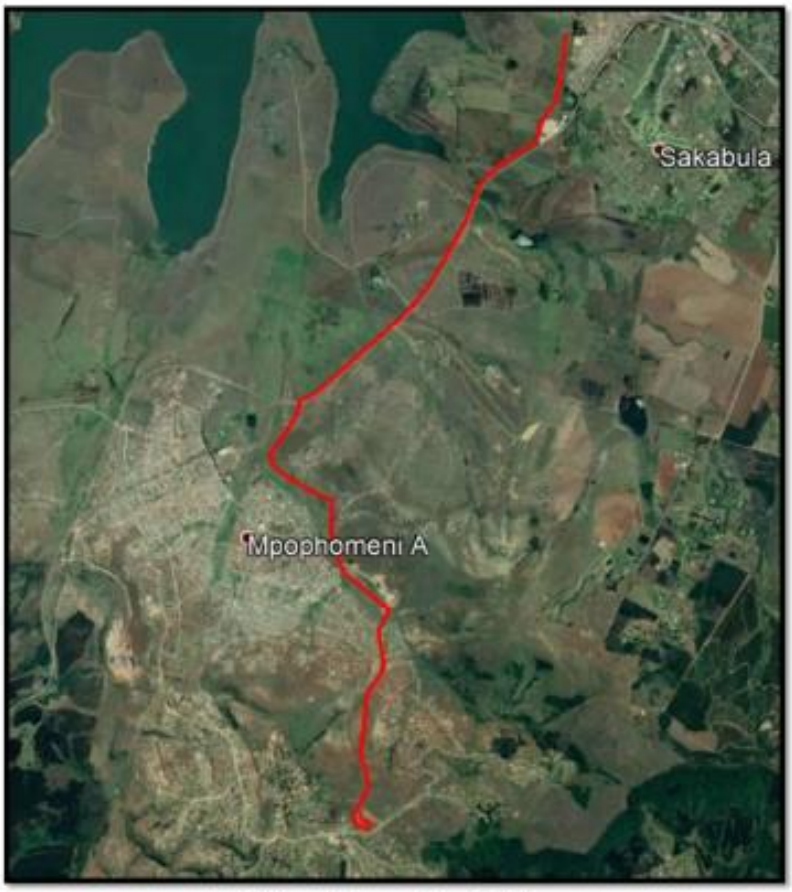
Maintenance

- Water all transplanted, planted and grassed areas until plants can survive independently. If seed germination is reliant on rain, once sprouted watering must commence and continue until establishment..... sum
- Cordon off rehabilitation areas if necessary or fence off as required..... m
- Re-seeding of failed areas..... m^2
- Sodded areas must be mown after 2 months and a further 3 times in 12 months to a height of 50mm above ground level to encourage spreading..... m^2

Route lengths for calculation purposes

The length of the proposed routes and alternatives are as seen below.

Proposed route: 9.5km



Alternative route: 10.5km

Given the servitude **working area of 20 metres**, the approximate areas for the routes is as follows:

- **Proposed route** (9.5km): 9500m x 20m = 190 000m^2 or **19 hectares of working area.**
- **Alternative route** (10.5km): 10500m x 20m = 210 000m^2 or **21 hectares of working area.**

The working area of 20m is **flanked on either side by a 25m buffer** (total 50m) yielding an approximate buffer area for the proposed routes as follows.

- **Proposed route** (9.5km): 9500m x 50m = 475 000m^2 or **47.5 hectares of buffer.**
- **Alternative route** (10.5km): 10500m x 50m = 525 000m^2 or **52.5 hectares of buffer.**

The **total area** of the work area plus the buffer (70m) for the proposed routes is as follows:

- **Proposed route** (9.5km): 9500m x 70m = 665 000m^2 or **66.5 hectares.**
- **Alternative route** (10.5km): 10500m x 70m = 735 000m^2 or **73.5 hectares.**

APPENDIX C
REHABILITATION PERFORMANCE SPECIFICATIONS

ASSUMPTIONS AND LIMITATIONS:
The calculations that follow have had to include a number of assumptions, since at this point in time there are a number of unknown quantities.

What follows is based on the **assumption that:**

1. The construction Contractor will leave the site as close to how it was before the construction took place in terms of replacing topsoil, shaping the terrain back to its original profile and putting in place structures to curb erosion that were removed during construction or required by the EO / ECO as part of the earthworks.
2. The final route to be selected is unknown and, therefore, both route options and their costings have been presented.
3. The potential exists (however remote) that the entire 70m servitude (20m working area and 25m on either side) will need to have soil amelioration, turfing, grass seeding, watering, alien plant control and/or erosion control. This means that cost estimates are based on the full 70m servitude as a "worst-case-scenario" potential costing and will almost certainly be less (but cannot be more). Actual costs are likely to be closer to one third of the potential costs.
4. It is not possible at this point to predict what specific requirements will need to be addressed in the EMP/EMPR and no costings for these have been included.
5. A contingency of 10-20% is often incorporated as part of costing. Since the costing is likely to be inflated due to assumption 3 above (70m servitude) a moderate 15% contingency has been selected.
6. A 20% take failure will require re-grassing/seeding.
7. A localised augmentation of topsoil at a rate of $1m^3$ per kilometre will be required.
8. Erosion control of 10% of the route length will be required.
9. Cordoning-off of sensitive areas equal to 10% of the route length will be required.
10. Alien plant control of 6 x monthly intensive control and 6 x monthly follow up (less intensive) related to growing season in first year. A further 2 x 6-monthly intensive controls during the second year.
11. Rehabilitation will be complete after two years.

1 TOPSOIL SHAPING, REPLACEMENT AND SOIL AMELIORATION					
Rehabilitator to refer to relevant section (pages 59-61) in Appendix A for additional specifications					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS (R)**
1	Undertake final hand trimming of soil profile and composting (5mm) of working area and buffer where necessary.				
Area A: Proposed route (66.5ha)		m^3	3325	490	**1 629 250**
Area B: Alternative route (73.5ha)		m^3	3675	490	**1 800 750**
2	Localised augmentation of topsoil.				
Area A: Proposed route		$6m^3$	2	3 000	**6 000**
Area B: Alternative route		$6m^3$	2	3 000	**6 000**
3	Application of Aqua Matrix biogel and fertiliser as appropriate.				
Area A: Proposed route		10kg	3	1 500	**4 500**
Area B: Alternative route		10kg	3	1 500	**4 500**
4	Contingency for ameliorative action	sum			
5	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

2 PLANTING					
Where aloes and geophytes are present in the topsoil, care should be taken to ensure that they are neither buried too deep nor left exposed on the surface of the soil. Rehabilitator to refer to relevant section (pages 59-61) in Appendix A for additional specifications.					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS**
1	After topsoil placement is complete, transplant aloes and bulbs removed during construction and spread available stripped vegetation randomly by hand over the top-soiled area including application of biogel.				
Area A: Proposed route (9.5km)		km	9.5	1 800	**17 100**
Area B: Alternative route (10.5km)		km	10.50	1 800	**18 900**
2	Water aloes and bulbs once directly after transplanting.	sum	1	21 000	**21 000**
3	Contingency for ameliorative action	sum			
4	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

3 GRASSING – Hand seeding					
Rehabilitator to refer to relevant section (pages 59-61) in Appendix A for additional specifications					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS**
1	Procure and sow seed as indicated on the planting plan. Halve the seed and fertiliser mixture as specified and apply evenly in two immediate successive applications perpendicular to each other. The seeded area must be raked over after seed application and watered well.				
Area A: Proposed route (9.5km)		m^2	665 000	8	**5 320 000**
Area B: Alternative route (10.5km)		m^2	735 000	8	**5 880 000**
2	Contingency for ameliorative action	sum			
3	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

4 EROSION CONTROL					
Rehabilitator to refer to relevant section (pages 61 - 63) in Appendix A for additional specifications					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS**
1	In general, slopes steeper than 1(V):3(H) or slopes where the soils are by nature dispersive or sandy, must be stabilised. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology (eg. Vetiver, turf, geotextile and seeding, etc.)				
Geotextile (if required) allowing for 10% of route					
Area A: Proposed route (950m)		m^2	66 500	11	**731 500**
Area B: Alternative route (1050m)		m^2	73 500	11	**808 500**
Vetiver (if required) allowing 100 m^2/route					
Area A: Proposed route		m^3	5	600	**3 000**
Area B: Alternative route		m^3	5	600	**3 000**
Sods (if required) allowing 500 m^2/route					
Area A: Proposed route		m^2	500	40	**20 000**
Area B: Alternative route		m^2	500	40	**20 000**
2	Contingency for ameliorative action	sum			
3	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

5 CONTROL OF ALIEN PLANTS					
Rehabilitator to refer to relevant section (pages 59-61) in Appendix A for additional specifications					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS**
1	Exotics and invasive plants to be eradicated. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion. Intensive control measures with initial monthly visit x 6 months and two further 6-monthly visits.				
Area A: Proposed route (66.5ha)		ha	532	5 000	**2 660 000**
Area B: Alternative route (73.5ha)		ha	588	5 000	**2 940 000**
2	Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge. Follow up monthly visits x 6 months.				
Area A: Proposed route (66.5ha)		ha	399	2 000	**798 000**
Area B: Alternative route (73.5ha)		ha	441	2 000	**882 000**
4	Contingency for ameliorative action	sum			
5	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

6 MAINTENANCE					
Rehabilitator to refer to relevant section (pages 59-61) in Appendix A for additional specifications					
NO.	**ITEMS**	**UNITS**	**QTY**	**RATES**	**TOTALS**
1	Water all transplanted, planted and grassed areas as specified until the plants are able to survive independently (i.e. depending on the rainfall).	sum	1	150 000	**150 000**
2	Cordon off any sensitive areas that are under rehabilitation as no-go areas using danger/hazard tape and steel droppers if required by EO / ECO. If necessary, these areas should be fenced off (5 strand barb) to prevent vehicular, pedestrian and livestock access until rehabilitation has been achieved.				
Area A: Proposed route		m	1 000	300	**300 000**
Area B: Alternate route		m	1 000	300	**300 000**
3	Re-seeding of failed areas (calculated on 20% fail of seeded area).				
Area A: Proposed route (13.3ha)		m^2	133 000	8	**1 064 000**
Area B: Alternative route (14.7ha)		m^2	147 000	8	**1 176 000**
4	Contingency for ameliorative action	sum			
5	Specific requirements, as per EMP/EMPR	sum			
TOTAL CARRIED TO SUMMARY					

SUMMARY: PROPOSED ROUTE	
REHABILITATION PERFORMANCE SPECIFICATIONS	
ITEM	TOTAL
1 TOPSOIL SHAPING, REPLACEMENT AND SOIL AMELIORATION	1 639 750
2 PLANTING	38 100
3 GRASSING	5 320 000
4 EROSION CONTROL	754 500
5 CONTROL OF ALIEN PLANTS	3 458 000
6 MAINTENANCE	1 514 000
Sub Total	12 724 350
Contingency (15%)	1 908 652.50
TOTAL	14 633 002.50
V.A.T.	2 194 950.38
GRAND TOTAL	16 827 952.88

SUMMARY: ALTERNATIVE ROUTE	
REHABILITATION PERFORMANCE SPECIFICATIONS	
ITEM	TOTAL
1 TOPSOIL SHAPING, REPLACEMENT AND SOIL AMELIORATION	1 811 250
2 PLANTING	39 900
3 GRASSING	5 880 000
4 EROSION CONTROL	831 500
5 CONTROL OF ALIEN PLANTS	3 822 000
6 MAINTENANCE	1 626 000
Sub Total	14 010 650
Contingency (15%)	2 101 597.50
TOTAL	16 112 247.50
V.A.T.	2 416 837.13
GRAND TOTAL	18 529 084.63

APPENDIX 12: EROSION CONTROL PLAN AND ALIEN PLANT REMOVAL

A full rehabilitation plan was created for the Vulindlela Bulk Water Supply Scheme by G.J. McDonald in 2017. The full rehabilitation plan document can be found under Appendix 10. Extracts of the rehabilitation plan inclusive of both alien invasive plant management and erosion control can be found in the sections below:

REHABILITATION PRINCIPLES AND GOALS

The need for rehabilitation

The digging of trenches for the laying of pipes, the clearing of vegetation for new reservoirs and pump stations and the associated earthworks makes the need for rehabilitation obvious. This level of disturbance is always associated with **alien plant invasion** and the potential for **soil erosion**. If these two impacts can be successfully managed, rehabilitation will be successful.

Restoration versus rehabilitation

Restoration is envisaged as an effort to reinstate ecosystems as they once would have occurred on this now much transformed site and would involve the re-introduction of species. Rehabilitation involves management methods, but not the introduction of species and allows natural recruitment and reversion to an original state. The following are broad rehabilitation objectives:

- Control of alien vegetation;
- Maintaining indigenous vegetation types and habitats as found on the site in order for natural processes to result in slow diversification of species over time.

Goals

The goals of the Rehabilitation Plan are:

- To successfully restore or rehabilitate habitats which will be impacted by the proposed activity;
- To manage the naturally occurring habitats in a manner which retains or enhances their ecosystem functioning and includes alien plant control and the prevention and control/remediation of soil loss.

PROPOSED INTERVENTIONS

Although most of a primary grassland's biomass is represented in its grass cover (i.e., above-ground biomass), most of its species' diversity is represented by 'non-grass' species in the form of forbs (herbaceous plants) and geophytes (fire-adapted plants with extensive underground organs). This is not the case for Secondary Grassland which tends to be dominated by a small number of grass species and those forb species present will be mainly common, pioneer and ruderal species (i.e., species that flourish in conditions of disturbance). There will also be some presence of alien plants, either because already present or because there will be some subsequent establishment in the newly created secondary grassland, which will need to be the focus of alien control efforts.

The predominant focus of the rehabilitation should be the prevention and remediation of soil loss and alien plant control while natural regeneration of vegetation cover takes place from the seed-bank and plants in the topsoil which was removed, stored and replaced after the pipes have been laid.

Given the Red List status of Least Concern for the geophytes encountered such as Ledebouria, Gladiolus, Satyrium, Crocosmia, Aristea and Freesia it does not seem practical to specifically remove these species ahead of the construction. Provided the principle of progressive re-instatement is followed, they can re-planted as encountered when re-topsoiling occurs.

1. **Fix any erosion points created and attend to potential problem areas (eg. slopes)**

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- Any erosion features created during the construction process /associated with the construction zone need to be stabilized using earthen berms or plugs, rock packs or gabions (for the purpose of plugging erosion gullies). For earthen structures used to fill erosion points, the soil used needs to be properly compacted to ensure this is not vulnerable to erosion.

During rehabilitation it may be necessary to address potential erosion sensitive areas by utilizing Vetiver grass, Soil Saver geotextile in association with grass seeding, or grass sods (instant turf).

2. **Reinstate soils and prepare planting area**

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- Stockpiled topsoil which was appropriately removed and set aside for use in backfilling shall be replaced.
- Reinstated soil is not to be compacted too heavily, as this will prevent water saturation and proper plant growth during rehabilitation. Where significant soil compaction has occurred, the soil may need to be ripped in order to reduce the bulk density of the soil such that vegetation can become established at the site.
- An average depth of 30-50cm topsoil should be maintained across the disturbed area where possible to provide sufficient depth for rooting of plants.

During rehabilitation it may be necessary to use additional topsoil to augment areas where trimming is still required after the construction contractor has completed. Soils will need to be prepared for planting by the addition of compost.

3. **Remove any waste products**

It is anticipated that the following will be undertaken by the construction contractor prior to rehabilitation:

- All waste products (spoil, construction materials, hazardous substances and general litter) need to be removed from the site of the proposed activity and disposed of in proper local waste facilities.
- Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations.

During rehabilitation it may be necessary to remove construction waste products (such as concrete) which have been disposed of inappropriately and which will hamper the rehabilitation efforts. The removal of such items should be for the construction contractor's account.

4. **Reinstate vegetation**

- Once the soil and topography have been returned to their pre-construction state, and waste products removed, the success of re-planting and grass seeding (along with natural regeneration) should then be monitored. The success of this process will depend on the careful stockpiling of topsoil, the control of **alien** plant species and the weather conditions. The process has the best chance of success if it is implemented at the start of the rainy season to allow for germination of sown seed and seed stored in the topsoil. This lack of vegetation cover will render the soils susceptible to **erosion** and the process will require very careful monitoring and **erosion** control measure. This will be especially true of slopes, which may require geotextile and seeding or turf as assessed by the EO/ECO.
- In areas flagged as requiring further intervention, a suitable replanting / re-vegetation programme should be implemented. This should comprise a mix wild collected seed of rapidly germinating indigenous species naturally occurring in the affected habitat and adapted to stabilizing areas. Locally occurring, indigenous runner grasses may be harvested and planted to help provide cover and stabilise soils, instant turf or sods broken up to provide plugs or runners can be used.
- All collection of any propagules, whether of fruit, seeds or live material must comply with the eKZN-Wildlife Conservation Ordinances.

Central to successful rehabilitation is the re-vegetation of the cleared areas with indigenous plants.

The aims of this process are:

- To stabilise bare, exposed soil once **alien** plants have been removed, preventing **erosion** and compaction; and
- To re-establish a natural ecosystem, encouraging increased biodiversity and ecosystem functioning.

SUCCESSFUL RE-VEGETATION IS LIKELY TO BE COMPOSED OF THREE STEPS, NAMELY:

1) Over-sowing bare soil with appropriate indigenous grass seed as required

This will have the following effects:

- Covering the soil surface and binding the soil, preventing **erosion** through raindrop action and human and cattle traffic;
- Stimulate nutrient cycling through increased organic matter inputs to the soil; and
- Providing a competitive influence on **alien** plant seedlings, thus reducing their recruitment.

The creeping perennial species *Cynodon dactylon* is an effective ground cover and will achieve the above effects, but can have undesirable long-term biodiversity impacts as it out-competes forbs and geophytes, especially when grazed as it can form a thick lawn. Other options are *Dactyloctenium australe* and commercial seed mixes of *Panicum maximum, Digitaria eriantha* and/or *Eragrostis tef.*

2) Periodic removal of **alien** plant seedlings

This will ensure that indigenous plants maintain dominance within the system. Both operations (clearing of alien vegetation and re-vegetation) lend themselves to poverty relief and community upliftment through the creation of employment opportunities and skills enhancement.

Alien plants:

General principles in alien plant control include the following:

- Contractors must ensure that workers know that all and not some alien species in target areas must be destroyed, and that handover of work areas requires that this be accomplished.
- They must, therefore, be able to identify all the alien plant species that will potentially be encountered along the routes, especially the dominant species and be capable of distinguishing alien from indigenous species to prevent loss of (or damage to) the latter.
- A high level of supervision is needed, therefore.
- Standard methods of control should be implemented and would mostly consist of chemical control and manual pulling as most of the alien species that will re-colonise the servitude will be herbaceous/forbs.
- Follow-ups, if carried out at the correct frequency, will allow for some hand-pulling of emergent seedling alien plants, particularly if done after rain when the soil is still soft and provided this does not disrupt newly germinated indigenous species.
- At the early stages of rehabilitation it is not always possible to be sufficiently selective when using chemical control and newly establishing indigenous species may be lost to over-spray if a high degree of selectivity is not displayed.
- Provided the controlled species are not in fruit or seed, the remaining material can be mulched to improve soil cover and organic matter in the soil, both of which will have the effect of preventing soil **erosion** and enhancing plant growth.

3. Re-vegetation

This usually has a positive effect in reducing **alien** species which are often poor at competing.

- Grassing, if required, should only occur during the spring to summer months. It should not occur during hot, dry periods unless sufficient water can be applied artificially;
- Grassing should occur on the basis that lands are exposed to forces of soil **erosion** for the minimum time.

Grassing should aim for the following results:

- Watercourses, drainage lines and slopes with a gradient greater than 1:3 — good germination of grass cover over at least 60% of the treated area within two weeks;
- All other areas — good germination of grass cover over at least 60% of the treated area within four weeks.

Re-vegetation will be considered successful when a final cover of 80 - 85% is reached.

Broadcasting using a simple hand spinner is useful mainly for very small areas such as the servitude, or for areas that are more inaccessible to conventional implements. Generally, broadcasting should be limited to slopes no steeper than 1:3 and should not occur in high wind conditions.

An even cover can be best achieved by applying half of the total mix in one direction and the second half of mix in direction perpendicular to first half. Sand can be added to the mix to assist with even spread. Soil should be harrowed after seed has been applied.

Turfing should be applied where immediate cover is required for stabilisation. Particular candidates are drainage channels and very steep banks.

Turf should be:

- Placed on a bed of fertilised topsoil of a minimum depth of 75 mm;
- Laid parallel to the contour on sites with steep slope gradients;

- Under or over a pegged artificial mesh in areas of very high water velocity;
- Tamped immediately as laid;
- Where necessary, pegged to the soil at 1 to 2 metre centres;
- Watered immediately to enhance establishment; and
- Watered regularly for the first seven days or as required to effect establishment.

Geotextiles (also referred to as **erosion** control blankets or mats) are any permeable textile material that is used to holding seed, fertilizers and/or topsoil in place, or holding disturbed soil on steep slopes and graded sites, in order to prevent **erosion**.

Good surface preparation is critical, as the soil surface should be relatively smooth and without projections. The blanket or mat should extend beyond the edge of the area to be covered, with the top end buried in a trench at least 10 cm deep by 20 cm wide. The mat or blanket will need to be further secured with staples. There must be maximum soil contact to prevent **erosion** underneath.

Although geotextiles have historically been made of natural plant materials, geotextiles are increasingly made from a synthetic polymer or a composite of natural and synthetic material. Plant fibre-based geotextiles are subject to decomposition and have a limited durability. However they may be left in place to form an organic mulch to help in establishment of vegetation. Different fibres will degrade at different rates. Coir geotextiles degrade in 2-3 years while jute degrades in 1-2 years. Coir is therefore useful in situations where vegetation will take longer to establish, and jute is useful in low rainfall areas because it absorbs more moisture.

Ideally, vegetation is the best form of **erosion** control, with geotextiles only used for temporary stabilisation purposes until this can establish. Geotextiles are only superior to hydromulching in the following situations:

- When the growing season is short or unfavourable and plants cannot stabilise a slope quickly;
- When surfaces are so unstable or contours so channelled that a heavy rain could result in significant and costly **erosion** damage.

Geotextiles can be ineffective when flows can get beneath the blanket/mat, and they may also mask slope failures until **erosion** is too far advanced to effectively and cheaply remediate the slope. In contrast where hydraulic applications fail damage is visible early.

Grasses

Wherever possible grass cover should be cultivated parallel to contours and ground should, where possible, be prepared for seeding. Plants with small seeds such as grasses establish best on a fine seedbed. However, a rougher seedbed should be prepared where the risk of soil dispersion or **erosion** is high by scarifying to a depth of about 50mm to 75mm. Compacted soils require ripping to a depth of 300mm. In all cases, if seeding is not followed by regular rain, follow-up watering will be needed to aid germination and quick establishment. There should be hand pulling or spot-herbicide treatment of recalcitrant **alien** plants and failure replacement should occur. Whatever the method used, treated areas must be inspected and monitored afterwards and periodically thereafter. Areas which fail to establish cover adequate to prevent **erosion** must be re-seeded and re-mulched as soon as they are identified.

On no basis should invasive **alien** grasses often used in lawns such as Pennisetum clandestinum (Kikuyu) be used in grassing.

EROSION

Surface erosion protection measures will be required to prevent erosion where slopes are steeper than 1:8 on all soil types. Erosion protection measures required may include all or some of the below, as specified in the project specification or upon instruction of the Engineer in conjunction with the Environmental (Control) Officer:

- construction of cut off berms (earth and/or rockpack) - these are to be angled across the contour and normally would approximate an angle of 30° from the bisector of the contour.
- placing of brush wood on bare surface
- pegging of wattle trunks or branches along the contour
- hard landscaping, e.g. use of Loffelstein walls, ground anchors, gabions etc.

After reinstatement and during rehabilitation, the use of geotextiles, turf and/or Vetiver grass can be utilised for susceptible areas.

Erosion control (Contractor)

- Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes or along pipeline routes without erosion protection measures being in place.
- Over-flow and scour channels should be lined with stone pitching along their length and at their points of discharge to prevent soil erosion. The point of discharge must be at a point where there is dense natural grass cover.
- Ensure that channels do not discharge straight down the contours. These must be aligned at such an angle to the contours that they have the least possible gradient.
- Locate any point of overland discharge at least 50m away from any river, stream or drainage way. Ensure that overland discharge occurs over areas that have a minimum cover of 90% grass cover at a minimum height of 150mm. This applies to areas down-slope of the discharge point as well.

Erosion protection

- Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas.
- Retain natural trees, shrubbery and grass species wherever possible.
- Do not permit vehicular or pedestrian access into natural areas beyond the demarcated boundary of the Work Area.
- Avoid access into seasonally wet areas and / or turf soils during and immediately after rainy periods, until such a time that the soil has dried out.
- Utilise only light equipment for access and deliveries into areas of unstable soils, in areas where erosion is evident, and at stream and river embankments.
- Limit vehicular access into rocky outcrops and ridges.
- Institute adequate sedimentation control measures at river crossings and when excavation or disturbance within riverbanks, or the riverbed takes place.
- Address erosion donga crossings as river crossings, applying soil erosion control and bank stabilisation procedures as specified by the EO / ECO.
- Do not allow erosion to develop on a large scale before effecting repairs. When in doubt, seek advice from the EO / ECO.
- Repair all erosion damage as soon as possible to allow for sufficient rehabilitation growth.
- In general, slopes steeper than 1(V):3(H) or slopes where the soils are by nature dispersive or sandy, must be stabilised. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:
    - Topsoil covered with a geotextiles (preferably made of sisal, with openings of at least be 225mm^2 and guaranteed to last at least 24 months), plus a specified grass seed mixture.
    - A 50:50 by volume rock:topsoil mix 200mm thick, plus specified grass seed mixture
    - Logging or stepping (logs placed in continuous lines following the contours)
    - Earth or rock-pack cut-off berms
    - Benches (sand bags)
    - Packed branches
    - Ripping and / or scarifying along the contours
    - Stormwater berms
- Near vertical slopes of 1(V):1(H) or 1(V):2(H) must be stabilised using hard structures, preferably with a natural look, and with facilities allowing for plant growth. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:
    - Retaining walls (loffel or otherwise)
    - Stone pitching
    - Gabions
    - Shotcrete
- Protect the slopes of all river diversions. One or more of the following methods may be used, as specified by the EQ / ECO:
    - Sandbags
    - Reno mattresses
    - Plastic liners and / or coarse rock (undersize rip-rap)
- During the course of construction, the EO / ECO may identify additional slopes in need of stabilisation and will specify actions in terms of the most appropriate approved method and technology.

Erosion control (Rehabilitator)

After withdrawal of the Contractor, it may still be necessary for the Rehabilitator to institute erosion control measures as required in order to stabilise soils including:

- Geotextiles and grass seeding.
- Laying of sods/ instant turf.
- Planting of Vetiver grass.

CONTROL OF ALIEN PLANTs (Rehabilitator)

All sites disturbed by construction activities will be monitored for colonisation by invasive alien plant species. The ECO will identify those plants which require removal during both the construction and maintenance period, for the Rehabilitator's action and will provide advice as to effective methods of removal and control of alien plant species. Alien plant control should take place monthly for the first year and then 6 monthly for a further year. Activities include:

- Identify, locate and map all exotics and invasive plants to be eradicated.
- Control exotics and invasive plants to be eradicated. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion.
- Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge.
- Follow manufacturer's instruction when using chemical methods, especially in terms of quantities, time of application etc., although hand-pulling may also be a mode of control.
- Ensure that only properly trained people handle and make use of chemicals.
- Dispose of the eradicated plant material at an approved solid waste disposal site. If no toxic sprays or persistent poisons were used during eradication and material is not fruiting or seeding then utilise as mulch.
- Sprayed herbaceous seedlings can remain as their roots will help stabilise the soil.

Rehabilitate all identified areas as soon as practically possible, utilising specified methods and species.

APPENDIX 13: SEARCH AND RESCUE PLAN

Proposed Vulindlela Bulk Water Supply (BWS) Upgrade between Howick West and Reservoir 2, uMngeni Local and Umgungundlovu District Municipalities, KwaZulu-Natal

PLANT SEARCH AND RESCUE PLAN

April 2023

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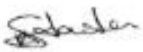
KERRY STANTON	*BSc (Hons)* - Estuarine Ecology, *MSc* – Urban Biogeography (Ecology) **EAPSA, *Pr.Sci.Nat.***	AUTHOR AND SENIOR ECOLOGIST	Kerry is the Managing Director of KSEMS and has over 20 years' experience in the environmental field. She has an MSc, majoring in Ecology, which was completed *cum laude*. She is a registered Professional Natural Scientist (*Pr. Sci. Nat*) and registered with EAPSA.	
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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions, and recommendations given in this report are based on KSEMS Consulting's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and the abovementioned authors reserve the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research or further work in this field or pertaining to this investigation.

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CONTENTS

1 INTRODUCTION

1.1 Background to Project

KSEMS Environmental Consulting (Pty) Ltd have been appointed by Umgeni Water to compile a search and rescue plan for the proposed Vulindlela Bulk Water Supply (BWS) Upgrade between Howick West and Reservoir 2, uMngeni Local and Umgungundlovu District Municipalities, KwaZulu-Natal. A pre-construction walk-through and scan for both alien and indigenous plant species was conducted by GJ McDonald, which information can be found in McDonald's combined ecological report (May, 2018).

This search and rescue report describes the methodology which was used to identify the protected species which were found along the proposed routes and visually illustrates the location of each protected species found within proposed footprint. The study area comprises of 2 routes, with a 'route' constituting a 2m working area with a 25m buffer on either side. This information is taken from GJ McDonald's combined ecological report (May, 2018).

2 METHODOLOGY

2.1 Search and Rescue

A walkover field survey was conducted on 24th and 25th of March and 22nd of April 2017 (McDonald, 2018). This assessment was used to verify the presence or absence of indigenous and/or protected species that occur within the study area. The GPS coordinates of each significant identified plant was recorded (See table 3) and mapped (see figure 1).

3 ASSUMPTIONS AND LIMITATIONS

- Seasonal variations may pose a visual limitation in identifying certain, more cryptic and rare species that may be found within the study area. The total number of each species is therefore regarded as an approximate amount.
- The major constraint in any vegetation survey is time in the field and season. Given time for more extensive/intensive field work it is possible that the rarer and more cryptic species may have been encountered, while season affects which species may be seen, as some are dormant/subterranean.
- The time field sampling occurred may have impacted on the species encountered, as flowering of certain species was over, but with the exception of some of the moribund grass areas which were difficult to sample, it is unlikely that significant differences in species observed would result from further sampling.
- The use of Google Earth imagery as well as the accuracy of hand-held GPS units means that coordinates cannot be guaranteed beyond a certain degree of accuracy on the ground. Should greater accuracy of any data be required, the points of interest will need to be pegged and surveyed using conventional surveying techniques.

4 APPLICABLE LEGISLATION AND POLICIES

Table 1: Legislation deemed applicable to the proposed development.

Legislation	Application to the Proposed Development
National Environmental Management Biodiversity Act (NEM:BA) (No. 10 of 2004 as amended) (DEA, 2004)	This Act seeks to manage and conserve biodiversity within the framework of the National Environmental Management Act, 1998. The developer has a responsibility for limiting the loss of biodiversity and ecosystems by adhering to the following legislation and restricted activities. The following legislation may be consulted throughout the various phases of the proposed development: • GNR 324 of Government Gazette No. 37596 of 2014 provides the Amendment to the Threatened or Protected Species Regulations. • GNR 1002 of Government Gazette No. 34809 of 2011, provides a national list of terrestrial ecosystems that are threatened and in need of protection. • GNR 151 of Government Gazette No. 29657 of 2007 and GNR 1187 in Government Gazette 30568 of 2007 provides a list of critically endangered, endangered, vulnerable and protected species. • GNR 988 of Government Gazette No. 41919 of 2018 provides amendments to the alien and invasive species list as well as the critically endangered, endangered, vulnerable and protected species. • GNR 599 of Government Gazette No. 37886 of 2014 and GNR 864 of Government Gazette No. 40166 of 2016 provides a list of invasive and alien plant species • GNR 598 of Government Gazette No. 37885 of 2014 provides the Alien and Invasive Species Regulations. GNR 112 of Government Gazzette No. 41445 of 2018 provides the draft alien and invasive species regulations in terms of categories, potential eradication and control techniques and the requirements for the application of permits. • GNR 529 of Government Gazette No. 40889 of 2017 provides the most updated amendments to the Regulations on the Convention of International Trade in Endangered Species (CITES) of wild fauna and flora. • Section 76 of the NEM:BA (No. 10 of 2004) provides guidelines for monitoring, control and eradication plans for species listed as invasive in terms of Section 70 of this Act.
KwaZulu-Natal Nature Conservation Ordinance No. 15 of 1974	This is the relevant statute in KwaZulu-Natal, which aims to manage the removal and destruction of rare and endangered species. Whilst this ordinance is in need of an update, it provides specialists with a basic tool to highlight both protected and specifically protected species which will require permits to relocate.

5 INDIGENOUS AND PROTECTED SPECIES IDENTIFIED

Table 2 below contains a list of all indigenous plant species identified during the field survey. Note that all specially protected species are highlighted in red.

Table 2: List of indigenous plant species identified during the field survey.

Scientific names of indigenous plant species identified			
Acalypha glandulifolia	Cyanotis speciosa	Hypoxis rigidula	Searsia sp.
Alectra sp.	Cynoglossum lanceolatum	Indigofera sp.	Sebaea sedoides
Alepidia natalensis	Cyperaceae species	Indigofera foliosa	Selaginella dregei
Aloe maculata	Cyperus dives	Juncus sp.	Senecio spp.
Aristea abyssinica	Cyphostemma sp.	**Kniphofia sp.**	Senecio coronatus
Aristea angolensis	Dais cotinifolia	**Ledebouria ovatifolia**	Senecio madagascariensis
Aristea ecklonii	Dalbergia obovata	**Ledebouria sp.**	Senecio oxyrilifolius
Aristida junciformis	Diclis reptans	Leobordea corymbosa	Sida dregei
Artemisia afer	Dicoma anomala	Leonotis ocymifolia	Sida rhombifolia
Asparagus laricinus	Diospyros lycioide	Leucosidea sericea	Solanum duplosinuatum
Asparagus virgatus	Drosera sp.	Maesa lanceolata	Spermacoce natalensis
Becium obovatum	Eriospermum mackenii	Melinis repens	Sporobolus africanus
Berkheya spp.	Felicia filifolia	Nidorella auriculata	Stachys natalensis
Boophone disticha	Ficus sur	Panicum maximum	Striga asiatica
Chamaecrista mimosoides	Gazania krebsiana	Pelargonium luridum	Sutera foribunda
Chaetacanthus burchellii	**Gladiolus crassifolius**	Pentanisia prunelloides	Tephrosia sp.
Cheilanthes bergiana	**Gladiolus ecklonii**	Persicaria serrulata	Teucrium kraussii
Cheilanthes viridis	**G. sericeovillosus**	Phragmites australis	Thunbergia atriplicifolia
Clematis brachiata	Grewia sp.	Phytolacca octandra	Trimeria grandifolia
Clutia monticola	Gunnera perpensa	Plectranthus hadiensis	Typha capensis
Conostomium natalense	Halleria lucida	Plectranthus laxiflorus	Vigna unguiculata
Cotula nigellifolia	Helichrysum aureonitens	Polygala hottentotta	Wahlenbergia banksiana
Crabbea acaulis	Helichrysum cephaloideum	Pupalia lappacea	Wahlenbergia undulata
Crassula pelucida	Helichrysum nudifolium	Pycnostachys reticulata	Xysmalobium undulatum
Crassula vaginata	Hermannia sp.	Ranunculus multifidus	Zizyphus mucronata
Crinum bulbispermum	Heteromorpha arborescens	Rabdosiella calycina	Zornia capensis
Cussonia spicata	Hypoestes forskaolii	Rhynchosia caribaea	
Cycnium tubulosum	Hypoxis colchicifolia	Rhynchosia totta	
Cymbopogon nardus	Hypoxis hemerocallidea	Rhodohypoxis baurii	

Table 3 below provides a summary of all the protected / threatened plant species (as per the Nature Conservation Ordinance No. 15 of 1974, Schedule 12) which were identified during the search and rescue exercise, and where they can be found individually or in groups. A number of Provincially Protected species enjoying the blanket protection of All *Aloe*, All *Amaryllidaceae*, All *Iridaceae* or All *Liliaceae*/ *Hyacinthaceae* were encountered, although the species are all Red Listed as of Least Concern.

These species are comprised of:

Amaryllidaceae: Boophone disticha and Crinum bulbispermum
Iridaceae: Aristea spp. and Gladiolus spp.
Liliaceae sensu lato: Aloe maculata, Kniphofia sp. and Ledebouria species

Table 3: Provincially protected species found along the proposed route

Species	Coordinates
Aloe maculata	29°33'49.36"S 30°12'15.16"E
	29°34'32.73"S 30°12'19.60"E
	29°34'34.99"S 30°12'18.80"E
	29°34'36.60"S 30°12'18.11"E
	29°35'08.84"S 30°11'53.29"E
Aristea species	29°35'11.30"S 30°11'52.67"E
	29°35'09.81"S 30°11'53.04"E
	29°35'09.81"S 30°11'53.29"E
Boophone disticha	29°33'22.56"S 30°11'24.95"E
	29°33'47.12"S 30°12'15.16"E
	29°33'49.11"S 30°12'15.04"E
	29°33'05.63"S 30°11'45.56"E
	29°33'06.90"S 30°11'44.01"E
Crinum bulbispermum	29°33'55.21"S 30°11'41.14"E
	29°33'57.48"S 30°11'41.47"E
Gladiolus species	29°32'49.23"S 30°12'09.28"E
	29°34'30.08"S 30°12'20.04"E
	29°35'01.44"S 30°11'54.23"E
Kniphofia species	29°33'55.90"S 30°11'41.67"E
Ledebouria species	29°32'00.43"S 30°12'42.82"E
	29°32'11.35"S 30°12'35.31"E
	29°32'20.67"S 30°12'32.09"E
	29°32'06.14"S 30°12'37.67"E
	29°33'22.49"S 30°11'24.99"E
	29°33'25.04"S 30°11'24.31"E
	29°33'44.27"S 30°12'15.18"E
	29°34'10.02"S 30°11'39.76"E
	29°34'38.24"S 30°12'16.72"E
	29°34'43.90"S 30°12'12.41"E
	29°34'57.26"S 30°11'56.23"E
	29°35'10.36"S 30°11'52.78"E
	30°12'42.82"E 30°12'15.20"E

The locations of these plants relative to the proposed route (yellow) and alternative route (red) are indicated below.

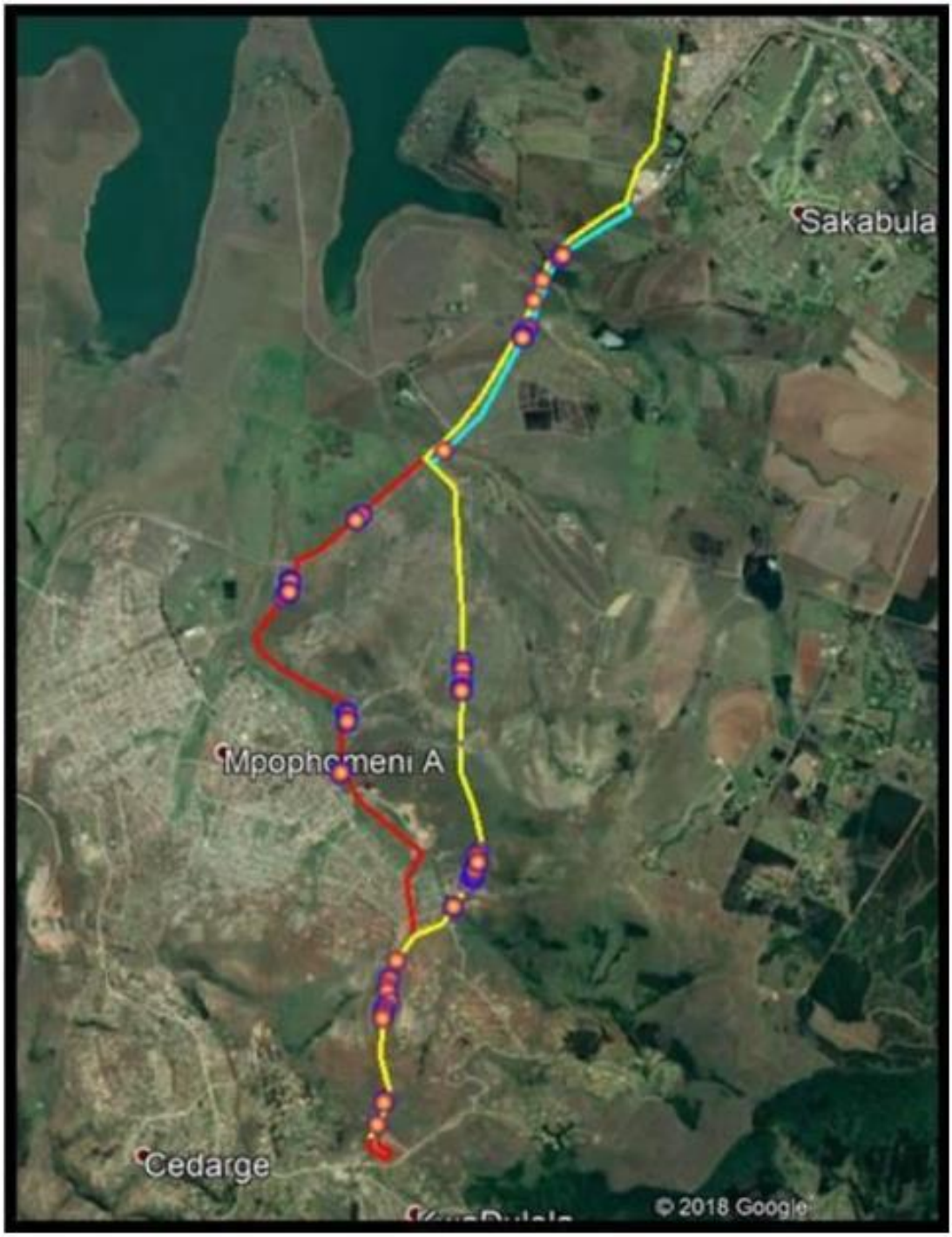

Figure 1: Distribution of Specially Protected species along the routes (GJ McDonald, 2018).

The plant species must only be moved if necessary. All of the plant species can be translocated to elsewhere outside the working areas of the Vulindlela BWSS routes by a botanist or landscaper with experience in indigenous plant relocation. Each plant species will need to be transplanted using methods appropriate for their specific biological requirements. If any plant individuals are too large to translocate as a whole specimen, a qualified botanist or landscaper will need to take cuttings from around branching points and allow it to form a callus before transplanting the specimen.

Table 4: A visual guide to the protected species identified along the route.

 *Aloe maculata* (http://pza.sanbi.org/aloe-maculata)	 *Aristea abyssinica* (https://www.pacificbulbsociety.org/pbswiki/index.php/Aristea)
 *Aristea angolensis* (https://www.inaturalist.org/taxa/580229-Aristea-angolensis/browse_photos?photo_license=cc0)	 *Aristea ecklonii* (http://pza.sanbi.org/aristea-ecklonii)
 *Boophone disticha* (http://pza.sanbi.org/boophone-disticha)	 *Crinum bulbispermum* (https://www.theplantlibrary.co.za/plants/Crinum-bulbispermum)
 *Gladioulus crassifolius* (http://pza.sanbi.org/gladiolus-crassifolius)	 *Gladiolus ecklonii* (http://pza.sanbi.org/gladiolus-ecklonii)

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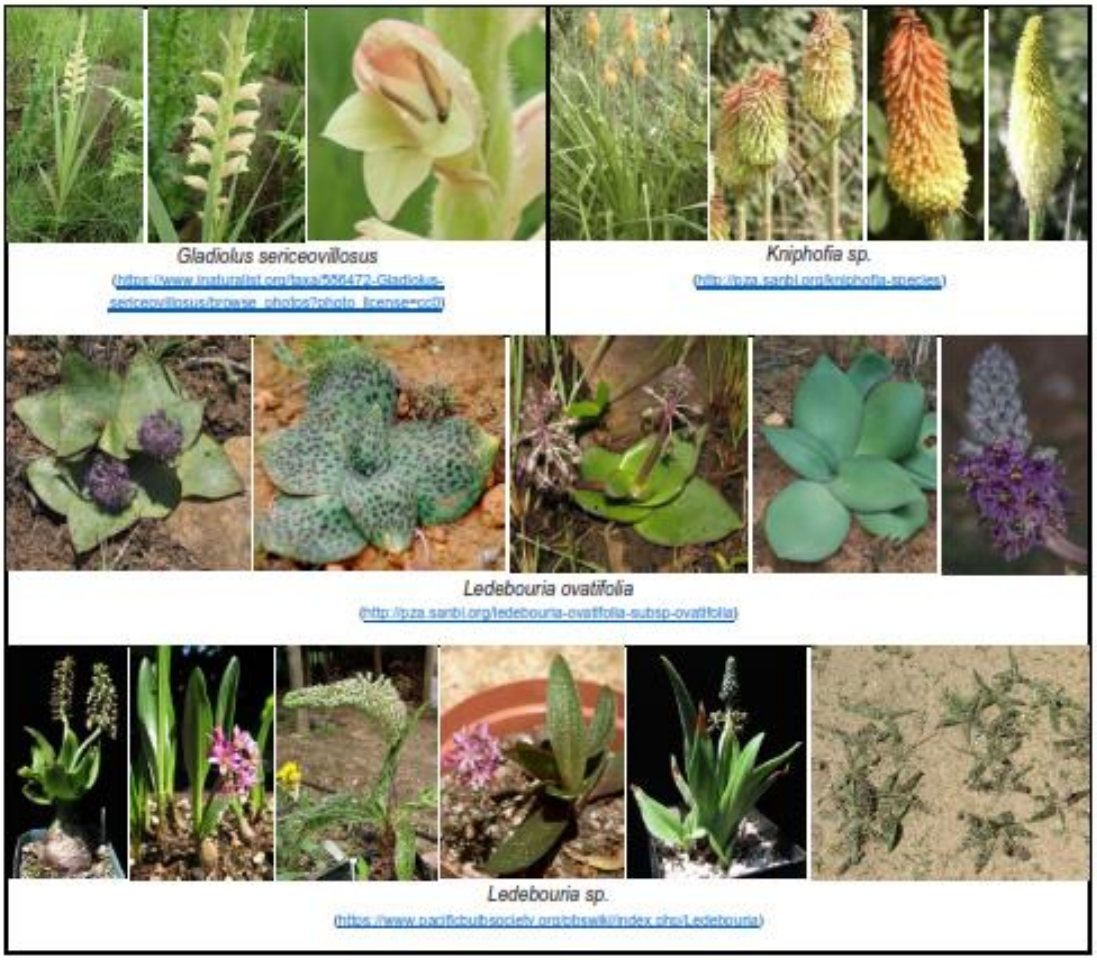

Gladiolus sericeovillosus
(https://www.inaturalist.org/taxa/556472-Gladiolus-sericeovillosus/browse_photos?photo_license=cc0)

Kniphofia sp.
(http://pza.sanbi.org/kniphofia-species)

Ledebouria ovatifolia
(http://pza.sanbi.org/ledebouria-ovatifolia-subsp-ovatifolia)

Ledebouria sp.
(https://www.pacificbulbsociety.org/pbswiki/index.php/Ledebouria)

6 GENERIC RECOMMENDATIONS

- Translocation is recommended, as opposed to the establishment of a temporary nursery on site. All translocated species may be removed and re-planted outside of the proposed footprint.
- Translocation of material will be the most successful for establishment in the spring after the first significant period of rainfall. Should any winter translocations take place, sufficient watering of transplanted plants must be ensured.
- Relocated plant species must be placed within the same soil depth, same orientation and within the same habitat as the original location/site.
- When translocating, do not cut the general leader (shoot).
- Remove all tags, string, plastic and any other non-biodegradable material from the plants prior to planting.
- For replanting, unless otherwise specified by the EO / ECO, excavate square holes of 500 mm x 500 mm x 500 mm on average for shrubs.
- If impenetrable shale, rock, clay or a high-water table is encountered, making the above hole sizes impossible, then seek advice from the DEO / ECO.
- Backfill planting holes with excavated material / approved topsoil, can be thoroughly mixed with weed free manure or compost (per volume about one quarter of the plant hole), one cup of 2:3:2 fertiliser (if required).
- A register is to be compiled of all the plant species (or group of plants) transplanted, along with their GPS coordinates. The Contractor must monitor the success of each transplant to ensure the survival of each protected species (if not planted within the recommended area).

7 SPECIFIC RECOMMENDATIONS

- Most of the identified protected species are herbaceous and are more susceptible to desiccation (drying out) once removed from the soil. For this reason, adequate moisture must be present in the soil and/or containers used for translocating the species. It is recommended that species are immediately placed into moist soil/containers as they are removed from their original locations. Where possible wrap larger root balls in Hessian or in plastic sheeting to retain the soil and to keep the root ball moist.
- Smaller specimens, such as clumps of *Ledebouria sp.*, should be translocated outside of the proposed development footprint. All individuals of the identified protected plant species should undergo attempted translocation. For specimens that are too large to translocate as a whole plant, cuttings of potential new shoots should be taken and allowed to form a callus before transplanting.
- No protected plant species should be damaged or transplanted without first receiving a signed permit from the assigned Competent Authority (CA)
- The findings and recommendations of this report must be read in conjunction with the Vulindlela Bulk Water Supply Scheme Revised route Combined Report (McDonald, 2018).