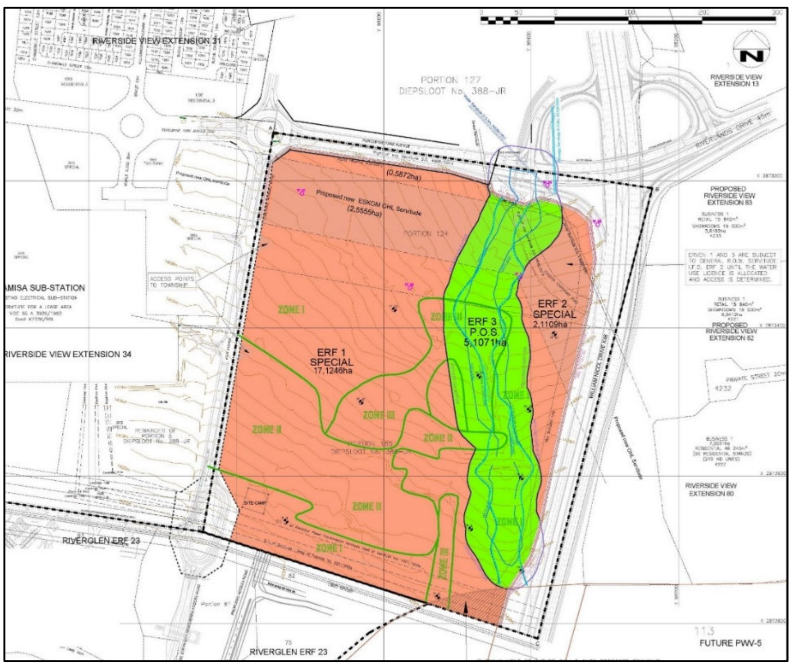
AQUATIC RESOURCES REHABILITATION AND PLANT SPECIES PLAN

Riverside View Ext. 84

Mixed-Use Township Development



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Aquatic Resources Rehabilitation Plan

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Specialist Name	Mr. P. Singh
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
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Table of Contents

LIST OF FIGURES

List of Tables

1. Introduction

Prism Environmental Management Services was requested by **Steyn City Properties (Pty) Ltd** to develop an Aquatic Resources Rehabilitation and Plant Species Pan. This, specifically to inform the Environmental Impact Assessment (EIA) and/or Water Use License Application (WULA) for the said development.

Southern Africa has freshwater biodiversity that is highly diverse and of great importance to livelihoods and economies. However, the conservation and importance of these aquatic ecosystems are often disregarded during the development planning process, and subsequently development is often not compatible with conservation of these resources. The value of the goods and services derived from freshwater ecosystems include essential products such as food and drinking water but many anthropogenic activities have led to the rapid decrease in the state of these resources (Darwall, et al., 2009). Due to the rapid population growth rate in Africa and the increased demand for safe drinking water and sanitation there is a potential large-scale impact to freshwater biodiversity. Action and mitigation are required to assess the status of freshwater ecosystems and to integrate that information into the water development planning process. This information is critical to minimise or mitigate significant impacts to freshwater biodiversity and the subsequent loss to livelihoods and economies which are dependent on these goods and services (Darwall, et al., 2009).

Rehabilitation is defined as the return of a disturbed area to a state which approximates the state that it was prior to disruption and construction activities. It is an important process whereby vegetation once disturbed can return to functionality within an area, ultimately conserving and preserving integral ecosystem goods and services (Kotze, et al., 2009). The rehabilitation of the wetland areas, streams, banks and riparian areas is vital to recover and maintain the required ecological function. The drivers should be enhanced as part of the rehabilitation of the affected areas. In respect of the construction phase, it is important to ensure that the required erosion-prevention measures linked to the impeding sections be carefully designed and installed. This document presents the Aquatic Resources Rehabilitation Plan for the study site.

1.1 Project Description

Steyn City Properties (Pty) Ltd is intending to develop a mixed-use township on portion 124 and 185 of the Farm Diepsloot 388 JR in the City of Johannesburg, Gauteng, to be known as Riverside View Ext 84. The development will be zoned for mixed-use to include, but not be limited to, Special: Place of Instruction, Residential dwelling units, Residential buildings, Storage, Offices, including ancillary uses such as restaurants and shop. The study site measures approximately 29,3ha. The site extends from North to South along the Provincial R511 Road (William Nicol Drive) and falls under jurisdiction of the City of Johannesburg (CoJ).

In addition, the proposed development also involves the provision of all necessary services to the development including water, sanitation, stormwater and internal roads.

1.2 Project Location

The proposed development is located on portion 124 and 185 of the Farm Diepsloot 388 JR in the City of Johannesburg, Gauteng Province (*here after referred to as the study site/s*) (Figure 1). The study site measures approximately 29,3ha. The study site is located in quaternary catchment A21C in the Limpopo Water Management Area (Figure 2). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans, et al., 2005) (Figure 3). The wetland delineation in relation to the study site is presented in Figure 4.

1.3 Terms of Reference

Prism Environmental Management Services was appointed by **Steyn City Properties (Pty) Ltd.** to develop an Aquatic Resources Rehabilitation and Plant Species Plan. These programs form the basis for mitigation implementations for the correct management of the aquatic resource.

The aquatic resource Rehabilitation Plan was developed according to the requirements as per the Department of Water and Sanitation. The aquatic rehabilitation methods were based on previous experience on similar projects and developments.

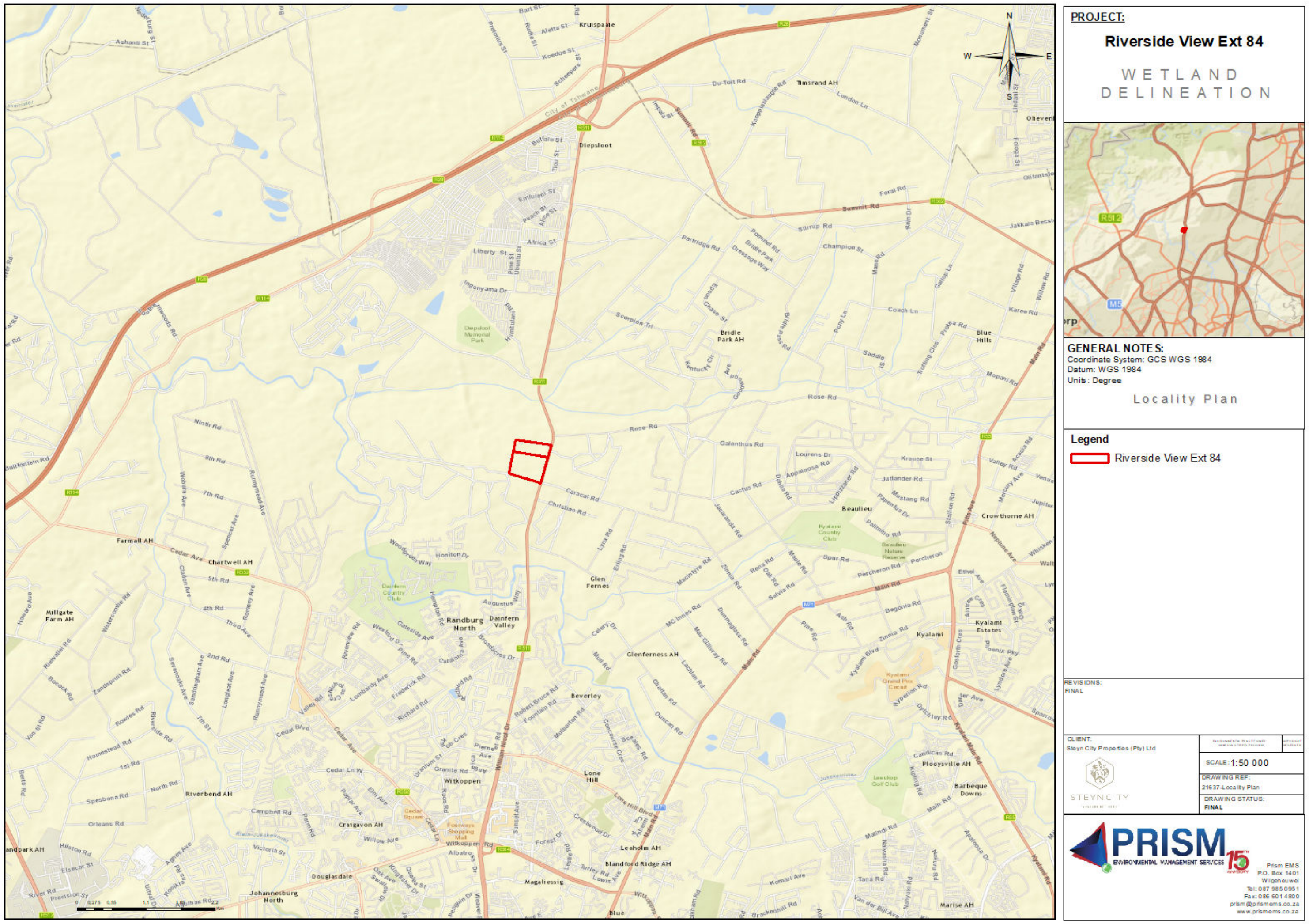


Figure 1: Locality map of the development.

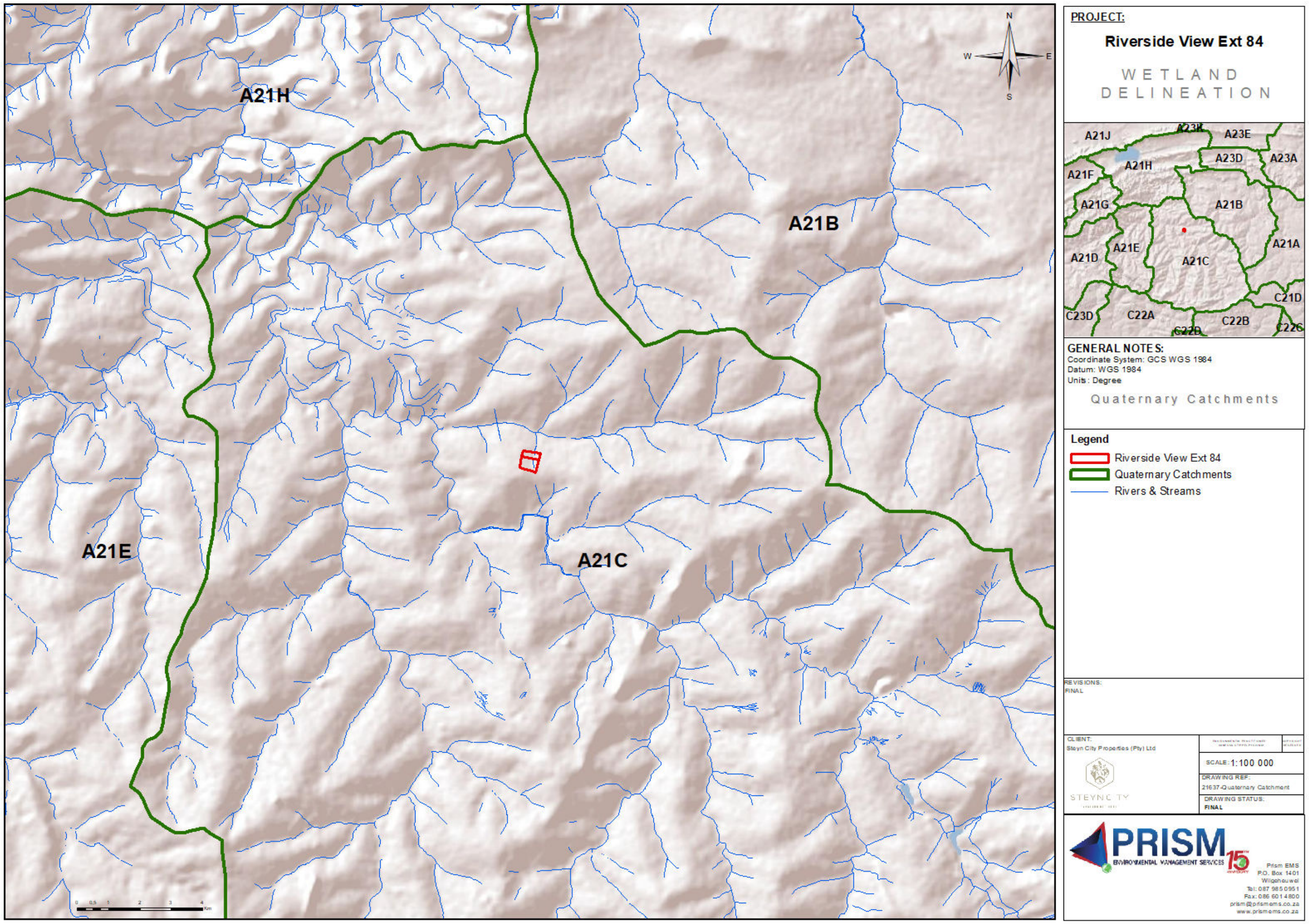


Figure 2: Map of the catchment areas.

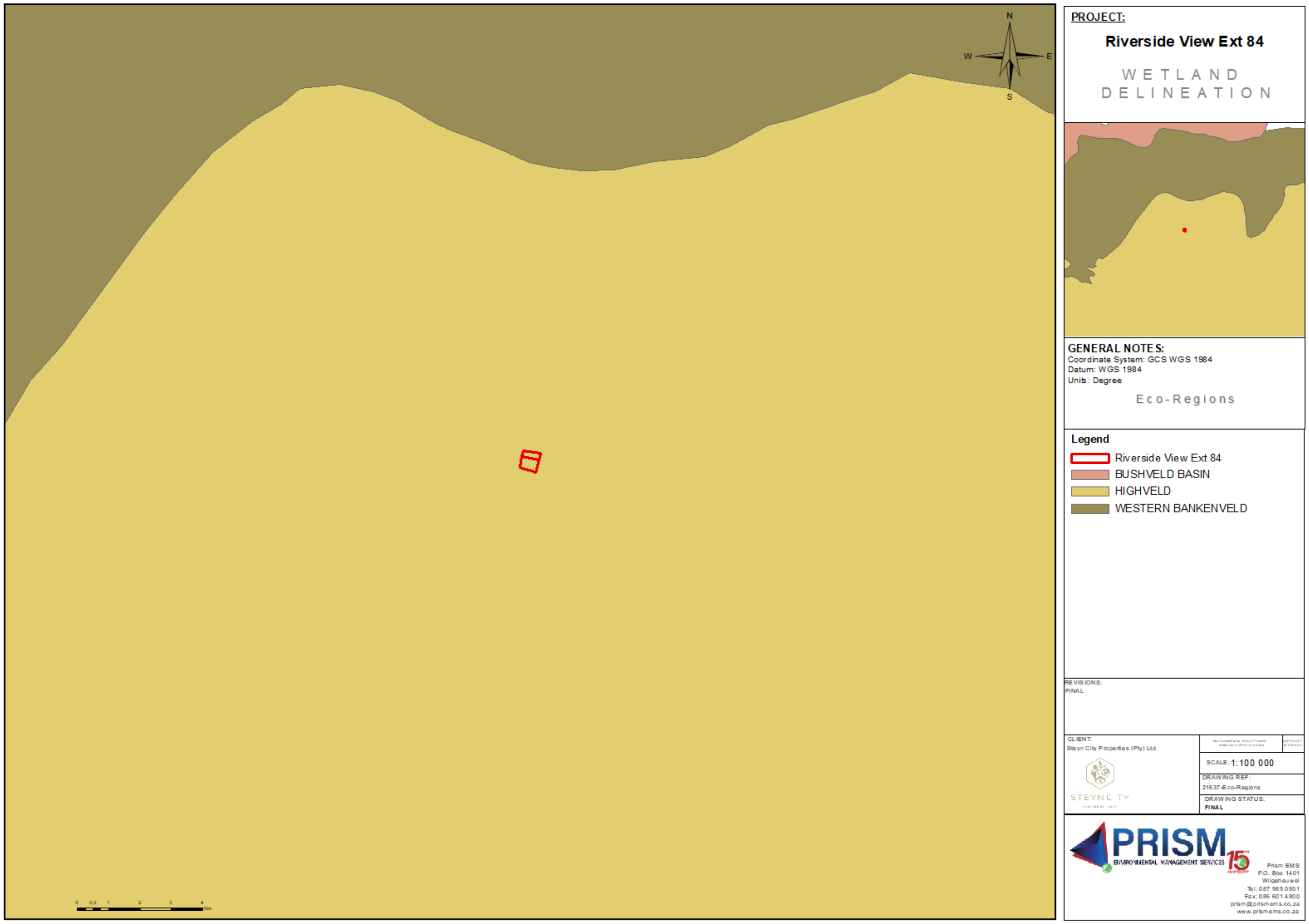


Figure 3: Map of Eco-regions.

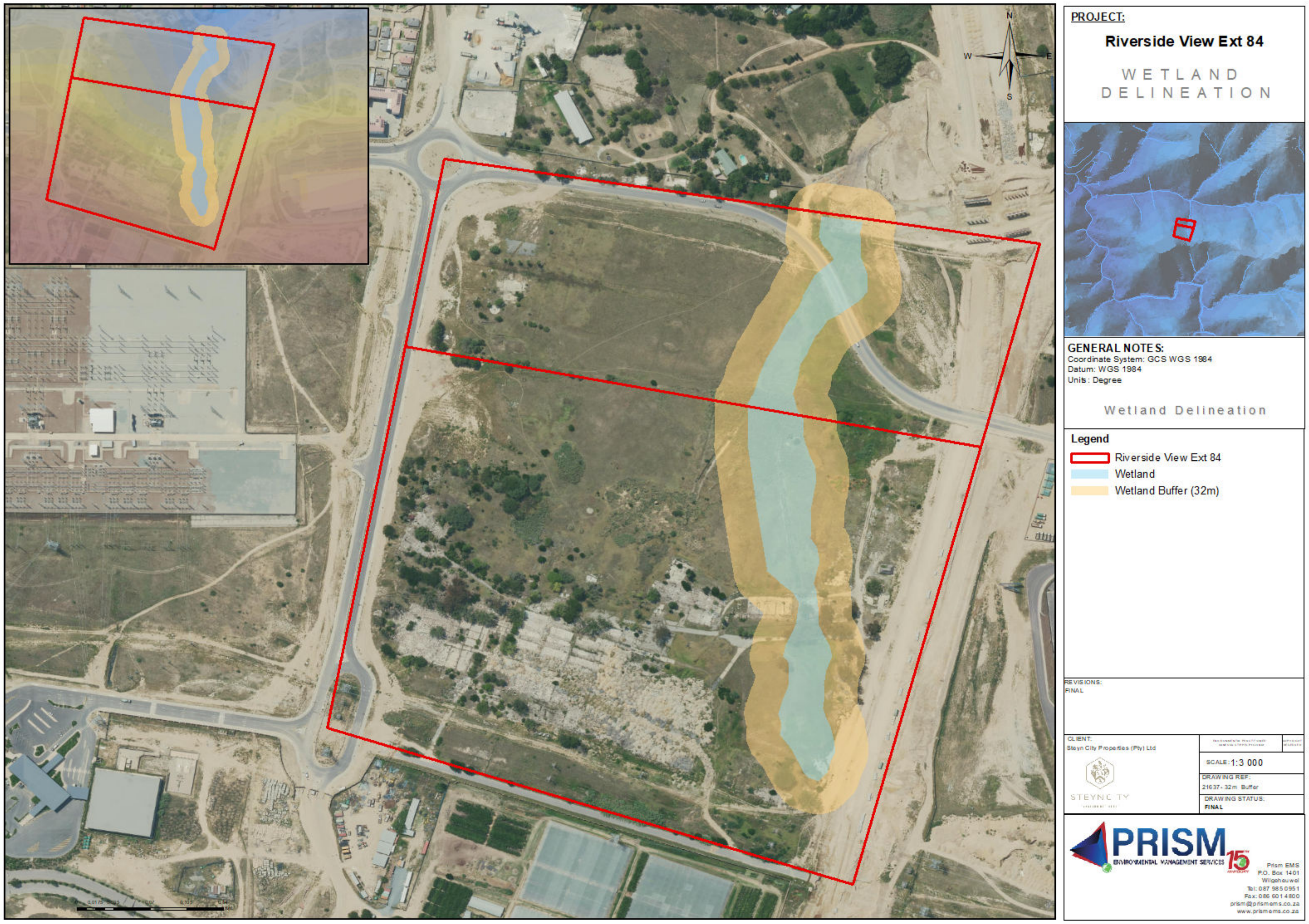


Figure 4: Wetland delineation.

2. Literature Review

2.1 Restoration of Aquatic Ecosystems

Various construction and other negatively influencing activities occur within an aquatic ecosystem and/or its catchment. These activities result in the degradation of the aquatic system through altering the adjoining land, water quality and quantity, channel connections and geomorphology, flow and sediment regime and native fauna and flora. The larger the degree of loss of these variables are, the further the systems functionality is reduced.

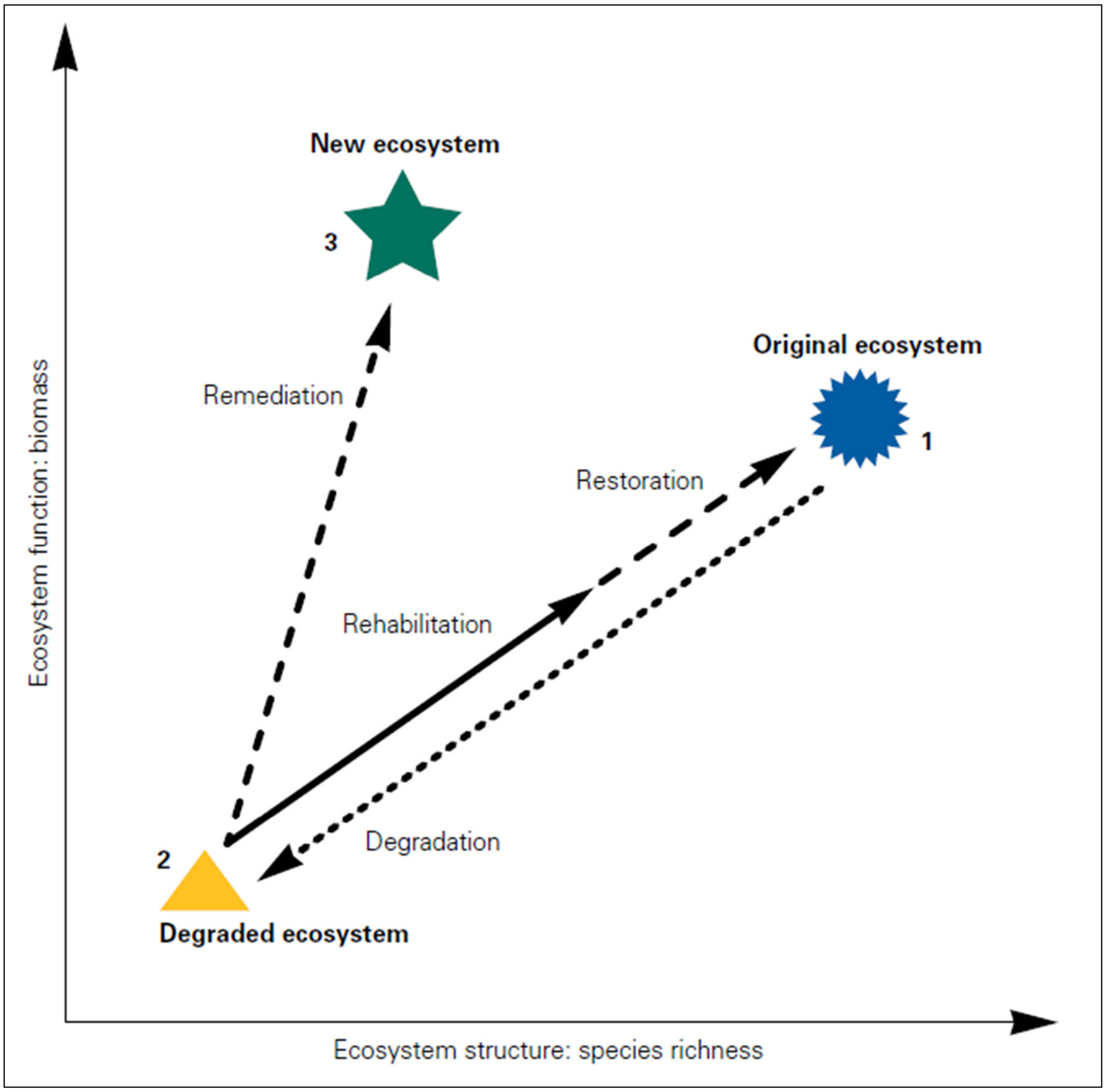


Figure 5: The differences between restoration, rehabilitation and remediation (Rutherfurd, et al., 1999).

Restoration of a degraded system - involves reinstating these abovementioned variables to natural conditions. The goal of restoring an aquatic ecosystem to its original natural condition is often impossible. As stated by Rutherfurd *et al.* (1999), this would involve restoring to pre-European conditions with the entire catchment surface and stream network linkages being restored. For this reason, aquatic systems are rehabilitated rather than restored.

Rehabilitation of a degraded system - more achievable when compared to restoration, and is often the less costly and a more common goal for improving the state of aquatic ecosystems. Rehabilitation involves improving the most important aspects of the aquatic ecosystem to resemble its original condition. A rehabilitated system still retains ecosystem functionality.

Remediation of a degraded system - recognises that the aquatic ecosystem has been altered so much that the original condition is no longer achievable due to irreversible changes that have taken place within the catchment and system itself. Therefore, remediation aims to improve the current ecological condition of the system, keeping in mind that the endpoint of that improvement will not necessarily resemble the original state of the system. In fact, it may not be possible to predict what that endpoint will be like.

It is important to know the differences between Remediation, Rehabilitation and Restoration and decide on which of these three restoration actions to take.

2.2 Rehabilitation

Rehabilitation is defined as the return of a disturbed area to a state which approximates the state that it was prior to disruption and construction activities. It is an important process whereby vegetation once disturbed can return to functionality within an area, ultimately conserving and preserving integral ecosystem goods and services (Kotze, et al., 2009).

Rehabilitation is a costlier exercise than protection. Where possible, an aquatic ecosystem (be it a stream, river, pan or wetland) should rather be protected from degrading to a point where rehabilitation is required. If this is not an option within the project area, then rehabilitation of the impacted area should be carried out.

‘The first rule of rehabilitation is to avoid the damage in the first place! It is easy, quick and cheap to damage natural streams. It is hard, slow and expensive to return them to their original state. Usually we are not capable of returning anything approaching the subtlety and complexity of the natural system. For this reason, the highest priority for stream rehabilitators is to avoid further damage to streams, especially streams that remain in good condition (Rutherfurd, et al., 1999). This same principle can be applied to wetlands.

The purpose of the rehabilitation plan is to provide a robust basis from which to implement rehabilitation interventions. An approved rehabilitation plan demonstrates that the correct information has been gathered in assessing the causes and effects of degradation and those rehabilitation interventions have been developed appropriately. The plan will also double as a source document for various authorizations that may be required.

Rehabilitation works best with ongoing environmental monitoring. Environmental monitoring according to DWAF is “the repetitive and continued observation, measurement and evaluation of environmental data to follow changes over a period of time to assess the efficiency of control measures”. Monitoring is undertaken on an ongoing basis for the duration of the project, programme or activity – usually before, during, and after implementation of each project or programme (DWAF, 2005).

The execution and success of rehabilitation plans for aquatic ecosystems are limited by a number of factors that include the efficiency of the implementers of the plan, the experience of the specialist guiding the process and the willingness of the construction crews and developer to adhere to the rehabilitation plan. To ensure the success of the rehabilitation process, it is of paramount importance that all parties involved be contractually bound to all the aspects of this rehabilitation plan. It has been shown that a fine (penalty) structure must be included in the negations to ensure that, in cases of non-compliance, a fine can be given.

Due to the dynamic nature of aquatic ecosystems, it is difficult to determine what impacts the construction activities will have. For this reason, the implementation of the rehabilitation must be guided by an environmental control officer with experience in implementing aquatic ecosystem rehabilitation while taking on an adaptive management approach.

A number of principles for wetland rehabilitation were proposed by RAMSAR (2002) that serve as guidelines. These principles can be further extended to the rehabilitation of other aquatic ecosystems. The principles are summarized as follows:

1. **Preserve and protect aquatic resources:** Existing, relatively intact ecosystems are the foundation for conserving biodiversity and provide the biota and other natural materials needed for the recovery of degraded systems.
2. **Restore ecological integrity:** Rehabilitation should re-establish insofar as possible the ecological integrity of degraded aquatic ecosystems.
3. **Restore natural structure:** Stream channelization, ditching in wetlands, disconnection from adjacent ecosystems and shoreline modifications are examples of structural alterations that may need to be addressed in a rehabilitation project.

4. **Restore natural function:** Structure and function are closely linked in river corridors, lakes, wetlands, estuaries and other aquatic resources.
5. **Understand the natural potential of the watershed:** A watershed has the capacity to become only what its physical and biological setting - its Ecoregion, climate, geology, hydrology and biological characteristics will support.
6. **Address on-going causes of degradation:** Rehabilitation efforts are likely to fail if the sources of degradation persist.
7. **Develop clear, achievable and measurable goals:** Rehabilitation may not succeed without good goals. Goals direct implementation and provide the standards for measuring success.
8. **Focus on feasibility:** Particularly in the planning stage, it is critical to focus on whether the proposed rehabilitation activity is feasible, taking into account scientific, financial, social and other considerations.
9. **Use a reference site:** Reference sites are areas that are comparable in structure and function to the proposed rehabilitation site before it was degraded.
10. **Anticipate future changes:** The environment and our communities are both dynamic. Although it is impossible to plan for the future precisely, many predictable ecological and societal changes can and should be factored into rehabilitation design. For example, in repairing a stream channel, it is important to take into account potential changes in runoff resulting from projected increases in upstream impervious surface areas due to development. In addition to potential impacts from changes in watershed land use, natural changes such as plant community succession can also influence rehabilitation.
11. **Involve the skills and insights of a multi-disciplinary team:** Rehabilitation can be a complex undertaking that integrates a wide range of disciplines including ecology, aquatic biology, hydrology and hydraulics, geomorphology, engineering, planning, communications and social science.

2.2.1 Law regarding rehabilitation

South Africa has legal framework that sets in place the need for the protection of the environment. This framework has stood the test of time and has been in use for a number of years, legally binding those who seek to or already have developed within the natural environment.

Section 24, under The South African Constitution (Act no 108 of 1996), states that an individual has the right to an environment that is not detrimental to their health and is protected for present and future generations. In keeping with this principal, any degradation of a natural system needs to be reversed to ensure the sustainability of the environment.

The National Environmental Management Act (NEMA) (Act no. 107 of 1998) puts forward three principles that hold great value in the protection of the environment and are further great for the rehabilitation of aquatic ecosystems:

1. **Precautionary approach:** Any activities undertaken must ensure the best method of environmental protection and when knowledge of impacts is limited, the best actions must be taken to avoid the possibility of serious or irreversible harm to the environment.
2. **Polluter pays:** This principle does not allow for the polluter to pollute indiscriminately, but provides a legal tool to affected parties to recover costs of rehabilitation and remediation completed (by another party) from the polluter.
3. **Duty of care:** It is the duty of the owners of properties to take care of their environment and to ensure the environment does not impede on other occupants surrounding the properties' Constitutional rights as described in Section 24 of the Constitution of South Africa.

The rehabilitation methods mentioned in this report should be applied as soon as the proposed activity commences. There are a variety of actions that must be taken at different phases to ensure that the rehabilitation of the different areas is done correctly and efficiently.

2.2.2 Rehabilitation approach

Rehabilitation is not a 'once-off' tool that is used to fix a degraded aquatic ecosystem, but rather an ongoing dynamic process requiring monitoring and adaptation as time goes by. The reason for ongoing monitoring and adaptation is due to two reasons: Firstly, the system being rehabilitated undergoes constant change from natural biotic and abiotic processes; and secondly, the efficiency of the original rehabilitation plan (this document) needs to be evaluated and adjusted according to the rehabilitation goals. The adaptive rehabilitation approach can be seen in Figure 6 below.

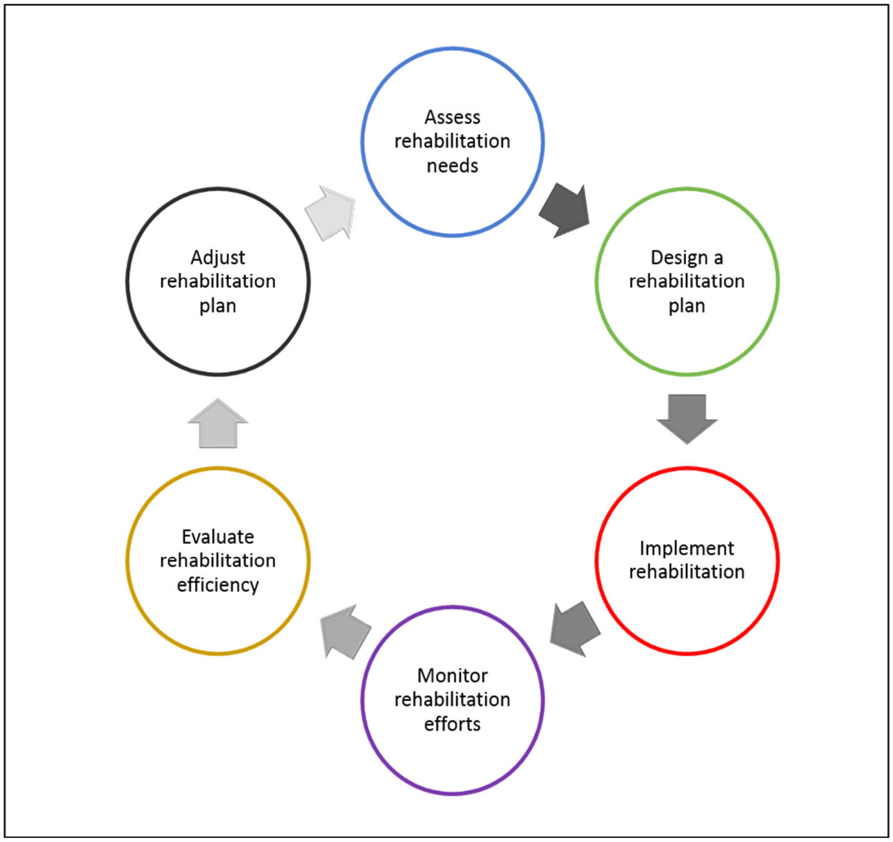


Figure 6: Adaptive Rehabilitation Approach.

2.2.3 Initial Rehabilitation Activities

Before the construction and rehabilitation activities commence, a number of initial rehabilitation activities need to take place:

- Construction workers must all undergo environmental training to be aware of the correct environmental principles;
- The wetland and/or riparian area needs to be demarcated and / or fenced off based on specialist consultation;
- The construction and regulated areas should be clearly marked;
- The construction area may be cleared of fauna and flora prior to construction if authorised by the competent authority and only under consultation with the relevant ecologist, wetland and/or aquatic scientist. Adequate signage should be erected that raises awareness about possible flora, fauna, protected areas and delineations in the area.
    - **Flora:**
        - Where cleared plants (terrestrial and riparian) can be reused later for rehabilitation, these plants must be relocated elsewhere on site with their root systems and some soil intact;

- All cleared wetland plants must be relocated to temporary non-stagnant storage impoundments with their root systems and some soil intact;
- If the water is stagnant, the roots will rot. Therefore, the water needs to be circulated.
- These plants must be kept in similar conditions to where they were originally from and wet to avoid desiccation of the plants;
- Monitoring of the plants should take place regularly to prevent root rot, desiccation and loss of the plants.
- These plants will be used later on in the project for rehabilitation and when available from nurseries, are expensive.
- All exotic vegetation identified must be managed and removed routinely and appropriately, in attempts to reduce the impacts of exotic species
- **Fauna:**
- If any fauna is encountered on site before construction, these should be removed (unharmed) from the construction site and relocated elsewhere on site / nearby open fields:
- No trapping, killing or poisoning of any wildlife should be allowed on site
- If any amphibians, snakes and other reptiles, baboon spiders, small mammals or fauna with a threatened status are to be relocated then the relevant specialist should be consulted for the removal thereof.
- Staff should be educated about the sensitivity of faunal species and measures should be put in place to deal with any species that are encountered during the construction process. The intentional killing of any animals including snakes, insects, lizards, birds or other animals should be strictly prohibited.
- Prior to construction and clearing, walkabouts need to be done to chase up any faunal species that might be found in the area. If the African Grass Owl is observed in the project area, enough time should be given to the specie to move out of the area; should the species not move away on its own the appropriate authority should be contacted to assist with the relocation. In this case the EWT associated with the Kyalami African Grass Owl project is suggested.
- During the operational phase it is suggested that the open land area be monitored for the presence of the African Grass Owl to assist with its conservation in the area (or access be given to the area to a monitoring program such as the one administered by the Endangered Wildlife Trust).

3. Rehabilitation Measures and Management Objectives

The management objectives that are listed below were compiled by using previous experience obtained with similar projects. This rehabilitation plan encompasses mitigation measures for soil, vegetation, impacts on surface water quality, impacts related to erosion, sedimentation and increased turbidity, and impacts on instream aquatic biota. For the proposed and current development of the study site a number of site-specific rehabilitation measures need to be implemented in order to achieve the management objectives. The management objectives that are listed below were compiled by using previous experience obtained with similar projects.

Before these objectives can be implemented, it is imperative that **STRICT DEMARCATION** of the wetland, wetland buffer and construction area must be **MAINTAINED and ENFORCED,** ensuring that no construction activities exceed the construction boundaries. This will ensure that no degradation of the wetland and/or riparian area occurs outside of the allocated construction area. Further, construction workers may not set traps, hunt, poach, kill, harm or consume any fauna from the study area.

3.1.1 Hydrology

- The drainage patterns of the study site that existed before the project commenced should be maintained as far as possible. If not, then new drainage patterns should be created so as to best maintain the hydrology of the study area;
    - The secondary movement of water from the slopes should be catered for, and preferably drain into a primary channel;
    - Slopes that were present should be maintained as far as possible throughout the project to assist with natural drainage of the project area.
- Storm water channels should be designed to help attenuate strong flows. These channels can, where possible, be constructed from natural materials along with various wetland type flora to create artificial wetland storm water channels with many benefits;
    - Various structures such as gabion structures, Reno mattresses and gabion steps (wire cages packed with rocks - Figure 7) and loose rocks (from site if present) can be used to slow down water flow velocities while allowing water to flow through the gabions infiltrating into the ground, with the added benefit of controlling soil erosion, acting as a natural filter and forming habitat for various biota. The gabion structures serve as retainer walls along the stormwater channels keeping the channel walls free from erosion, while adding a natural look;
    - The loose rocks will help slow down the water flow velocity, which will alleviate the force of the water flowing from the storm water channel into the receiving wetland and river while further creating habitat for various fauna;
    - Wetland type plants are known natural flood attenuating features (Figure 8). These should be incorporated (if applicable) in channels where water flows need to be slowed;

        - Wetland plants further help filter out pollutants and other constituents from the water that passes through them, trapping suspended sediments allowing them to settle out of the water and limiting the amount of topsoil loss from site. The wetland plants also slow the water flow velocity allowing the water time to infiltrate into the ground.
    - Slow release permeable retention ponds (where feasible) can be used to catch and retain much of the storm water, while increasing the lag time of the water into the receiving system putting less pressure on the receiving environment;
        - If many smaller retention ponds are used, more storm water is allowed to infiltrate into the ground rather than over ground as surface runoff;
- Where storm water flow velocities are slowed using the abovementioned measures, more water is allowed to infiltrate through the ground with less water flowing into the wetland or river as surface runoff (with a slower flow velocity) putting less pressure on the receiving system.

Figure 7: Gabion structures

Figure 8: Wetland plants play a crucial role in slowing water flow, while allowing infiltration of water into the soils below.

3.1.2 Soil

3.1.2.1 Topsoil:

- The Contractor is required to strip topsoil together with grass / groundcover from all areas where permanent or temporary structures are located, construction related activities occur, and access roads are to be constructed, etc.;
- Topsoil must be stockpiled for later use, including shaping of the topography;
- Topsoil is to be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify;
- Topsoil stockpiles are not to exceed 2 m in height and should be protected to prevent erosion where needed;
- Topsoil stockpiles must be located outside of the regulating zones and pre-approved in consultation with the ECO.
- Topsoil stockpiles are to be maintained in a weed free condition. The ECO can assist with guidance as to which plants are weeds and require removal;
- Topsoil is to be replaced by direct return where feasible (i.e. replaced immediately on the area where construction is complete), rather than stockpiling it for extended periods and;
- Replaced topsoil should be compacted as per the pre-determined trench profile and associated method statements and;
- The construction servitudes must be identified and be clearly demarcated prior to the commencement of any construction activities on site and before the arrival of construction machinery. These demarcated areas must be outside of the delineated wetland/riparian area.
- Vehicles must use a single route into the construction site and one route to exit the construction site. This will ensure that the compacting of the soils of these areas is kept to a minimum. The compacting of the soil can lead to an increase in runoff that in return will lead to sedimentation of the aquatic ecosystems.

3.1.2.2 Erosion control:

- The Contractor shall protect all areas susceptible to erosion and shall take measures, according to the ECO;
- The Contractor shall not allow erosion to develop on a large scale before effecting repairs and all erosion damage shall be repaired as soon as possible;
- Erosion control of all banks must take place to reduce erosion and sedimentation into the aquatic resource;
- Pillars, columns, thrust blocks or parapets should not be placed within wetland and/or riparian areas. If this is necessary, all precautions should be taken to avoid excessive disturbance of the area;
- Erosion control measures (silt fences, hay bales, berms and geotextiles) should be implemented as the primary means of sediment control throughout the construction of the relevant pipelines.
    - Light penetration may be affected by the increase in turbidity;
    - Increased turbidity and sedimentation resulting from erosion will have a negative effect on the aquatic environment. According to DWAF (2008) an increase in sediment input into the system due to erosion is a serious issue; and
    - Increased turbidity also affects benthic invertebrates by smothering the substrate and available habitat.
- Silt fences or hay bales need to be placed near the base of a slope to limit the amount of silt entering the watercourse and to reduce the velocity of runoff.
    - Silt fences should be “planted” in the soil by excavating a narrow trench and to place the base of the silt fence in the trench, backfill and compact, securing the silt fence in place;
    - Use straw bale filters on long unprotected slopes to prevent surface erosion and the movement of sediment via runoff;
    - Where several lines of bales are installed on a slope in a more permanent application, erosion will be minimized if the top of the down-slope bale is on the same level as the bottom of the next line up;
    - Silt fences need to be inspected regularly, especially after heavy rainfall events;
    - All silt fences that are damaged, need to be replaced as soon as possible; and
    - The suggested installation and placement of hay bales is illustrated below (Figure 9).

Figure 9: Pegged (staked) hay bales can be used effectively to curb soil erosion.

- Berms and Dips need to be placed on areas of the right-of-way that occur on slopes to minimise rill and gully erosion.
    - Geotextiles may be used on berms that cannot contain water sufficiently;
    - Berms/contour drains should ideally be broad enough to create a low-profile bank to allow for trucks and large trenching equipment to safely move over them (Clemens, 2010);
    - Where native materials are highly erodible, the upslope of the berm can be protected by sod or by burying a geotextile liner (16 to 20 cm) below the surface or by armouring the upslope face of the berm with earth filled sand bags;
    - Herringbone berms and cross-ditches can be used where the direction of the slope and surface water movement is parallel to right-of-way, so runoff does not cross the ditch line;
    - Diagonal berms need to be implemented where the direction of the slope and surface water movement is oblique to the right-of-way;

- The location and direction of the berm based on local topography and drainage patterns must be determined; and
- Inspection needs to be carried out after high rainfall events.

- Geotextiles may be used to protect unstable erodible slopes and assist in vegetation reinstatement (Figure 10):
  - Geotextiles will immediately reduce the erosion potential of disturbed areas and/or to reduce or eliminate erosion on critical sites (such as river banks) while vegetation is being established;
  - Geotextiles may be used on short steep slopes or stockpiles in periods during which the site is inactive; and
  - Geotextiles may be used in areas where an adequate permanent vegetative cover may be slow to establish, where the geotextile will provide an initial protective layer as well as assisting in maintaining higher soil temperatures.

Figure 10: Geotextile used for re-seeding

- Mulching can be used where instant erosion protection is needed (Clemens, 2010).
  - Mulch should never be used on its own as erosion protection measure; and
  - Instances where straw is used as mulch it can achieve a stabilised surface cover for a maximum of five months before the straw becomes part of the overall soil matrix and the effectiveness of the surface cover is lost (Clemens, 2010).
  - Mulching reduces runoff velocity while increasing infiltration, providing moist areas for plant growth and protection against extreme temperatures.
- The 100-year floodline (if determined), wetland and buffer areas must be kept clear of all excavated material.
  - Topsoil must be placed in distinct piles on a level slope and adequate erosion measures need to be implemented to prevent the topsoil from being washed away via storm water runoff;

- Topsoil stockpiles may not exceed 1,5m in height, this to maintain the soil structure and integrity;
- Top soiling does not provide a stabilised surface but simply provides a media within which vegetation can be re-established and maintained (Clemens, 2010); and
- Spoil berms need to be constructed (Figure 11) to contain excavated spoil/top soil so that sediment-laden runoff does not enter the watercourse or flow off the right-of-way.

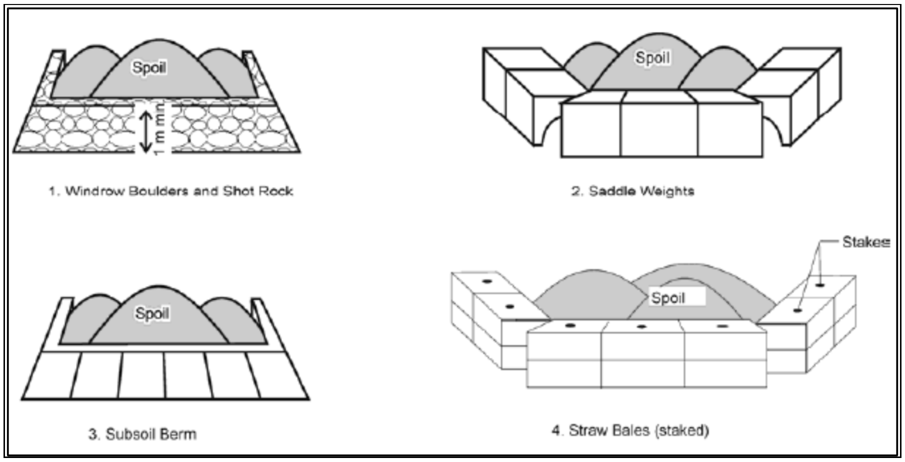


Figure 11: Suggestion for different types of spoil berms.

- Berms can also be used to direct water away from the trenches;
- Water accumulated with the trenches (rainfall events etc.) needs to be pumped out through a water bypass system to filter out sediment.
  - These bypass systems need to be placed outside the riparian zone to allow for adequate absorption thereby preventing the discharge from entering the watercourse; and
  - The size of the water bypass system needs to be adequate to accommodate the volume of water thereby preventing overflow.
- Runoff channels should be constructed above the work area, to ensure that clean water is diverted around the work area to prevent siltation (Clemens, 2010).
- With regards to construction equipment, changing of oil, refuelling and lubricating mobile and immobile construction equipment needs to be carried out outside the riparian zone to minimize the potential for water pollution.
  - Spill kits must be available in case of spillage;
  - Drip trays need to be placed under construction machinery to minimise the spread of hydrocarbons; and
  - Hydrocarbon waste needs to be collected and disposed of at an approved location and in an appropriate manner.
- The formation of lateral gullies in the fill material of the pipeline trench must to be prevented.
  - The formation of lateral gullies in the fill material may result in the pipeline being exposed;

    - Prevention will be achieved with the use of above mention erosion control measures.
- Oil storage and workshop areas should be surrounded by a bund wall to contain spillages. In the case where soil becomes contaminated with oil, it must be removed for proper disposal or treatment (Bioremediation).

- Excavated soil from the wetland/riparian area must be filled in according to the soil profiles:
    - Last out first in approach.
    - All stockpiles must be covered until refilled.

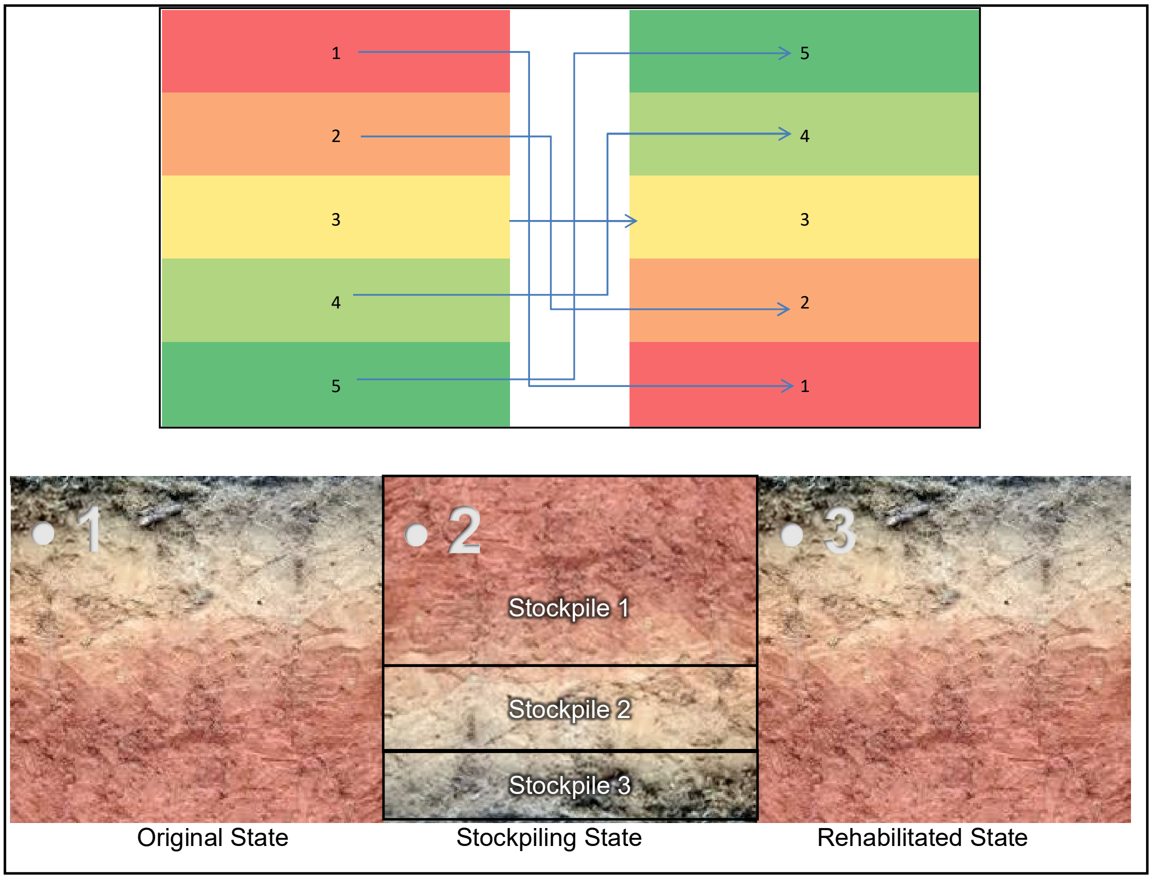


Figure 12: Soil Stockpiling and refilling according to original state.

- Rehabilitation must be carefully sited to minimize the footprint and ultimately the loss of the natural habitat within the wetland/riparian areas;

- Re-vegetation of disturbed areas must be undertaken with indigenous species and in accordance with the instructions issued by the ECO; and

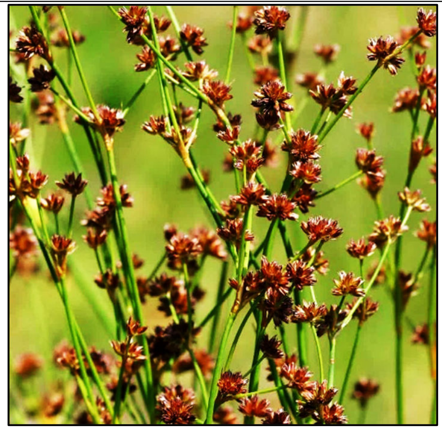
- Trenches must be backfilled and re-vegetated as described in this Rehabilitation Plan.

3.1.3 Vegetation

- No heavy machinery shall be permitted within unauthorised water resource areas for any purpose, without the prior approval of the ECO (except emergency procedures). Clearing of vegetation shall be conducted by hand. All cleared and trimmed vegetation shall be removed from any watercourse to prevent flooding / snagging hazards being created;
- Re-vegetation of disturbed areas must be undertaken with site indigenous species (Table 1) and in accordance with the instructions issued by the ECO (please note these species suggested are indicative species which the contractor in conjunction with the ECO can agree upon with the Department of Water and Sanitation, for rehabilitation of the wetland/riparian areas);
- The construction servitude must be identified and be clearly demarcated prior to the commencement of any construction activities on site and before the arrival of construction machinery. Vehicles must use a single route into the construction site and one route to exit the construction site. This will ensure that the compacting of the soils of these areas is kept to a minimum. The compacting of the soil can lead to an increase in runoff that in return will lead to sedimentation of the aquatic ecosystems;
- The demarcations must stay in place for the entire construction phase and no personnel, construction machinery or construction material should move or be placed outside the demarcated construction servitude;
- The servitude must accommodate all construction related activities, including materials storage, access routes, soil stockpiles etc.;
- Areas where vegetation removal has taken place must be re-vegetated after construction has been completed;
- Dry seeding or hydro seeding may be used. If dry seeding is used it must be done at the beginning of the wet season, as soon as 5mm – 20mm rain has fallen. This will ensure the seeds germinate and will not be washed away during high rainfall events.
- Seeding must be done in accordance with the vegetation that surrounds the construction area.
- All present exotic and invasive plant species should be eradicated if the development is approved. Therefore, as part of the rehabilitation plan, regular removal of exotic and invasive plant species should take place.
- Possible plant species are illustrated in Table 1.
- As previously mentioned, the study area falls within the Grassland Biome (Biome 06). The plants selected to be included into the re-vegetation portion of the study site have been chosen with the specific biome characteristics considered. The vegetation landscape of the biome is dominated by medium-to-high dense grassland (Mucina & Rutherford, 2006).

Table 1: Plant species to be included in re-vegetation portion of the rehabilitation program.

No.	Species	Common Name	Illustration
1.	*Kniphofia ensifolia*	Torch lily	
2.	*Ranunculus multifidus*	Wild buttercup	
3.	*Cyperus sexangularis*	Bushveld sedge	
4.	*Juncus rigidus*	Sea rush	

No.	Species	Common Name	Illustration
5.	*Juncus oxycarpus*	Rushes	
6.	*Kyllinga melanosperma*	Spike sedges	
7.	*Combretum erythrophyllum*	River bushwillow	

No.	Species	Common Name	Illustration
8.	*Searsia lancea*	Kareeboom	
9.	*Typha capensis*	Bulrush	
10.	*Paspalum distichum*	Knotgrass	

No.	Species	Common Name	Illustration
11.	*Agrostis lachnantha*	Bent grass	
12.	*Themeda triandra*	Red grass	
13.	*Andropogon eucomus*	Snowflake grass	

3.1.4 Aquatic Resource Mitigation Measures

The following mitigation measures should be implemented during the construction and rehabilitation phases.

3.1.4.1 Impacts on surface water and soil quality.

- Changing of oil, refuelling and lubricating of equipment should not be carried out within proximity of the Aquatic Resources (Wetland and Riparian areas) to minimize the potential for water and soil pollution.
- Construction equipment and machinery should not be serviced or refuelled near watercourses. A suitable area should be designated outside the buffer area.
- Oil storage and workshop areas should be surrounded by a bund wall to contain spillages. In the case where soil becomes contaminated with oil, it must be removed for proper disposal or treatment (e.g. bioremediation).
- Construction workers should not use watercourses for sanitation purposes.
- Contaminated water needs to be isolated. Water with a chemical signature different to that of the receiving aquatic environment should be considered contaminated and should be isolated.
- Solid waste (plastics, polystyrene, etc.) is expected to build up post-construction. This should be considered and managed accordingly.
- All litter and wastes generated from the construction activities and construction workers must be disposed of correctly.

3.1.4.2 Impacts related to erosion, sedimentation and increased turbidity.

- It is recommended that construction activities should make use of the dry seasonal construction window. This will further reduce the risk associated with erosion/siltation.
- Dredging activities should be kept to the minimum practicable timescales and should comply with conditions as granted by the Responsible Authority.
- Removed sediment should not be placed on the shoreline prior to disposal. Same must be removed from site and / or stockpiled 32m wayward from the delineated riparian/wetland zones.
- It is recommended that a silt curtain be used where possible to contain increased turbidity and limit the extent of the impact during construction. Silt curtains can be used to contain re-suspended sediment to a smaller area.
- The selection of an appropriate construction method to maximize the capture of sediment and minimize the re-suspension of silt / sediment.
- The design consideration for the construction of the proposed activity should be based on environmental best practises.

- Access roads need to be inspected on a regular basis for signs of erosion and sedimentation as it is anticipated that large vehicles and heavy machinery will be utilised for the construction.
- Stormwater should not discharge perpendicularly to the aquatic resources, but rather as parallel as possible to reduce impacts to the stream flow and the opposite bank.
- Additionally, breakers should be incorporated at the discharge points to reduce the velocity of stormwater entering the aquatic resource.
- This Rehabilitation Plan has included the planting of indigenous vegetation that would function ecologically and in attenuating stormwater flow.
- It is also recommended that during the construction activities the turbidity be monitored to maintain baseline levels. Routine monitoring of turbidity should not yield values varying more than 15% that of baseline values for similar periods of the year. Monitoring should be done directly up- and downstream of the proposed construction.
- Frequent monitoring should consider possible sources of sediment and whether these are controlled and managed appropriately. Special attention should be given to the presence of any new erosion features and unstable slopes.

3.1.4.3 Impacts on aquatic resource integrity.

- Removal of alien and invasive plant species during the construction and operational phases.
- Re-vegetation and landscaping the wetland and buffer areas with indigenous wetland plant species.
- Stabilisation of gullies and drainage lines to prevent erosion.
- Planting of indigenous herbaceous plants on shallow banks and indigenous woody vegetation on steep banks to increase stability of banks, thereby preventing erosion.
- Implementation of topsoil management (stockpiling, topography shaping) and erosion control (berms, geotextiling, silt fences, hay bales and gabion structures).

4. Conclusions and Recommendations

Rehabilitation plans must be used to ensure the correct construction principles are followed throughout the construction phase. A project-whole environmental mind-set (from the construction workers to the project manager) will assist greatly in achieving the successful rehabilitation of the project area through correct methodologies and efficient, coordinated teamwork by all involved. Monitoring of the entire process will further ensure the successful rehabilitation of the impacted area.

- Rehabilitation must be carefully sited to minimize the footprint and the loss of the natural habitat within the aquatic resource areas during the construction phase;
- The sensitive areas and buffer zones/flood line areas must be demarcated and strictly adhered to;
- Re-vegetation of disturbed areas must be undertaken with site-specific indigenous species and in accordance with the instructions issued by the ECO/Aquatic Specialist;
- Trenches must be backfilled and re-vegetated as described in this Rehabilitation Plan.
- Stormwater should not discharge perpendicularly to the aquatic resource, but rather as parallel as possible to reduce impacts to the stream flow and the opposite bank.
- Additionally, breakers should be incorporated at the discharge points to reduce the velocity of stormwater entering the aquatic resource.
- This Rehabilitation Plan has included the planting of indigenous vegetation that would function ecologically and in attenuating stormwater flow.
- Consultation with Mr. D. Botha from Prism EMS along with other relevant experts regarding the proper disposal methods or use of the removed sediment is imperative; and
- The environmental impacts of the construction must be closely monitored in terms of both the upstream and downstream environment with regards to sediments loads & plumes, water flows and pollution build up (plastics, polystyrene, etc.

The rehabilitation may be undertaken with minimal harmful effects to the associated aquatic resources if the relevant rehabilitation measures as prescribed in the document are implemented and monitored correctly. If all mitigatory actions are adhered to, the construction activities will not have any detrimental impact on the aquatic resource.

5. References

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Appendix A – Specialist Qualifications

Table A1: Specialists consulted for this environment Rehabilitation Plan and their qualifications

ASPECT INVESTIGATED	SPECIALIST	QUALIFICATION	REPORT DATE
Report Compilation	P. Singh Senior Aquatic Specialist Pr.Sci.Nat	MSc *Cum Laude*: Aquatic Health BSc Hons. Biodiversity and Conservation BSc Life and Environmental Sciences SASS5 Accredited Practitioner (*DWS and WRC)* Wetland Management Course: Ecology, Hydrology, Biodiversity, Legislation, Delineation and Management (*University of the Free State*) Hydropedology and Wetland Functioning (*Water Business Academy / Terra Soil Science*) SACNASP 116822	May 2020
Mapping and Peer Review	D. Botha Principle EAP Pr.Sci.Nat	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma Wetland and Riparian Delineation *(DWAF Accredited Short Course)* Soil Classification and Wetland Delineation - Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University* Hydropedology and Wetland Functioning (*Water Business Academy / Terra Soil Science*) SACNASP 119979	May 2020