Report No: 109664/8810

REHABILITATION PLAN FOR THE WORKING FOR WETLANDS PROGRAMME, KWAZULU-NATAL PROVINCE

PROJECT: KZN NORTH

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MAY 2014

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Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

EXPANDED PUBLIC WORKS PROGRAMME
Creating opportunities towards human fulfilment

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Working for Wetlands

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REHABILITATION PLAN FOR THE KZN NORTH WETLAND PROJECT, KWAZULU-NATAL: PLANNING YEAR 2014/2015 AS PART OF THE WORKING FOR WETLANDS PROGRAMME FOR THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE

MAIN REPORT

May 2014

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PROJECT DETAILS

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WORKING FOR WETLANDS: CONTEXT DOCUMENT

1. Introduction

Working for Wetlands (WfWetlands) is a government programme managed by the South African National Biodiversity Institute (SANBI), and is a joint initiative of the Departments of Environmental Affairs (DEA), Water Affairs (DWA) and Agriculture, Forestry and Fisheries (DAFF). In this way the programme is an expression of the overlapping wetland-related mandates of the three parent departments, and besides giving effect to a range of policy objectives, also honours South Africa's commitments under several international agreements, especially the Ramsar Convention on Wetlands.

The programme is mandated to rehabilitate damaged wetlands and to protect pristine wetlands throughout South Africa, with an emphasis on complying with the principles of the Expanded Public Works Programme (EPWP) and using only local Small, Medium and Micro Enterprises (SMMEs). The EPWP seeks to draw significant numbers of unemployed people into the productive sector of the economy, gaining skills while they work and increasing their capacity to earn an income.

2. Wetlands and their importance

Once considered valueless wastelands that needed to be drained or converted to more useful landuse purposes, wetlands are now seen in an entirely different light. Today wetlands are more commonly perceived as natural assets and natural infrastructure able to provide a range of products, functions and services free of charge.

That which actually constitutes a wetland is often not fully understood. Common misconceptions have been that wetlands must be wet, must have a river running through them, or must always be situated in low-lying areas. The definition of a wetland is much broader and more textured: they are characterised more by soil properties and flora than by an abundance of water.

The National Water Act, No. 36 of 1998 defines a wetland as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

The Ramsar Convention defines wetlands as:

"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6m" (Article 1, Ramsar Convention on Wetlands. 1971).

Wetlands can therefore be seasonal and may experience regular dry spells (sometimes even staying dry for up to several years), or they can be frequently or permanently wet. Wetlands can occur in a variety of locations across the landscape (Plate A), and may even occur at the top of a hill, nowhere near a river. A pan, for example, is a wetland which forms in a depression. Wetlands also come in many sizes; they can be as small as a few square metres (e.g. at a low point along the side of a road) or cover a significant portion of a country (e.g. the Okavango Delta).

Plate A: A large, seasonal wetland identifiable by the characteristic flora. This wetland contained no surface water at the time of the photograph

Wetland ecosystems provide a range of ecological and social services which benefit people, society and the economy at large:

Wetlands offer services such as water provision, regulation, purification and groundwater replenishment are crucial in addressing objectives of water security and water for food security.

Wetlands play a critical role in improving the ecological health of an ecosystem by performing many functions that include flood control, water purification, sediment and nutrient retention and export, recharge of groundwater, as well as acting as vital habitats for diverse plant and animal species.

Wetlands provide ecological infrastructure, replacing the need for municipal infrastructure by providing the same or better benefit at a fraction of the cost.

Wetlands retard the movement of water in the landscape, which offers the dual benefit of flood control as well as a means of purification. The slow movement of water allows heavier impurities to settle and phreatic vegetation and micro-bacteria the opportunity to remove pollutants and nutrients. For these reasons, artificially created wetlands are often used in newer urban drainage systems to aid both mitigation of flooding and improvement of water quality.

Wetlands function as valuable open spaces and create recreational opportunities for people that include hiking, fishing, boating, and bird-watching.

Many wetlands also have cultural and spiritual significance for the communities living nearby. Commercially, products such as reeds and peat are also harvested from wetlands (Plate B).

Wetlands are thus considered to be critically important ecosystems as they provide both direct and indirect benefits to the environment and society.

Plate B: Commercial products made by locals from reeds harvested from wetlands

3. Wetland Degradation

It has been estimated that originally over 10% of the Republic of South Africa (RSA) was covered by wetlands; however, this figure decreases significantly every year owing to unsustainable land-use practices. It is estimated that more than 50% of South Africa's wetlands have been destroyed through drainage of wetlands for crops and pastures, poorly managed burning regimes, overgrazing, disturbances to wetland soils, vegetation clearing as well as industrial and urban development (including mining activities).

Although wetlands are high-value ecosystems that make up only a small fraction of the country; they rank among the most threatened ecosystems in South Africa. According to a recent Council for Scientific and Industrial Research (CSIR) study[1], South Africa's remaining wetlands were identified as the most threatened of all South Africa's ecosystems, with 48% of wetland ecosystem types being critically endangered, 12% endangered and 5% vulnerable. Only 11% of wetland ecosystem types are well protected, with 71% not protected at all.

The remaining wetland systems suffer from severe erosion and sedimentation, undesirable plant species and aquatic fauna infestations, unsustainable exploitation, artificial drainage and damming, and pollution. The continued degradation of wetlands will impact on biodiversity, ecological function, and the provision of ecosystem services with subsequent impacts on livelihoods and economic activity, as well as health and wellbeing of communities. In the absence of functional wetlands, the carbon cycle, the nutrient cycle and the water cycle would be significantly altered, mostly detrimentally.

Wetland rehabilitation and conservation should be at the heart of water management. It is necessary to prioritise South Africa's remaining wetlands such that those that offer valuable ecosystem services and are least impacted by current pressures or threats are offered immediate attention to avoid further loss, conversion or degradation.

4. The Working for Wetlands Programme

South Africa is a dry country, but is endowed with exceptionally rich biodiversity. The nation has a pressing reason to value the water-related services that wetlands provide. It is estimated that by 2025, South Africa will be one of fourteen

[1] Nel J.L. and Driver A. 2012. South African National Biodiversity Assessment 2011: Technical Report. Volume 2: Freshwater Component. CSIR Report Number CSIR/NRE/ECO/IR/2012/0022/A, Council for Scientific and Industrial Research, Stellenbosch.

African countries classified as "subject to water scarcity" (SANBI Working for Wetlands Strategy 2006-2010). The conservation of wetlands is fundamental to the sustainable management of water quality and quantity, and wetland rehabilitation is therefore essential to conserving water resources in South Africa.

The guiding principles of the National Water Act, No. 36 of 1998, recognise the need to protect water resources. In responding to the challenge of stemming the loss of wetlands and maintaining and enhancing the benefits they provide, government has recognised that, in order to be truly effective, strategies for wetland conservation need to include a combination of proactive measures for maintaining healthy wetlands, together with interventions for rehabilitating those that have been degraded. These objectives are currently being expressed in a coordinated and innovative way through the WfWetlands Programme.

The two main objectives of the WfWetlands Programme are **wetland conservation** in South Africa and **poverty reduction** through **job creation** and **skills development** amongst **vulnerable** and **marginalised** groups.

Wetland conservation: The strategic framework of the WfWetlands Programme underlines the need for a more refined planning process at catchment scale. Catchment scale planning seeks to promote ecosystem-scale outcomes, long-term custodianship, and the entrenchment of rehabilitation in broader local institutions and frameworks. The recent move to a systematic wetland rehabilitation planning process has provided a fertile and conducive platform for partnerships to be formed and/or strengthened as the process draws in a much wider stakeholder base.

Wetlands are not easy ecosystems to map at a broad scale as they are numerous, often small and difficult to recognise and delineate on remotely sensed imagery such as satellite photos. The WfWetlands Programme houses the National Wetlands Inventory Project (NWI) which aims to provide clarity on the extent, distribution and condition of South Africa's wetlands. The project clarifies how many and which rivers and wetlands have to be maintained in a natural condition to sustain economic and social development, while still conserving South Africa's freshwater biodiversity.

The National Freshwater Ecosystem Priority Areas (NFEPA) has used the NWI data to produce the most comprehensive national wetland map to date, called the NFEPA Atlas. This atlas enables the planning of wetland rehabilitation on a catchment scale.

Skills development: In the 12 years since its inception, the WfWetlands Programme has invested R530 million in wetland rehabilitation and has been involved in over 900 wetlands, thereby improving or securing the health of over 70 000 hectares of wetland environment. The WfWetlands Programme currently has a budget of approximately R94 million per year, of which R32 million is allocated directly to paying wages. Being part of the Expanded Public Works Programme (EPWP), the WfWetland Programme has created more than 12 800 jobs and 2.2 million person-days of paid work. The local teams are made up of a minimum of 60% women, 20% youth and 1% disabled persons.

Training and Capacity Building during the Working for Wetlands Programme

The WfWetlands Programme has established a working relationship with the Department of Public Works through the Working for Water programme. This partnership provides accredited training in accordance with the special public works Code of Good Practice agreements. Capacity building in the WfWetlands Programme operates primarily at two levels:

- The first concerns the need to ensure the development of adequate capacity to rehabilitate, manage and conserve wetlands in South Africa.
- The second relates to the commitment of the WfWetlands Programme as an EPWP to provide appropriate training to its workers in order for them to exit the programme with marketable skills and enhanced personal development.

Workers receive two days of training, either vocational or social development-related, for every 22 days worked. Vocational training includes technical matters related to project activities, occupational health and safety, first aid, fire awareness, and business skills (contractor development). Social development includes literacy, primary health, personal finance, HIV/Aids and diversity awareness.

Wage information sourced from the best practice guidelines suggests that workers and contractors would be paid daily rates of R 82 and R 251 respectively and would be employed on limited term contracts, i.e. 24 months in a five-year cycle. Employment of workers complies with the Ministerial Determination on Special Public Works Programmes (Government Notice No. R 63, 25 January 2002) and the Code of Good Practice for Employment and Conditions of Work for Special Public Works Programmes (Government Notice No. R 64, 25 January 2002). Targets for employment specify that the programme's workforce should comprise at least 60% women, 20% youth and 1% disabled people.

The WfWetlands Programme engages with provinces, especially government departments and agencies responsible for biodiversity and environment, and municipalities through individual projects. A stronger working relationship with these spheres of government is being promoted through the programme's emphasis on partnerships. In particular, compatibility with Integrated Development Plans (IDPs) and rehabilitation project objectives will be a key area of future focus. The WfWetlands Programme encourages municipalities to participate in provincial wetland forums as these forums are the platform for the roll out of all the programmes' processes, including planning for future work. Provincial forums also offer support from the government departments and private sectors that are represented. Partnerships with non-governmental organisations and the private sector are also critical, requiring collaboration and cooperation with a wider range of stakeholders and role players in the wetland management field.

Other activities that form part of the WfWetlands Programme include:

- Raising awareness of wetlands among workers, landowners and the general public; and
- Providing adult basic education and training, and technical skills transfer (in line with the emphasis of the EPWP on training, the WfWetlands Programme has provided 168 400 days of training in vocation and life skills).

5. Rehabilitation interventions

The successful rehabilitation of a wetland requires that the cause of damage or degradation is addressed, and that the natural flow patterns of the wetland system are re-established (flow is encouraged to disperse rather than to concentrate). Approximately 500 interventions are implemented every year in the WfWetlands Programme. The key purposes of implementing interventions include:

- Restoration of hydrological integrity (e.g. raising the general water table or redistributing the water across the wetland area);
- Recreation of wetland habitat towards the conservation of biodiversity; and
- Job creation and social upliftment.

- Typical activities undertaken within the projects include:
- Plugging artificial drainage channels created by development or historical agricultural practices to drain wetland areas for other land use purposes;
- Constructing structures (gabions, berms, weirs) to divert or redistribute water to more natural flow paths, or to prevent erosion by unnatural flow rates that have resulted from unsustainable land use practices or development; and
- Removing invasive alien or undesirable plant species from wetlands and their immediate catchments (in conjunction with the Working for Water initiative).

Increased labour requirement for the Working for Wetlands Programme

In response to the government request to increase the labour component of all government funded projects, the WfWetlands Programme project team has had to consider, and where practically feasible incorporate, more labour intensive ways of rehabilitating wetlands in order to obtain the increased labour component. Accordingly the project team members have factored this requirement into their planning when designing structures for wetland rehabilitation.

- Methods of wetland rehabilitation may include hard engineering interventions such as:
- Earth berms or gabion systems to block artificial channels that drain water from or divert polluted water to the wetland;
- Concrete and gabion weirs to act as settling ponds, to reduce flow velocity or to re-disperse water across former wetland areas thereby re-establishing natural flow paths;
- Earth or gabion structure plugs to raise channel floors and reduce water velocity;
- Concrete or gabion structures to stabilise head-cut or other erosion and prevent gullies; and
- Gabion structures (mattresses, blankets or baskets) to provide a platform for the growth of desired wetland vegetation.

Soft engineering interventions also offer successful rehabilitation methods, and the following are often used together with the hard engineering interventions:

- The revegetation of stabilised areas with appropriate wetland and riparian plant species;
- The fencing off of sensitive areas within the wetland to keep grazers out and to allow for the re-establishment of vegetation;
- The use of biodegradable or natural soil retention systems such as eco-logs, plant plugs, grass or hay bales, and brush-packing techniques;
- In some instances, the use of appropriate fire management and burning regimes. The removal of undesirable plant and animal species; and

- Alien invasive plant clearing, which is an important part of wetland rehabilitation (and this is supported by the Working for Water Programme).

6. Programme, projects and phases

In order to manage the **WfWetlands Programme**, wetlands have been grouped into "projects", and each **Wetland Project** encompasses several smaller wetland systems which are each divided into smaller, more manageable and homogenous wetland units. A Wetland Project may be located within one or more quaternary catchments within a Province. SANBI is currently managing 35 Wetland Projects countrywide, and rehabilitation activities range from stabilising degradation to the more ambitious restoration of wetlands to their original conditions.

Each Wetland Project is managed in three phases over a two-year cycle as shown in the flow diagram in Plate C. The first two phases straddle the first year of the cycle and involve planning, identification, design and authorisation of interventions. The third phase is implementation, which takes place during the second year.

The first phase is the identification of suitable wetlands which require intervention. The purpose of Phase 1 and the associated reporting is to identify:

- Priority catchments and associated wetlands/ sites within which rehabilitation work needs to be undertaken; and
- Key stakeholders who will provide meaningful input into the planning phases and wetland selection processes, and who will review and comment on the rehabilitation proposals.

The **Project Team** currently comprises the SANBI Programme Manager who oversees the WfWetlands Programme and Provincial Coordinators (PCs) who oversee the identification and implementation of projects in their regions. They are supported by a small team based at the Pretoria Botanical Gardens who fulfil various roles such as planning, monitoring and evaluation, implementation, Geographical Information Systems (GIS) and training. Independent Design Engineers and Environmental Assessment Practitioners (EAPs) are appointed to undertake the planning, design and authorisation components of the project. The project team is assisted by a number of wetland ecologists who provide scientific insight into the operation of wetlands and bring expert and often local knowledge to the project teams.

The programme makes use of external support to implement its work. External implementing agents are currently employed and some are Section 21 companies. Implementers are responsible for employing contractors and their teams (workers), and ensuring that rehabilitation plans are adequately implemented. Funds are transferred from SANBI to the implementing agents, who in turn pay contractors and their teams.

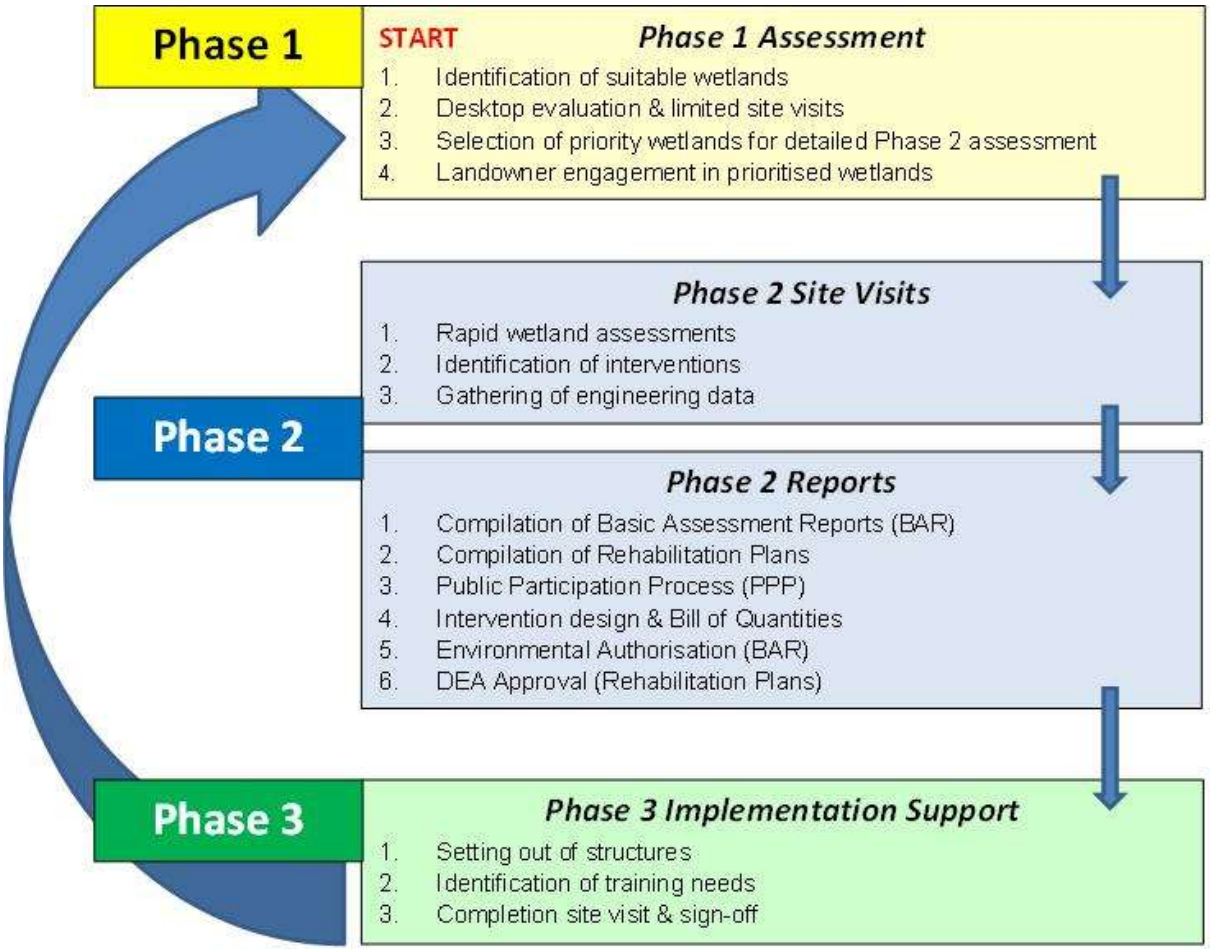

Plate C: The Working for Wetlands planning process (Phase 1 to Phase 3).

Phase 1 commences with a catchment and wetland prioritisation process for every province. The wetland ecologist responsible for a particular province undertakes a desktop study to determine the most suitable wetlands for the WfWetlands rehabilitation efforts. The involvement of Provincial Wetland Forums and other key stakeholders is a critical component of the wetland identification processes since these stakeholders are representative of diverse groups with shared interests (e.g. from government institutions to amateur ecological enthusiasts). This phase also involves initial communication with local land-owners and other Interested and Affected Parties (I&APs) to gauge the social benefits of the work. Aerial surveys of the areas in question may be undertaken, as well as limited fieldwork investigations or site visits to confirm the inclusion of certain wetland projects or units. Once wetlands have been prioritised and agreed on by the various parties, specific rehabilitation objectives are determined for each wetland following a rapid wetland status quo assessment undertaken by the wetland ecologist.

Phase 2 requires site visits attended by the fieldwork team comprising a wetland ecologist, a Design Engineer, an Environmental Assessment practitioner, and a SANBI Provincial Coordinator. Other interested stakeholders or authorities, landowners and in some instances the implementing agents may also attend the site visits on some occasions. This allows for a highly collaborative approach, as options are discussed by experts from different scientific disciplines, as well as local inhabitants with deep anecdotal knowledge. While on site, rehabilitation opportunities are investigated. The details of the proposed interventions are discussed, some survey work is undertaken by the engineers, and GPS coordinates and digital photographs are taken for record purposes. Furthermore, appropriate dimensions of the locations are recorded in order to design and calculate quantities for the interventions. At the end of the site visit the rehabilitation objectives together with the location layout of the proposed interventions are agreed upon by the project team.

During Phase 2, monitoring systems are put in place to support the continuous evaluation of the interventions. The systems monitor both the environmental and social benefits of the interventions. As part of the Phase 2 site visit, a maintenance inventory of any existing interventions that are damaged and/or failing and thus requiring maintenance is compiled by the PC, in consultation with the Design Engineer.

Based on certain criteria and data measurements (water volumes, flow rates, and soil types); the availability of materials such as rock; labour intensive targets; maintenance requirements etc., the interventions are then designed. Bills of quantity are calculated for the designs and cost estimates made. Maintenance requirements for existing interventions in the assessed wetlands are similarly detailed and the costs calculated. The Design Engineer also reviews and, if necessary, adjusts any previously planned interventions that are included into the historical Rehabilitation Plans.

Phase 2 also comprises a reporting component where Rehabilitation Plans are prepared for each Wetland Project. The Rehabilitation Plans include details of each intervention to be implemented, preliminary construction drawings and all necessary documentation required by applicable legislation. The Rehabilitation Plans are reviewed by various government departments, stakeholders and the general public before a specific subset of interventions are selected for implementation.

Phase 3 requires that certain Environmental Authorisations are obtained before work can commence in the wetlands (please see subsequent sections of this document for detail on Environmental Authorisations). Upon approval of the wetland Rehabilitation Plans by DEA, DWA, and the directly affected landowners is obtained, the work detailed for the project will be implemented within a year with on-going monitoring being undertaken thereafter. The Rehabilitation Plans are considered to be the primary working document for the implementation of the project via the construction/ undertaking of interventions[2] listed in the Plan.

It is typically at this point in the process when the final construction drawings are issued to the Implementing Agents (IAs). Seventeen Implementing Agents are currently employed in the WfWetlands Programme and are responsible for employing contractors and their teams (workers) to construct the interventions detailed in each of the Rehabilitation Plans. For all interventions that are based on engineering designs (typically hard engineered interventions), the Design Engineer is required to visit the site before construction commences to ensure that the original design is still appropriate in the dynamic and ever-changing wetland system. The Design Engineer will assist the IAs in pegging and setting-out interventions. The setting-out activities often coincide with the Phase 1 activities for the next planning cycle. Phase 3 concludes with the construction of the interventions, but there is an on-going monitoring and auditing process that ensures the quality of interventions, the rectification of any problems, and the feedback to the design team regarding lessons learnt.

[2] This could include soft options such as alien clearing, eco-logs, gabion structures as well as hard structures for example weirs.

Rehabilitation work within floodplain systems

Based on lessons learnt and project team discussions held during the National Prioritisation workshop in November 2010 SANBI took an in-principle decision regarding work within floodplain systems.

Recognising the ecosystem services provided by floodplain wetlands and the extent to which they have been transformed, SANBI do not intend to stop undertaking rehabilitation work in floodplains entirely. Instead, SANBI propose to adopt an approach to the rehabilitation of floodplain areas that takes into account the following guiding principles:

1. As a general rule, avoid constructing hard interventions within an active floodplain channel; and rather
2. Explore rehabilitation opportunities on the floodplain surface using smaller (possibly more) softer engineering options outside of the main channel.

When rehabilitation within a floodplain setting is being contemplated, it will be necessary to allocate additional planning resources, including the necessary specialist expertise towards ensuring an adequate understanding of the system and appropriate design of the interventions.

7. Environmental legislation

One of the core purposes of the WfWetlands Programme is the preservation of South Africa's valuable wetland systems through rehabilitation and restoration. The WfWetlands Programme operates within the context of the Constitution of South Africa, Act No. 108 of 1996, whereby everyone has the right to have the environment protected and conserved for the benefit of present and future generations. The following legislation (listed in **Table A**) informs and guides the WfWetlands Programme in terms of its vision and objectives, whilst simultaneously regulating the wetland rehabilitation activities which WfWetlands carries out.

South Africa has rigorous and comprehensive environmental legislation aimed at preventing degradation of the environment, including damage to wetland systems. Development proposals within or near any wetland system are subject to thorough bio-physical and socio-economic assessment as mandatory processes of related legislation. These processes are required to prevent degradation of the environment and to ensure sustainable and environmentally conscientious development.

The WfWetlands Programme requires that both hard and soft interventions are implemented in the wetland system, and it is the activities associated with the construction of these interventions that triggers requirements for various authorisations, licenses or permits. However, it is important to note that the very objective of the WfWetlands Programme is to improve both environmental and social circumstances. The WfWetlands Programme gives effect to a range of policy objectives of environmental legislation, and also honours South Africa's commitments under several international agreements, especially the Ramsar Convention on Wetlands.

Memorandum of Understanding for Working for Wetlands Programme

A Memorandum of Understanding (MOU) has been entered into between the DAFF, DEA, DWA and SANBI for the WfWetlands Programme. Through co-operative governance and partnerships, this MOU aims to streamline the authorisation processes required by the National Environmental Management Act, No. 107 of 1998, the National Water Act. No. 36 of 1998, and the National Heritage Resources Act, No. 25 of 1999 to facilitate efficient processing of applications for authorisation of wetland rehabilitation activities.

Table A: List of applicable legislation

Title of legislation, policy or guideline:	Administering authority:	Date:
The Constitution of South Africa, Act No.108 of 1996	National Government	1996
National Environmental Management Act, No.107 of 1998	Department of Environmental Affairs	1998
The National Water Act, No. 36 of 1998	Department of Water Affairs	1998
Conservation of Agricultural Resources Act, No. 43 of 1983	Department of Agriculture, Forestry & Fisheries	1983
National Heritage Resources Act, No. 25 of 1999	National Heritage Resources Agency	1999
World Heritage Conventions Act, No. 49 of 1999	Department of Environmental Affairs	1999
The National Environmental Management: Biodiversity Act, No. 10 of 2004	Department of Environmental Affairs	2004
National Environmental Management: Protected Areas Act, No. 57 of 2003	Department of Environmental Affairs	2003
The Mountain Catchments Areas Act, No. 63 of 1970	Department of Water Affairs	1970
• EIA Guideline Series, in particular: • Guideline 3 – General Guide to the Environmental Impact Assessment Regulations, 2006 (DEAT 2006) • Guideline 4 – Public Participation in support of the EIA regulations, 2006 (DEAT 2006) • Guideline 5 – Assessment of Alternatives and Impacts, 2006 (DEAT 2006) • Implementation Guidelines: Sector Guidelines for the EIA Regulations (draft) (DEA, 2010). • DEA&DP. 2013. Guideline on Public Participation (DEA&DP, March 2013). • DEA&DP. 2013. Guideline on Alternatives (DEA&DP, March 2013).	Department of Environmental Affairs	2006 - 2013
International Conventions, in particular: • The Ramsar Convention • Convention on Biological Diversity • United Nations Conventions to Combat Desertification • New Partnership for Africa's Development (NEPAD) • The World Summit on Sustainable Development (WSSD)	International Conventions	N/A

Of particular relevance in **Table A** is the following legislation and the WfWetlands Programme has put systems in place to achieve compliance:

- The National Environmental Management Act, No. 107 of 1998 (NEMA)

- In terms of Regulations pursuant to the NEMA, certain activities that may have a detrimental impact on the environment (termed Listed Activities) require an Environmental Authorisation from the Department of Environmental Affairs (DEA). The implementation of interventions will trigger NEMA Listing Notices 1 and 3 (G.N. R544 and G.N R546 respectively). In order to meet the requirements of these Regulations, it is necessary to undertake a Basic Assessment Process and apply for an EA. This was previously undertaken on an annual basis per Province as the Wetland Projects became known. However as from 2014, an application is now made per Province for Wetland Projects required in the next few planning cycles (anywhere from one to three planning cycles depending on the information gained through the Catchment Prioritisation Process).
- **Basic Assessment Reports** (BARs) will be prepared for each Province where work is proposed by the WfWetlands Programme. These BARs will present all Wetland Projects that are proposed in a particular province, together with information regarding the quaternary catchments and the wetlands that have been prioritised for the next few planning cycles (anywhere from one to three planning cycles depending on the information gained through the Catchment Prioritisation Process). The EA's will be inclusive of all Listed Activities that may be triggered and will essentially authorise any typical wetland rehabilitation activities required during the WfWetlands Programme implementation phase.
- A condition of the EA's is that **Rehabilitation Plans** will be prepared every year after sufficient field work has been undertaken in the wetlands that have an EA. These Rehabilitation Plans will be made available to registered Interested and Affected Parties (I&APs) before being submitted to DEA for approval. The Rehabilitation Plans will describe the combination and number of interventions selected to meet the rehabilitation objectives for each Wetland Project, as well as an indication of the approximate location and approximate dimensions (including footprint) of each intervention.

- The National Water Act, No.36 of 1998 (NWA)
  - In terms of Section 39 of the NWA, a General authorisation[3] (GA) has been granted for certain activities that are listed under the NWA that usually require a Water Use License; as long as these activities are undertaken for wetland rehabilitation. These activities include '*impeding or diverting the flow of water in a watercourse*[4]' and '*altering the bed, banks, course or characteristics of a watercourse*[5]' where they are specifically undertaken for the purposes of rehabilitating[6] a wetland for conservation purposes. SANBI are required to register the 'water use' in terms of the GA.
- The National Heritage Resources Act, No. 25 of 1999 (NHRA)
  - In terms of Section 38 of the NHRA; any person who intends to undertake a development as categorised in the NHRA must at the very earliest stages of initiating the development notify the responsible heritage resources authority, namely the South African Heritage Resources Agency (SAHRA) or the relevant provincial heritage agency. These agencies would in turn indicate whether or not a full Heritage Impact Assessment (HIA) would need to be undertaken. Should a permit be required for the damaging or removal of specific heritage resources, a separate application will be submitted to SAHRA or the relevant provincial heritage agency for the approval of such an activity. SANBI has engaged with SAHRA regarding the wetland planning process and has committed to achieving full compliance with the heritage act over the next few years.

[3]Government Notice No. 1198, 18 December 2009
[4]Section 21(c) of the NWA, No. 36 of 1998
[5]Section 21(i) of the NWA, No. 36 of 1998
[6]Defined in the NWA as "*the process of reinstating natural ecological driving forces within part of the whole of a degraded watercourse to recover former or desired ecosystem structure, function, biotic composition and associated ecosystem services*"

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i. CONTEXT OF THE INFORMATION CONTAINED IN THIS REHABILITATION PLAN

Approach to the NEMA Environmental Process

The legislation protecting the environment in South Africa was not written with the intention of preventing wetland rehabilitation efforts, but rather at curtailing development in sensitive environments. It is important to remember that the WfWetlands Programme is not a development proposal, and although this programme technically requires authorisations, licenses and permits, such rehabilitation projects were never meant to be sent through legislative processes aimed at preventing negative environmental impact.

In terms of the environmental management principles of the National Environmental Management Act, No. 107 of 1998 (NEMA), certain activities that may have a detrimental impact on the environment (termed Listed Activities) require Environmental Authorisation (EA) from the Department of Environmental Affairs (DEA). The WfWetlands Programme will require that interventions be implemented and/or constructed in the wetland systems to ultimately restore some of the more natural wetland functions that have been lost to unsustainable land use practices or development. The implementation of certain interventions triggers Listing Notices 1 and 3 (G.N. R544 and G.N R546 respectively).

In order to meet the requirements of the Regulations pursuant to NEMA, it was necessary to undertake a Basic Assessment Process. Basic Assessment Report (BARs) were prepared and these reports presented all Wetland Projects for each Province, together with information regarding the quaternary catchments and the wetlands that were prioritised for the next few planning cycles (anywhere from one to three planning cycles depending on the information gained through the Catchment Prioritisation Process).

The EA that has been applied for will be inclusive of all Listed Activities that may be triggered whilst implementing the wetland rehabilitation interventions. Essentially this EA would authorise any typical wetland rehabilitation activities on condition that the specific intervention proposals are submitted in a Rehabilitation Plan to DEA for approval.

The Rehabilitation Plans for each Wetland Project will be prepared annually after sufficient field work and stakeholder consultation has been undertaken in the wetlands that have an EA. These Rehabilitation Plans will be submitted to DEA for approval as a condition of the EA for the respective Provincial BAR.

ii. CONTACT DETAILS

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iii. ABBREVIATIONS

BAR	Basic Assessment Report
BGIS	Biodiversity Geographical Information System
BMP	Best Management Practise
CARA	Conservation of Agricultural Resources Act
CEMP	Construction Environmental Management Programme
CPP	Catchment Prioritisation Process
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
EA	Environmental Authorisation in terms of the NEMA
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EPWP	Expanded Public Works Programme
GA	General authorisation in terms of the NWA
GIS	Geographical Information System
HIA	Heritage Impact Assessment
IA	Implementing Agent
I&APs	Interested and Affected Parties
IDP	Integrated Development Plans
M&E	Monitoring and Evaluation
MAP	Mean Annual Precipitation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Area
NHRA	National Heritage Resources Act
NWA	National Water Act
NWI	National Wetlands Inventory
PC	Provincial Coordinator
PET	Potential Evapotranspiration
PIP	Project Implementation Plan
PPP	Public Participation Process
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SMME	Small, Medium and Micro Enterprises
WfWetlands	Working for Wetlands

iv. GLOSSARY OF TERMS

Bedrock: The solid rock that underlies unconsolidated material, such as soil, sand, clay, or gravel (Wetland Management Series: WET-Origins, WRC Report TT 334/08, March 2008).

Basic Assessment Report (BAR): A report as described in regulation 23 of the EIA regulation, 2006 that describes the proposed activities and their potential impacts.

Best Management Practice (BMP): Procedures and guidelines to ensure the effective and appropriate implementation of wetland rehabilitation by WfWetlands implementers.

Biophysical: The biological and physical components of the environment (Wetland Management Series: WET-Origins, WRC Report TT 334/08, March 2008).

Catchment: All the land area from mountaintop to seashore which is drained by a single river and its tributaries. Each catchment in South Africa has been subdivided into secondary catchments, which in turn have been divided into tertiary catchments. Finally, all tertiary catchments have been divided into interconnected quaternary catchments. A total of 1946 quaternary catchments have been identified for South Africa. These subdivided catchments provide the main basis on which catchments are subdivided for integrated catchment planning and management (consult DWAF [1994]) (Wetland Management Series: WET-Origins, WRC Report TT 334/08, March 2008).

Environmental Assessment Practitioner (EAP): The individual responsible for the planning, management and coordination of the environmental impact assessments, strategic environmental assessments, environmental management plans and/or other appropriate environmental instruments introduced through regulations of NEMA.

Eco-log: A cylindrical wire mesh sleeve filled with organic material and/or soil used to prevent and/or repair minor erosion.

Ecosystem Services or 'eco services': The services such as sediment trapping or water supply, supplied by an ecosystem (in this case a wetland ecosystem).

Environmental Impact Assessment (EIA): A study of the environmental consequences of a proposed course of action via the process of collecting, organising, analysing, interpreting and communicating information that is relevant to the consideration of that application.

Environmental Management Plan (EMP): Details the methods and procedures for achieving environmental targets and objectives.

Gabion: A structure made of wire mesh baskets filled with regularly sized stones, and used to prevent and/or repair erosion. They are flexible and permeable structures which allow water to filter through them. Vegetation and other biota can also establish in/around the habitat they create.

Interested and Affected Parties (I&APs): People and organizations that have interest(s) in the proposed activities.

Environmental Impact: An environmental change caused by some human act.

Implementer: The person or organisation responsible for the construction of WfWetlands rehabilitation interventions.

Intervention: An engineered structure such as a concrete or gabion weir, earthworks or revegetation that that achieves identified objectives within a wetland e.g. raising of the water table within a drainage canal.

Mitigation: Actions to reduce the impact of a particular activity.

Maintenance: The replacement, repair or the reconstruction of an existing structure within the same footprint, in the same location, having the same capacity and performing the same function as the previous structure ('like for like').

Public Participation Process (PPP): A process of involving the public in order to identify issues and concerns, and obtain feedback on options and impacts associated with a proposed project, programme or development. Public Participation Process in terms of NEMA refers to: a process in which potential interested and affected parties are given an opportunity to comment on, or raise issues relevant to specific project matters.

Project: An area of WfWetlands intervention generally defined by a quaternary catchment or similar management unit such as a national park in which a single implementer operates.

Quaternary Catchment: All land area drained by a fourth order tributary river and its tributaries.

Rehabilitation: Refers to re-instating the driving ecological forces (including hydrological, geomorphological and biological processes) that underlie a wetland, so as to improve the wetland's health and the ecological services that it delivers.

Rehabilitation: Restoring processes and characteristics that are sympathetic to and not conflicting with the natural dynamic of an ecological or physical system (Wetland Management Series: WET-Origins, WRC Report TT 334/08, March 2008).

Significant impact: An impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Weir: A dam-type structure placed across a watercourse to raise the water table of the surrounding ground and trap sediment on the upstream face without preventing water flow. Weirs are generally used to prevent erosion from progressing up exposed gullies.

Wetland: "Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soils." (SA Water Act of1998) **and** "Land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants living there" (Wetland Management Series: WET-Origins, WRC Report TT 334/08, March 2008).

v. ASSUMPTIONS AND LIMITATIONS

In compiling this report, the following has been assumed:

- The information provided in this report is based on site visits that have been undertaken by the project team (EAP, Engineer, Wetland Ecologist, and SANBI PC) and their subsequent input into the Reporting, which includes intervention design drawings, the wetland status quo assessment, in addition to input from SANBI's PC. It is understood that this information is sufficient for the authorisation processes and associated Phase 3 (Implementation phase). This data and relevant information has informed the findings and conclusions of this report.
- Information contained in this Report will be used during Phase 3 to guide and inform the Implementing Agents on design and construction specifications as part of Phase 3. Implementing Agents will thus use this Rehabilitation Plan and the information contained herein when constructing all interventions, the designs of which have been included in this Report.
- SANBI's PCs will be undertaking the landowner engagement and have obtained the requisite landowner consent forms required as part of Phase 1 and 2 of this project. These include:
  - WW(0): Standard operating procedure,
  - WW(1): Wetland survey and Inspection consent,
  - WW(2): Terms and Conditions for carrying out wetland rehabilitation,
  - WW(3): Wetland Rehabilitation Activities Consent, and
  - WW(4): Property Inspection Prior to Wetland Rehabilitation.
- SANBI have provided all relevant information and documentation required to compile this Rehabilitation Plan.
- Rehabilitation activities should not be carried out until the Wetland Rehabilitation Plan has been approved by DEA and formally signed off by SANBI.
- The implementation of this Rehabilitation Plan must take into account all relevant provisions of Working for Wetlands Best Management Practices (BMPs) and Construction Environmental Management Plan (CEMP), the recommendations of the Basic Assessments and the requirements of the Environmental Authorisation (EA) for the project.
- DEA's prerequisite to increase the requirement of percentage of funding to be spent on labour within the Working for Wetlands (WfWet) programme, has been taken into consideration by the project team during the planning process for wetland rehabilitation.
- Due to the dynamic nature of site conditions and associated biophysical changes within wetlands, this wetland Rehabilitation Plan is only valid for the 2013/14 financial year. Where appropriate interventions have not been implemented previously or included in the 2009/10, 2010/11, 2011/12, 2012/2013 and 2013/14 Project Implementation Plans (PIPs), these have been reviewed and where necessary re-designed for inclusion into the 2014/15 wetland Rehabilitation Plan. This wetland Rehabilitation Plan therefore supersedes all previous plans for this project and only interventions from this plan should be included in the 2014/15 PIP.

- Should it be necessary to exclude interventions from the Rehabilitation Plan, the prioritisation of interventions across the project should strictly be followed.

vi. GAPS IN KNOWLEDGE

- The information in this Report is based on existing available information and input from SANBI's PC, the specialist wetland ecologists, the Engineer, the EAP as well as comments from Interested and Affected Parties (I&APs). Until this Report has been finalised and signed off by SANBI, the content of the Report should be considered as preliminary.
- Designs for the rehabilitation interventions have been developed for site conditions as at the time of the planning site visits. Should site conditions change before the designs are implemented, changes to the design may be necessary. In this case, project implementers may require the assistance of a professional engineer.
- The cost of construction at each project location will vary due to factors such as the local cost and availability of material, transport distances etc. The unit costs have been agreed with SANBI's PCs based on their knowledge of past projects and therefore include an allowance for escalation.
- The labour intensive targets identified in this project are based on assumed productivity rates for various components of the construction process. This will vary in practise and will require regular monitoring to ensure that labour targets are attained.

Aurecon acknowledges the authorship of any information contained in this document from previous planning years, to the previous provider: Land Resources International (LRI).

This Report must be read in conjunction with the following reports for this project:

1. Phase 1 Report – October 2013; and
2. Other Phase 2 Planning Reports which include the:
    a. Basic Assessment Report (2014),
    b. KZN North Rehabilitation Plan (February 2013), and the
    c. Wetland Reports (2014) (**Appendix A** of this report).

vii. DISCLAIMER

- This Rehabilitation Plan is for the KZN North Wetland Project in the KwaZulu-Natal Province. The plan is to be used to implement the interventions identified as necessary to rehabilitate the KZN North wetlands, and is to be approved by the Department of Environmental Affairs (DEA) as part of the conditions of Environmental Authorisation (EA).
- The intervention points and wetland boundary polygons provided in this report are based on the shapefiles that have been provided by the South African National Biodiversity Institute (SANBI). The datasets included in the Phase 1 Reports have been updated by the Wetland ecologists and verified by the SANBI Provincial Co-ordinators (PCs). All reasonable efforts have therefore been made to ensure that the data is accurate. However Aurecon South Africa (Pty) Ltd (Aurecon) does not accept responsibility for any remaining inaccuracies in the spatial data provided to us, which may be reflected in this report.
- Aurecon accepts responsibility for the engineering design to the extent that this is based on available information. The available information is limited to what could be interpreted during a single site visit of no longer than a few hours. No geotechnical, topographical, geomorphologic and other engineering related surveys have been undertaken to inform the design. This is non-standard engineering practice and therefore Aurecon is indemnified by the Client and does not accept responsibility for the associated risk of failure from the above limitations or any damages that may occur.
- This Rehabilitation Plan must not be amended without prior consultation and approval from DEA, the responsible Aurecon Environmental Assessment Practitioner (EAP), Engineer, SANBI PC and the SANBI Planning, Evaluation and Monitoring Manager.
- All changes must be motivated using the standard change request form supplemented with additional information as necessary.
- Aurecon is indemnified against any associated damages and accepts no liability associated with the construction and implementation of engineering interventions due to Aurecon being instructed to have limited contact with the implementer during the construction phase resulting in our inability to diligently supervise and assess any progress.
- The Client confirms that by accepting these drawings or reports, he acknowledges and accepts the abovementioned limitation of Aurecon's liability.

viii. DISTRIBUTION LIST

NAME	TITLE	FOR ACTION	FOR INFORMATION	RECEIVED PRIOR TO RELEASE
PROPONENT				
Umesh Bahadur	Programme Manager: Working for Wetlands		✓	
Eric Munzhedzi	Implementation Manager		✓	
Mbali Kubheka	SANBI Provincial coordinator	✓		✓
NATIONAL STAKEHOLDERS				
Refer to **Appendix G**			✓(E-copy of Rehab Plan)	
PROVINCIAL STAKEHOLDERS & I&APs				
Refer to **Appendix H**			✓(E-mail notification)	
LANDOWNERS				
Refer to **Appendix E**			✓(E-copy of Rehab Plan)	

1. INTRODUCTION

1.1 Working for Wetlands programme overview

The Working for Wetlands (WfWetlands) Programme is a government programme (similar to Working for Water, Working on Fire and Working on Land) managed by the South African National Biodiversity Institute (SANBI) on behalf of the national government departments of Environmental Affairs (DEA), Water Affairs (DWA), and Agriculture, Forestry and Fisheries (DAFF), and forms part of the Expanded Public Works Programme (EPWP).

The vision of the WfWetlands Programme is to facilitate the protection, conservation, rehabilitation and sustainable use of wetlands in South Africa, in accordance with national policies and commitment to international conventions and regional relationships. The two main objectives of the programme are **wetland conservation** in South Africa and **poverty reduction** through job creation and skills development amongst vulnerable and marginalised groups.

The WfWetlands Programme forms part of the EPWP which seeks to draw significant numbers of unemployed into the productive sector of the economy. These individuals gain skills while they work thus increasing their capacity to earn an income. Rehabilitation efforts are thus focused on wetland conservation and the appropriate use of wetlands in a way that attempts to maximise employment creation, support for small business and the transfer of skills to the unemployed and poor.

In the 12 years since its inception, the WfWetlands Programme has invested R530 million in wetland rehabilitation and has been involved in over 900 wetlands, thereby improving or securing the health of over 70 000 hectares of wetland environment. The WfWetlands Programme has created more than 12 800 jobs and 2.2 million person-days of paid work. Local people are recruited to work and targets for employment specify that the programme's workforce should comprise at least 60% women, 20% youth and 1% people with disabilities.

1.1.1 Programme, projects and phases

In order to manage the WfWetlands Programme, wetlands that have been prioritised and identified for rehabilitation have been grouped into "Wetland Projects" within each Province. Each Wetland Project encompasses several wetland systems which are each divided into smaller, more manageable and homogenous wetland units. As a result a Wetland Project may be located within one or more quaternary catchments within a Province.

Each Project is managed in three phases over a two-year cycle. The first two phases (Phase 1 and Phase 2) straddle the first year of the cycle and involve planning, identification, design and authorisation of interventions. The third phase (Phase 3) is implementation of specific interventions to achieve rehabilitation, and this takes place during the second year. SANBI is currently managing 35 Wetland Projects countrywide, and approximately 500 interventions within these Wetland Projects will be implemented to meet the objectives of the Programme.

1.1.2 Methods of rehabilitation

The successful rehabilitation of a wetland requires that the cause of damage or degradation is addressed, and that the natural flow patterns of the wetland system are re-established (flow is encouraged to disperse rather than to concentrate). The main aims of the WfWetlands Programme are:

- Restoration of hydrological integrity (e.g. raising the general water table or redistributing the water across the wetland area);
- Recreation of wetland habitat towards the conservation of biodiversity;
- Job creation and social upliftment.

Rehabilitation activities range from stabilising degradation to the more ambitious restoration of wetlands to their original conditions. Typical activities within the Wetland Projects include:

- Plugging artificial drainage channels created by development or historical agricultural practices to drain wetland areas for other land use purposes;
- Constructing structures (gabions, berms, and weirs) to divert or redistribute water to more natural flow paths, or to prevent erosion by unnatural flow rates that have resulted from unsustainable land use practices or development; and
- Removing invasive alien or undesirable plant species from wetlands and their immediate catchments as part of the Working for Water Programme.

1.1.3 Intervention options

Methods of wetland rehabilitation may include hard engineering interventions such as:

- Earth berms in conjunction with gabion systems to block artificial channels that drain water from or divert polluted water to the wetland;
- Concrete weirs to act as settling ponds, to reduce flow velocity or to re-disperse water across former wetland areas thereby re-establishing natural flow paths;
- Concrete, earth or gabion structure plugs to raise channel floors and reduce water velocity;
- Concrete or gabion structures to stabilise head-cut or other erosion and prevent gullies; and
- Gabion structures (mattresses, blankets or baskets) to provide a platform for the growth of desired wetland vegetation.

Soft engineering interventions also offer successful rehabilitation methods, and the following are often used together with the hard engineering interventions:

- The revegetation of stabilised areas with appropriate wetland and riparian plant species;
- The fencing off of sensitive areas within the wetland to keep grazers out and to allow for vegetation to become re-established;
- The use of biodegradable or natural soil retention systems such as eco-logs, plant plugs, grass or hay bales, and brush-packing techniques.
- The removal of undesirable plant and animal species as part of the Working for Water

initiative. Alien invasive plant clearing is an important part of wetland rehabilitation; and

- In some instances, the use of appropriate fire management and burning regimes.

For more information on the WfWetlands Programme, please refer to the WfWetlands Context Document included in the front of this report.

1.2 Project team

The project team currently comprises the SANBI Programme Manager who oversees the WfWetlands Programme and Provincial Coordinators (PCs) who oversee the identification and implementation of projects in their regions. They are supported by a small team based at the Pretoria Botanical Gardens who fulfil various roles such as finance, Geographical Information Systems (GIS) and training.

Aurecon South Africa (Pty) Ltd (Aurecon) has been appointed to undertake the project activities and associated reporting required by the WfWetlands Programme. The Aurecon team comprises Design Engineers and Environmental Assessment Practitioners (EAPs) who undertake the planning, design and authorisation components of the project. The Aurecon Team is assisted by an external team of Wetland Ecologists who provide scientific insight into the operation of wetlands and bring expert and often local knowledge of the wetlands. The project team is also complimented by the SANBI Provincial Coordinators (PCs) who are each responsible for provincial planning and implementation.

1.3 KwaZulu-Natal Wetland Projects

Wetland Projects for the 2014/2015 planning cycle were identified during the Phase 1 activities associated with the WfWetlands Programme. Catchment and wetland prioritisation assessments were undertaken by the wetland ecologist/s to identify priority catchments and associated wetlands within which rehabilitation work needed to be undertaken. A review was undertaken to determine local knowledge and identify existing studies of the quaternary catchments in the province. SANBI's current five year strategic plans were further used as a guide to identify wetlands, as well as data from the National Freshwater Ecosystem Priority Areas (NFEPA) project. Decisions on priority areas were informed by input from wetland forums, biodiversity/ conservation plans, municipalities, state departments and various other stakeholders.

Based on this process, the following quaternary catchments (and associated wetland systems) were identified for the 2014/2015 planning cycle in the KwaZulu-Natal Province (**Table 1**):

Table 1: KwaZulu-Natal Wetland Projects

ID	*Project Name*	*Wetland Number*	*Wetland System*
Ai	KZN North Project	V60B-01	Boschberg Vlei
Aii		V60D-01	Padda Vlei 1
Aiii		V60D-02	Padda Vlei 2
Bi	KZN Upper Mzintlava Project	T32B-05	Ivanhoe
Bii		T32C-04	Penny Park
Biii		T32C-05	Mount Currie
Biv		T32C-07	Ross'
Ci	KZN Maputaland Project	W31L-01	Kleinspan
Cii		W32B-03	Tshanetshe –Mpempe Channel
Di	iSimangaliso Wetland Park Project	W32H-01	iSimangaliso – Eastern Shores
Dii		W32H-02	iSimangaliso – Western Shores
Ei	KZN Midlands Project	U20A-01	Runnymeade (Ivanhoe)

A basic Environmental Impact Assessment (EIA) application was lodged with the National DEA on 4 March 2014 for the undertaking of listed activities in terms of NEMA. The DEA will issue an EA that will permit the WfWetlands Programme to undertake wetland rehabilitation in the above-mentioned wetland systems within the KwaZulu-Natal Province. This Rehabilitation Plan focuses on the KZN North Wetland Project (Ai, Aii and Aiii) and is to be submitted to DEA for their approval as a condition of the EA.

1.3.1 The KZN North Wetland Project

This document comprises the Rehabilitation Plan for the KZN North Wetland Project and includes the following wetland systems: Boschberg Vlei, Padda Vlei 1 and Padda Vlei 2. The Rehabilitation Plan will be the primary working document for the project via the implementation (construction/ undertaking) of interventions[7] required to meet the wetland rehabilitation objectives. The document details the general methodology that has been adopted for the planning of rehabilitation interventions for identified wetlands. Details of the Rehabilitation Planning for each wetland and the selected intervention options (including designs, dimensions and locations) within each wetland are presented, along with baseline Monitoring and Evaluation (M&E) data.

Reports on the current status of the wetland and design drawings are included as **Appendix A** of this report. Upon approval of this Rehabilitation Plan by both DEA and the directly affected landowners, the work detail for the project will be implemented within a year with on-going monitoring being undertaken from thereon.

[7] This could include soft options such as alien clearing, eco-logs, gabion structures as well as hard structures, for example weirs.

1.4 Project Scope

The scope of this Wetland Project is detailed in the **Table 2** below:

Table 2: Project Scope

Quaternary Catchments	**V60B and V60D**	
Quaternary Catchment areas (Ha)	V60B	55 163.77 Ha
	V60D	30 788.1 Ha
Number of wetlands identified during the assessment	3	
Extension of existing work (previous financial year)	No	
Work to commence at new wetlands in 2014/ 2015	Yes	
Available budget for new interventions	R2 018 082.00 (V60B: R1 254 408.50) (V60D: R763 673.50)	
Estimated cost of new interventions	Total: R 6 215 073.34 (Boschberg Vlei: R 2 880 769.44) (Padda Vlei 1: R 1 584 854.50) (Padda Vlei 2: R 1 749 449.40)	
Estimated cost of maintenance to existing interventions	N/A	

2 GENERAL METHODOLOGY

Each Wetland Project is managed in three phases over a two-year cycle as shown in the flow diagram in **Figure 1** below. The first two phases straddle the first year of the cycle and involve planning, identification, design and authorisation of interventions. The third phase is implementation, which takes place during the second year.

2.1 Landowner consent

The flow diagram **Figure 1** also clearly demonstrates the point at which various consent forms must be approved via signature from the directly affected landowner. SANBI's PCs are responsible for undertaking the necessary landowner engagement and for ensuring that the requisite landowner consent forms required as part of Phase 1 and 2 of this project are signed. These include:

- WW(0): Standard operating procedure
- WW(1): Wetland survey and Inspection consent,
- WW(2): Terms and Conditions for carrying out wetland rehabilitation,
- WW(3): Wetland Rehabilitation Activities Consent,
- WW(4): Property Inspection Prior to Wetland Rehabilitation, and
- WW(5): Notification of Completion of Rehabilitation.

Refer to **Appendix E** for a copy of the landowner agreements.

2.2 Phase 1

The wetland ecologist responsible for the KwaZulu-Natal Province undertook a desktop study to determine the most suitable wetlands for the WfWetlands rehabilitation efforts. The involvement of Provincial Wetland Forums and other key stakeholders was a critical component of the wetland identification processes since these stakeholders are representative of diverse groups with shared interests (e.g. from government institutions to amateur ecological enthusiasts). This phase also involved initial communication with local land-owners and other Interested and Affected Parties (I&APs) to gauge the social benefits of the work. An aerial survey flight of the Padda Vlei, Blood River and Aloeboom wetlands was undertaken with the Bateleurs (Pilot William O'Driscol) in April 2009. Desktop prioritisation and site visits were then undertaken to confirm the inclusion of certain wetland projects or units between 2010 and 2013. The following wetlands were prioritised and agreed to by the various parties for the KZN North Wetland Project:

1. Boschberg Vlei
2. Padda Vlei 1
3. Padda Vlei 2

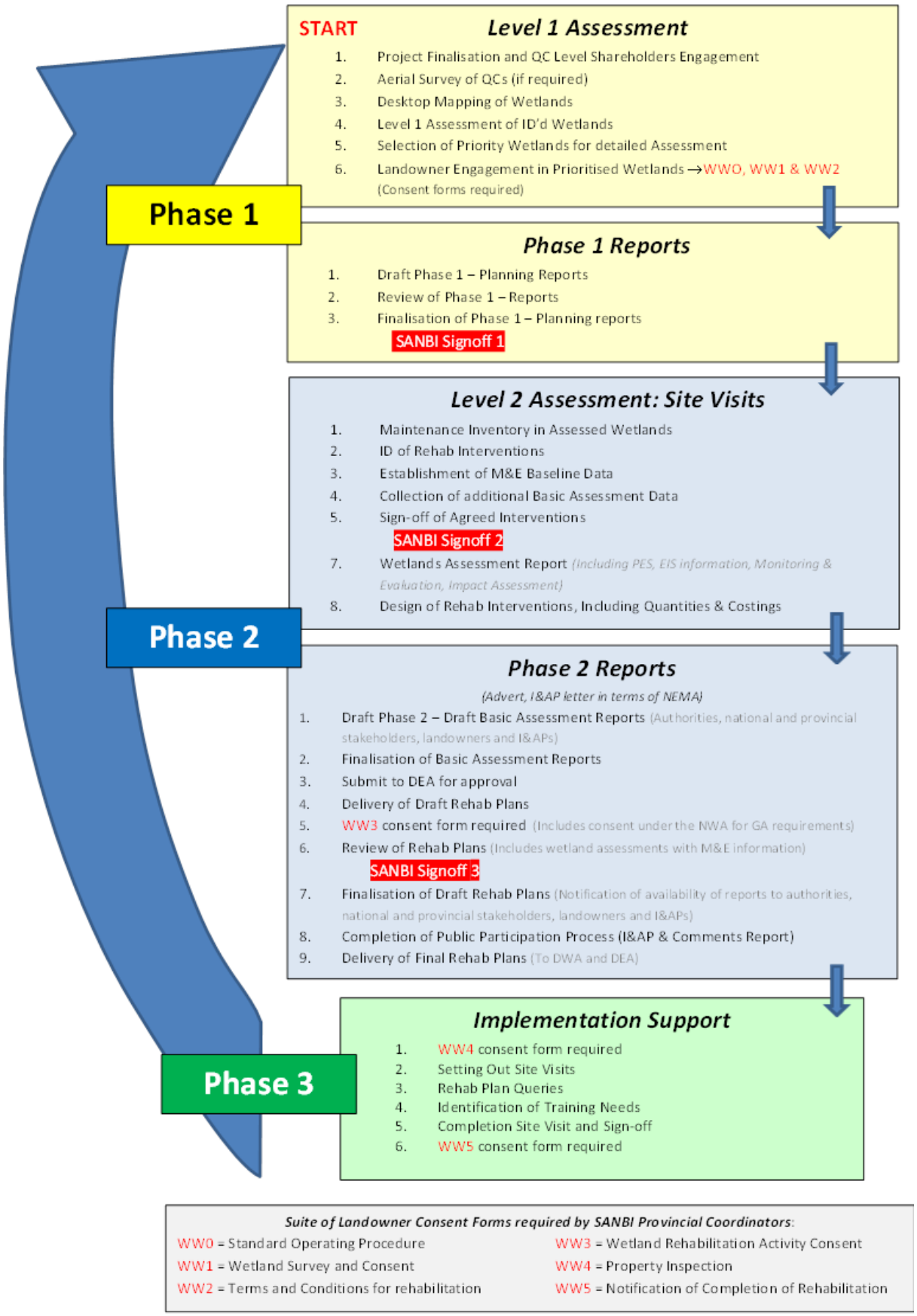

Figure 1: The three phases that must be undertaken for the successful rehabilitation of wetlands

2.3 Phase 2

2.3.1 Site visits

Phase 2 required site visits attended by the fieldwork team comprising a Wetland Ecologist, a Design Engineer, and a SANBI provincial coordinator. Landowners and the implementing agents also attended a number of the site visits on this occasion. This allowed for a highly collaborative approach to be used, as options were discussed by experts from different scientific disciplines, as well as local inhabitants with deep anecdotal knowledge. The following site visits were undertaken for the KZN North Wetland Project:

1. Boschberg Vlei: (12 November 2013)
2. Padda Vlei 1 and 2: (13 November 2013)

The following team members attended the site visits:

- Mbali Kubheka (SANBI PC),
- Doug Macfarlane (Wetland Ecologist),
- Trevor Pike (Engineer),
- Zweli Dlalisa (Implementing Agent's Project Manager).

At the end of the site visit the rehabilitation objectives together with the location layout of the proposed interventions were agreed upon by the project team.

During Phase 2, monitoring systems were put in place to support the continuous evaluation of interventions. The systems monitor both the environmental and social benefits of the interventions. As part of Phase 2 site visit, a maintenance inventory of any existing interventions that were damaged and/or failing and thus requiring maintenance was compiled by the PC, in consultation with the Design Engineer.

2.3.2 Wetland Reports

The time and resources required to determine the current status of the wetlands was generally limited, and thus a rapid procedure was adopted to assist the project team in systematically carrying out the assessments under constraints. The procedure was based on the following steps:

a. Assess impacts and threats

The following steps were used by the wetland ecologist to assess the impacts and threats within each wetland system:

- Describing the hydro-geomorphic setting of the wetland according to Kotze *et al*. (2008);
- Assessing the overall health of the wetland at a Level 2 using WET-Health (Macfarlane *et al*., 2007); and
- Identifying specific impacts and/or threats (based on the wetland status quo assessment) to be addressed by structural rehabilitation and describing in more

detail where necessary. For example, for headcut erosion, the specific dimensions and level of activity of headcuts would be described.

b. Set rehabilitation objectives and choose appropriate measures for achieving the objectives

Rehabilitation objectives were informed by the above assessments (*e.g*., if the primary threat to the wetland was identified as headcut erosion threatening to propagate through the wetland then an appropriate rehabilitation objective would be to halt propagation of the erosion headcut). The engineer was assisted by the wetland ecologist in selecting appropriate interventions to achieve the identified rehabilitation objectives.

c. Assess the likely contribution of rehabilitation interventions to wetland health and ecosystem delivery

An assessment was undertaken of the predicted contribution that the identified rehabilitation interventions will make to improving wetland health and ecosystem delivery by addressing the identified impacts/threats. Without these assessments, a wetland rehabilitation programme is unlikely to have a well-informed basis on which to improve the rehabilitation's "return on investment" (with return being measured in terms of wetland health and ecosystem services delivery). This is directly linked into the *WfWetlands* Monitoring and Evaluation Framework. The following steps were followed to assess the contribution of rehabilitation interventions within each wetland system:

- The spatial area likely to be affected by the proposed intervention/s was identified; and
- The benefits that were likely to result from achievement of the rehabilitation objective/s were determined in terms of the integrity of the affected area of the wetland (using WET-Health) and the ecosystem services that the area delivers (using WET-Ecoservices: Kotze *et al.*, 2008).

The same approach was used for the assessment of the different threats/impacts that would be addressed through rehabilitation. In this instance, the situation without rehabilitation (i.e. no intervention or *status quo*) was compared to the situation with rehabilitation. For health, both situations were scored on a scale of 0 (critically altered) to 10 (pristine), and this was undertaken for the hydrology, geomorphology and vegetation components of health.

The benefit achieved is the improvement in relation to the maximum score. For example, in areas threatened by headcut erosion which are to be rehabilitated by halting the spreading of the headcut, the benefits in terms of health would be determined based on the difference between the current health and the projected health if the headcut proceeded to erode through the threatened area. In such a case, stopping the expansion of the headcut would presumably secure the current situation.

Refer to **Appendix A** which contains the Wetland Reports.

2.3.3 Identification and location of intervention designs

The project teams evaluated the various rehabilitation intervention options available and selected the most appropriate to achieve the rehabilitation objectives for the wetland. Choices of intervention options were also informed by the increased labour component as required by DEA. Any previously planned interventions that had not been implemented or included into the previous planning cycle reports were assessed and included into the current year's selection, if appropriate to the re-assessed rehabilitation objectives for the wetland. Agreed cost/benefit ratios in terms of 'Rands per hectare of rehabilitated wetland' were taken into account, along with operational considerations and larger scale project objectives.

After the appropriate intervention options were selected by the planning team, the engineer, in consultation with the wetland ecologist determined the most appropriate designs and locations for the identified interventions in order to achieve the rehabilitation objectives for the wetland in question. GPS coordinates and digital photographs – sufficiently detailed to clearly identify the selected locations were then taken for record purposes. Appropriate dimensions of the locations were measured in order to be able to design and calculate quantities for the interventions.

a. Intervention naming convention

A new naming convention was introduced in the 2011/2012 planning phase and this has been continued in this years' Rehabilitation Plans.

The **historical naming convention** for interventions is explained below:
A00A-00-000, where

Number	Explanation
A00A	quaternary number
00	wetland number
000	intervention number

The accepted **naming convention** which has been applied to all interventions (old and new) is explained below with examples being provided as well.

A00A-00-000-00 (new),

A00A-00-000-01 (maintenance), where

Number	Explanation		
A00A	quaternary number		
00	wetland number		
200	intervention number with the '**200**' included for differentiation from previous interventions		
00	**New** intervention	**01**	**Maintenance** to intervention

An additional two digits will therefore be added to the end of each of the intervention numbers to indicate maintenance on this specific intervention and/or whether the structure is new (00) for tracking purposes. All new interventions will have a default of 00. Should built structures require maintenance, they would be numbered numerically beginning with '01' e.g. 01, 02, 03, etc. for each year that maintenance is undertaken on the intervention.

In addition, the new naming convention also added a '200' digit in the front of the intervention number to avoid confusion from previously named interventions.

2.3.4 Collection of Monitoring & Evaluation Baseline and Basic Assessments Data

In accordance with WET-Rehab-Evaluate (Cowden & Kotze, 2007) the collection of baseline monitoring information is important to allow for the evaluation of the performance of wetland rehabilitation activities. Monitoring and evaluation facilitate the dissemination of lessons learnt and provide a means of reporting on the success of specific wetland rehabilitation initiatives. The monitoring and evaluation (M&E) of an identified wetland rehabilitation project's performance is therefore considered vital to inform the evaluation of wetland rehabilitation success. Baseline monitoring needs to be carried out prior to the implementation of rehabilitation activities to provide comparable data for monitoring at a later stage, following the wetland rehabilitation.

While the engineer was working on measurement of the intervention locations, the wetland ecologist gathered the additional data required for M&E baselines which included the following:

- Photographs and GPS co-ordinates of the identified problems;
- Fixed-point photography (in accordance with the guidelines outlined in WET-Rehab-Evaluate: Cowden & Kotze, 2007);
- WET-Health information (allowing the comparison of wetland ecological integrity before and after rehabilitation activities); and
- Details relating to the estimated hectare equivalents.

Any additional data/information required for the assessment of the potential impacts of the proposed interventions and construction activities was also collected by the wetland ecologist and the EAP to inform the Basic Assessments.

At the end of the site visit a location layout of the agreed interventions and rehabilitation objectives was signed off by the SANBI PC and landowner, as indicated by SANBI Signoff 2 in **Figure 1.**

2.3.5 Engineering design

The detailed procedure followed by the engineers is described in the Engineering Design Brief, which documents the procedure agreed upon by Aurecon and SANBI. The document also addresses important issues such as risk and liability. A summary of the process followed for the engineering design is described below:

- A hydrological assessment was undertaken to quantify the volume of water expected to be dealt with by the intervention for various recurrence intervals. The results of this assessment allowed the engineer to select a design flow to be applied to the intervention.
- Construction materials were selected based on a range of site specific criteria including expected velocities, availability of materials such as rock, labour intensive targets, maintenance requirements etc.
- Interventions were designed based on the above to meet the objectives for wetland rehabilitation.
- The intervention designs were drafted to show, at a minimum, a plan view, a longitudinal section and front elevation at appropriate scales, and appropriate dimensions. A legend indicating basket sizes was included for gabion structures to improve design clarity for the implementers.
- Bills of quantities were calculated for the designs and cost estimates were made based on unit costs and norms for each project area, as agreed with the SANBI PC.
- Maintenance requirements for existing interventions in the assessed wetlands were similarly detailed and the anticipated costs calculated.

The engineer also reviewed and, if necessary, adjusted any previously planned interventions that are included into the current Rehabilitation Plan.

2.3.6 Development of the Rehabilitation Plan

The standardised Rehabilitation Plan format has been approved by SANBI Programme Manager: Planning, Monitoring and Evaluation.

Summaries of the wetland prioritisation, problems and rehabilitation objectives were documented in the KZN North Rehabilitation Plan. Reports on the current status of the wetland, based on, *inter alia*, the information collected during the implementation of WET-Tools, were prepared by the wetland ecologist, and are included as **Appendix A** to this report.

The KZN North Rehabilitation Plan was submitted to the SANBI PC and wetland ecologist for review before it was made available to stakeholders for comment. Any comments received during the comments period were taken into account in the finalisation of the Rehabilitation Plans.

a. Reporting Format

All relevant information acquired during the assessments and field visits has been included in this document and its appendices in a hierarchy as shown in **Figure 2** below.

- All intervention locations are given in geographical coordinates, (Degrees, Minutes and Seconds), based on the WGS84 datum.
- Mapping was done in Albers Equal Area Conic projection, WGS84 datum. The grids displayed on all maps are geographic and measured in Degrees Minutes and Seconds. The scale bar on each map is based on Albers Equal Area Conic projection and measured in metres.

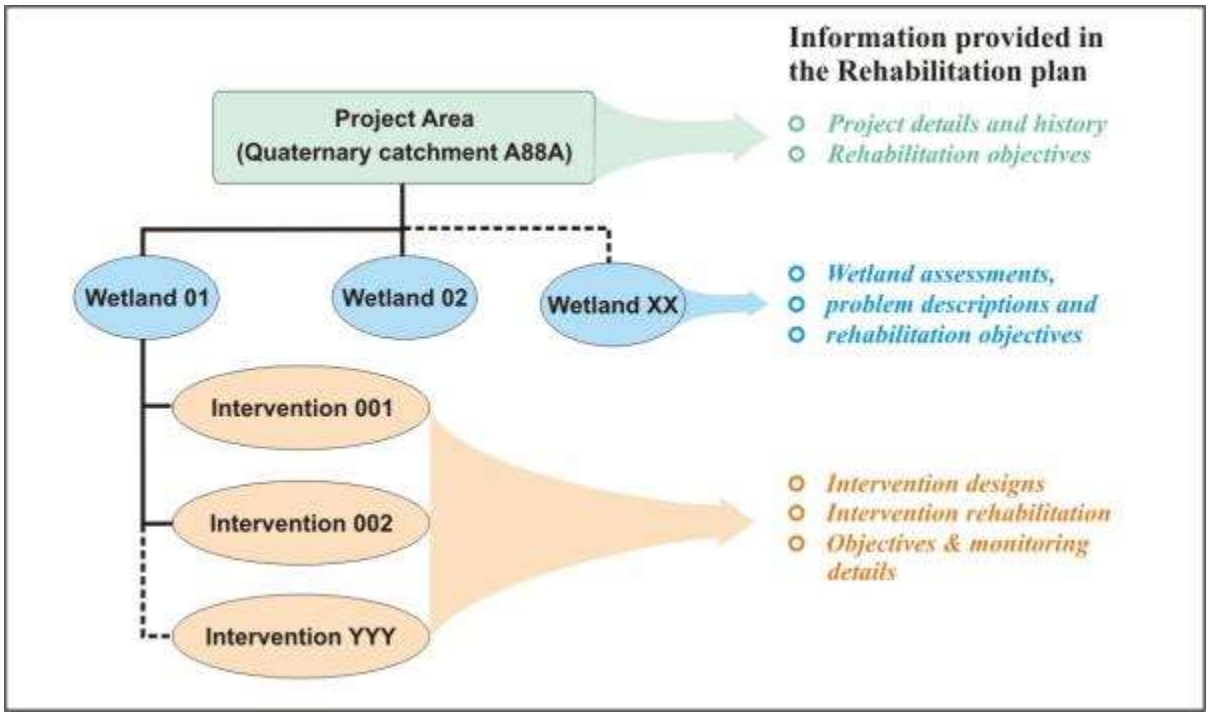

Figure 2: Hierarchy used in the Wetland Rehabilitation Plan

3 PROJECT DESCRIPTION

3.1 Project details

Background: The KZN North Wetland Project focuses on wetlands in the North of KwaZulu-Natal. Wetland rehabilitation has been carried out in this region for a number of years with historic work having been implemented in the Aloeboom and Blood River wetland systems. However, as this rehabilitation work was nearing completion, alternative sites were required in order to continue with the wetland rehabilitation programme in the area. Focus then shifted away from quaternary catchment V32G and into the Padda Vlei wetland system in quaternary catchment V60D near Vryheid. While work is ongoing at the Padda Vlei wetland, several new priority areas for further work were identified in 2013, and this included the Boschberg Vlei system in quaternary catchment V60B near the towns of Wasbank and Elandslaagte (refer **Table 3**).

Table 3: Project details

Project Name	KZN North	
Region (Province)	KwaZulu-Natal	
Planning Category	Boschberg Vlei	Category 2
	Padda Vlei 1 & 2	Category 3
Nearest Town/s	Wasbank and Dundee	
Partnership	N/A	

Current focus area: The KZN North Wetland Project is currently focussed in the V60B and V60D quaternary catchments, within the upper reaches of the Sundays as well as the KwaMahlaba and Wasbank Rivers, respectively (refer **Figure 3** and **Figure 4**). The KwaMahlaba River flows out of the Padda Vlei wetland area and joins the Wasbank River near Glencoe. From there, it flows south past Wasbank before joining the Sundays River and later the Tugela River.

Wetlands selected: The three wetlands within the KZN North Wetland Project that have been identified for rehabilitation efforts for this planning cycle are the Boschberg Vlei (V60B-01), Padda Vlei 1 (V60D-01) and Padda Vlei 2 (V60D-02) (refer **Table 4**).

Table 4: Identified wetlands within the KZN North Wetland Project

Wetland Number	Wetland Name	Latitude	Longitude
V60B-01	Boschberg Vlei	28°15'12.72"S	29°48'22.58"E
V60D-01	Padda Vlei 1	28° 8'51.94"S	30° 1'1.78"E
V60D-02	Padda Vlei 2	28° 8'55.95"S	30° 2'30.46"E

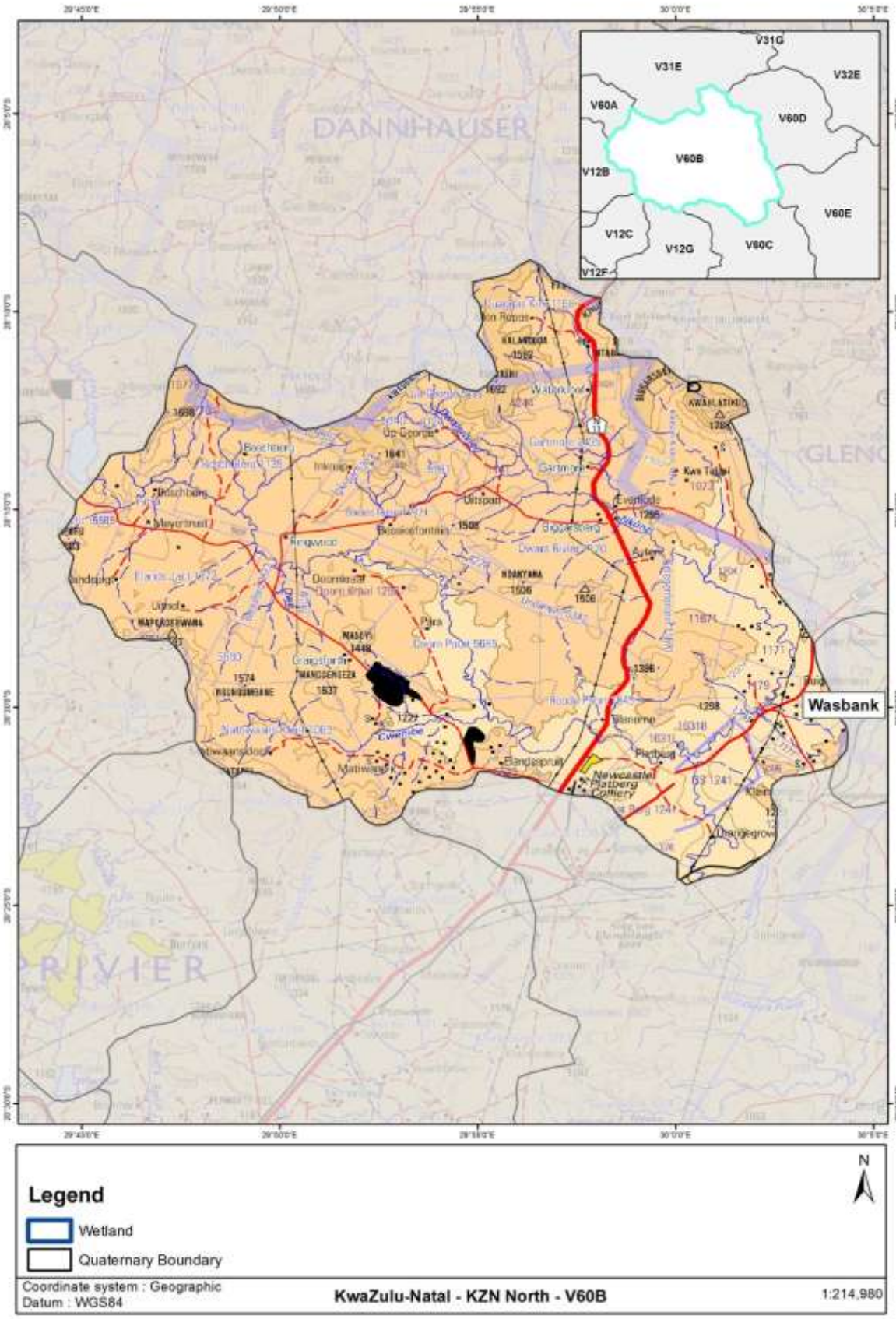

Figure 3: Topographic map showing the location, cadastral boundaries and access routes of quaternary catchment V60B

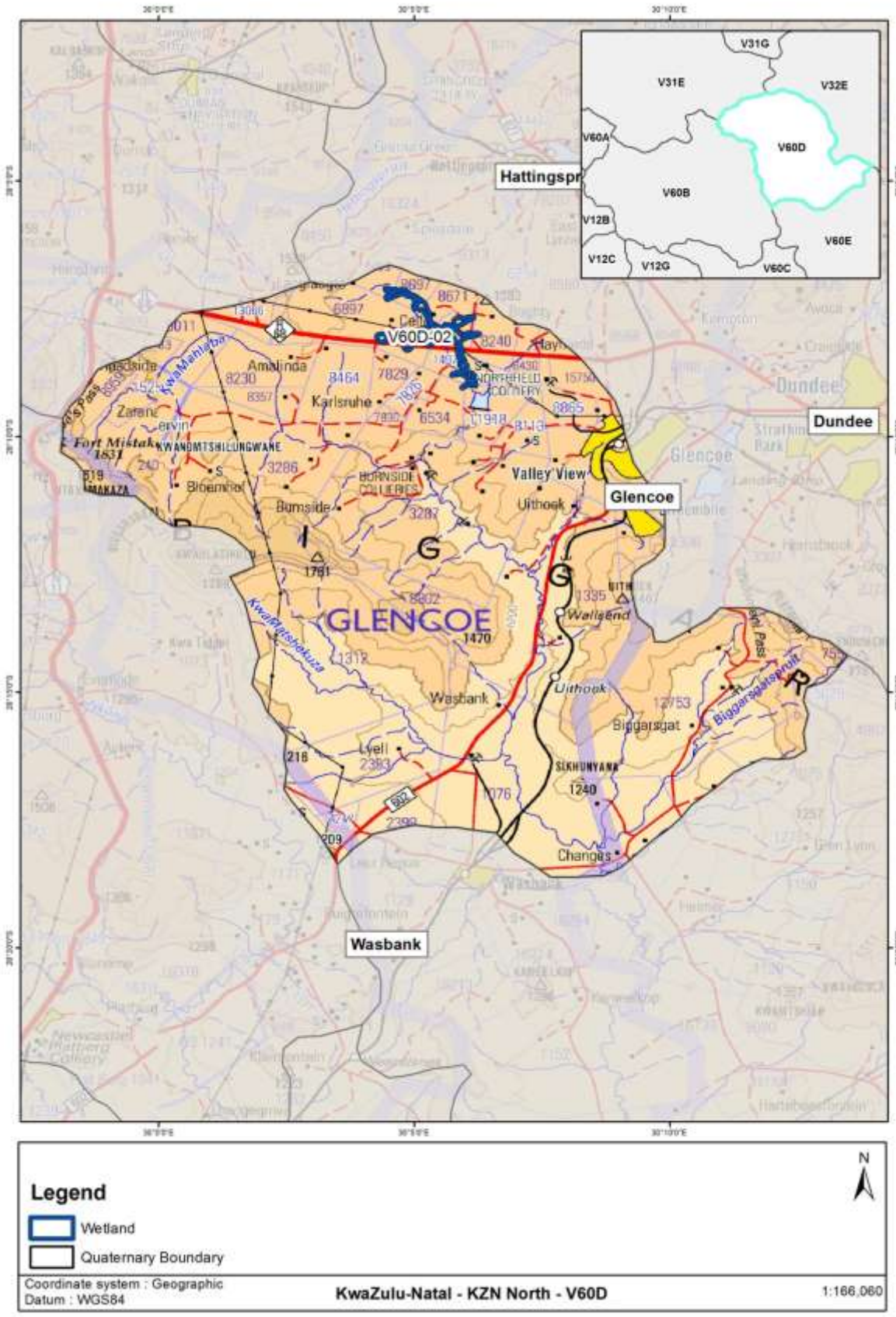

Figure 4: Topographic map showing the location, cadastral boundaries and access routes of quaternary catchment V60D

Motivation: The rehabilitation of the wetlands in the KZN North Wetland Project will meet the objectives of enhancing the water storage and water quality of the area as well the conservation and of habitat and species in the area. Both the Boschberg Vlei and the Padda Vlei wetland systems, in quaternary catchments V60B and V60D respectively, are considered to be in an area that is relatively dry, with high Potential Evapotranspiration (PET) relative to Mean Annual Precipitation (MAP). Therefore, maintenance of base flows and improvement in water quality are regarded as important functions in this area. In addition, these wetland systems are classified as National Freshwater Ecosystem Priority Areas (NFEPAs). However, from a biodiversity perspective, only the Boschberg Vlei falls within a Biodiversity Priority Area 1 as well as a crane priority area (Priority 2: Wattled Crane Nesting Site/ Current Crowned Crane Nesting Site).

3.2 Landowner details

The majority of the KZN North project area comprises privately-owned land, and the focus of the wetland rehabilitation efforts has been on those properties where the landowner is enthusiastic about the proposed rehabilitation, and has agreed to the proposed rehabilitation interventions.

The landowners were identified for this Wetland Project (**Table 5**) and consent for any proposed wetland rehabilitation (subject to the approval of the Rehabilitation Plans) has been sought. Copies of the consent obtained are provided in **Appendix E**.

Table 5: List of Landowners and SG Key

Wetland Number	Property SG Key	Owner / Trust	Consent Obtained
V60B-01	N0GS00000000113500007	Renée Meyer	9 October 2013
	N0GS00000001501000000		
	N0GS00000001659900000	Hercules Trust (M.G & H Richmond)	7 November 2013
V60D-01	N0GT00000000823000000	Johannes Petrus Coetzee	9 January 2014
	N0GT00000000835700000		
V60D-02	N0GS00000000240800004		
	N0GT00000000328600002		

3.3 Projected rehabilitation indicators

The rehabilitation planning process relies on the measurement of wetland ecological integrity based on the assessment of the hydrology, geomorphology and vegetation components of the specified systems. In theory this information could be converted into a hectare equivalent which could serve as a baseline indicator to then provide a projection of the area of wetland habitat gained or secured. In practice the level of confidence associated with interpretations of this nature are usually low and difficult to defend and hence should be interpreted with

great caution. For example, this approach should not be followed for hectare equivalents secured where a large wetland complex with many contiguous tributary arms of unknown size are present upstream. Similarly, the area of wetland gained should not be determined if there isn't good knowledge of inter alia the hydrogeological characteristics of both the bedrock and unconsolidated sedimentary cover. In well-known systems Rehabilitation Plans can outline the following projected values for the proposed wetland rehabilitation, which can be used as an indicator of wetland rehabilitation success within each wetland system (**Table 6**):

Table 6: Projected Values

Wetland No.	Area (ha)	Current hectare equivalents	Projected hectare equivalents gained	Total projected hectare equivalents	% Increase on current hectare equivalents	Projected hectare equivalents secured
V60B-01	2318	134.9	18	24.7	18	6.7
V60D-01	691	543.9	24.6	27.5	5	2.9
V60D-02	97	61.5	1.6	8.9	14	7.3

Please note that important factors such as biodiversity, species habitat, sense of place cultural significance etc. are not incorporated into hectare equivalents and therefore the full value of the system is not quantified. For the purpose of this report and due to the reasons above, the above table (**Table 6**) only reflects the amount of hectares likely to be physically gained and/or secured as a result of the planned interventions.

3.4 Prioritisation of wetlands

Based on the wetland status quo assessments conducted, the current progress of implementation within the project and the prioritisation of the rehabilitation interventions detailed in the following sections, the wetlands will be prioritised for rehabilitation in the following order (**Table 7**):

Table 7: Prioritisation of wetlands

Priority	Wetland number	Wetland name	Rationale
	V60B-01	Boschberg Vlei	While useful work has been identified in this wetland, this work should only commence once work on existing projects has been completed.
	V60D-01	Padda Vlei 1	Work is already underway in this wetland and should be completed before targeting new areas.
	V60D-02	Padda Vlei 2	This wetland is located on the main tributary arm of Padda Vlei and is located close to existing teams. This wetland should therefore be prioritised for implementation prior to moving to Boschberg.

3.5 Interventions required

The following table (**Table 8**) provides a list of interventions requiring redesign, maintenance and or new structures for this project and their associated new intervention number.

Table 8: Summary of the interventions including a cross reference of intervention numbers

Descriptive name	Old intervention number (if applicable)	New Intervention number	Proposed action	Reference document
NEW				
Boschberg Vlei (V60B-01)				
Earthen berm	N/A	V60B-01-201-00	Divert flows out of a channel in order to re-activate adjacent wetland area.	KZN North Rehab Plan: 2014
Concrete road strips (100m)	N/A	V60B-01-202-00	Prevent damage to the wetland by vehicles.	KZN North Rehab Plan: 2014
Concrete weir	N/A	V60B-01-203-00	Stabilise existing drain to reduce risk of incision and allow controlled entry into lateral drain.	KZN North Rehab Plan: 2014
Concrete weir	N/A	V60B-01-204-00	Stabilise existing drain to reduce risk of incision and allow controlled entry into lateral drain.	KZN North Rehab Plan: 2014
Gabion control wall	N/A	V60B-01-205-00	Stabilise lateral drain running parallel to district road.	KZN North Rehab Plan: 2014
Gabion deflection wall	N/A	V60B-01-206-00	Elevate water levels in upstream channel. Deflect flows out of a channel to promote re-wetting of downstream wetland.	KZN North Rehab Plan: 2014
Concrete weirs, wing walls, sloping and biojute	N/A	V60B-01-207-00	Deactivate multiple headcuts to prevent loss of upstream wetland habitat.	KZN North Rehab Plan: 2014

Descriptive name	Old intervention number (if applicable)	New Intervention number	Proposed action	Reference document
Geocell covered earthen berm	N/A	V60B-01-208-00	Divert flows out of a channel onto adjacent wetland area.	KZN North Rehab Plan: 2014
Earthworks (backfill drain - 120m long)	N/A	V60B-01-209-00	Block existing drain and re-instate diffuse flows across seepage zone.	KZN North Rehab Plan: 2014
Concrete road strips (22m)	N/A	V60B-01-210-00	Formalise crossing point in order to prevent damage to the wetland by vehicles.	KZN North Rehab Plan: 2014
Earthworks and earthen plugs	N/A	V60B-01-211-00	Deactivate minor drains to encourage diffuse flows.	KZN North Rehab Plan: 2014
Earthworks and earthen plugs	N/A	V60B-01-212-00	Deactivate a berm and drains to promote water retention and flows to down-slope wetland area.	KZN North Rehab Plan: 2014
Earthen Plugs	N/A	V60B-01-213-00	Deactivate drain to facilitate flows into downstream wetland area.	KZN North Rehab Plan: 2014
Geocell covered earthen berm	N/A	V60B-01-214-00	Deflect flows out of drain and re-activate downstream wetland area.	KZN North Rehab Plan: 2014
Concrete wall incorporating a pipe with gate valve	N/A	V60B-01-215-00	Create opportunity for farmer to deflect flows into dam when needed. Prevent high flows from exiting a channel and entering the dam.	KZN North Rehab Plan: 2014
Lined rock drain	N/A	V60B-01-216-00	Deactivate headcut erosion.	KZN North Rehab Plan: 2014

Descriptive name	Old intervention number (if applicable)	New Intervention number	Proposed action	Reference document
Rockpack with sack gabion toe	N/A	V60B-01-217-00	Deactivate headcut erosion.	KZN North Rehab Plan: 2014
Concrete road strips (45m)	N/A	V60B-01-218-00	Prevent damage to the wetland by vehicles.	KZN North Rehab Plan: 2014
Rockpack with sack gabion toe	N/A	V60B-01-219-00	Deactivate headcut erosion.	KZN North Rehab Plan: 2014
Lined rock drain	N/A	V60B-01-220-00	Deactivate headcut erosion.	KZN North Rehab Plan: 2014
Padda Vlei 1 (V60D-01)				
Concrete buttress weir with sack gabion protection	N/A	V60D-01-206-00	Deactivate head-cut erosion	KZN North Rehab Plan: 2014
Reno mattress chute with sack gabion protection	N/A	V60D-01-207-00	Deactivate head-cut erosion	KZN North Rehab Plan: 2014
Access road, dish drains and concrete strips	N/A	V60D-01-209-00	Provide vehicular access route across the wetland for the farmer; reduce current impeding effect of existing road; and prevent vehicle disturbance to the wetland.	KZN North Rehab Plan: 2014

Padda Vlei 2 (V60D-02)				
Concrete buttress weir	N/A	V60D-02-201-00	Stabilise the channel and prevent vertical incision.	KZN North Rehab Plan: 2014
Reno mattress chute	N/A	V60D-02-202-00	Deactivate head-cut erosion	KZN North Rehab Plan: 2014
Concrete drop inlet weir with extended concrete wing wall	N/A	V60D-02-203-00	Deactivate head-cut erosion	KZN North Rehab Plan: 2014
Gabion wall with reno mattress downstream protection	N/A	V60D-02-206-00	Deactivate head-cut erosion and create an artificial control to prevent vertical channel incision	KZN North Rehab Plan: 2014
Gabion wall with reno mattress downstream protection	N/A	V60D-02-207-00	Create an artificial control to prevent vertical channel incision	KZN North Rehab Plan: 2014
Concrete drop inlet weir	N/A	V60D-02-208-00	Stabilise existing drain and prevent head-cut advancement.	KZN North Rehab Plan: 2014
MAINTENANCE				
N/A				
INTERVENTION REDESIGNS				
N/A				

The intervention designs/ drawings included in this Rehabilitation Plan have been labelled according to the **new naming convention** only. For historical labelling of interventions, please use the table above (Table 8) as a cross reference.

4 BOSCHBERG VLEI –V60B-01

The assessment of the Boschberg Vlei wetland units V60B-01A to V60B-01H, their problems, and the development of the rehabilitation objectives are described in detail in **Appendix A**: Wetland Reports. The following subsections provide a brief summary for this wetland system. For the purposes of rehabilitation this wetland was separated into eight wetland units by the Wetland Ecologist, which are specific focal areas of the wetland targeted for rehabilitation (refer **Figure 7**). These targeted areas are predominantly the tributaries that feed the main floodplain wetland.

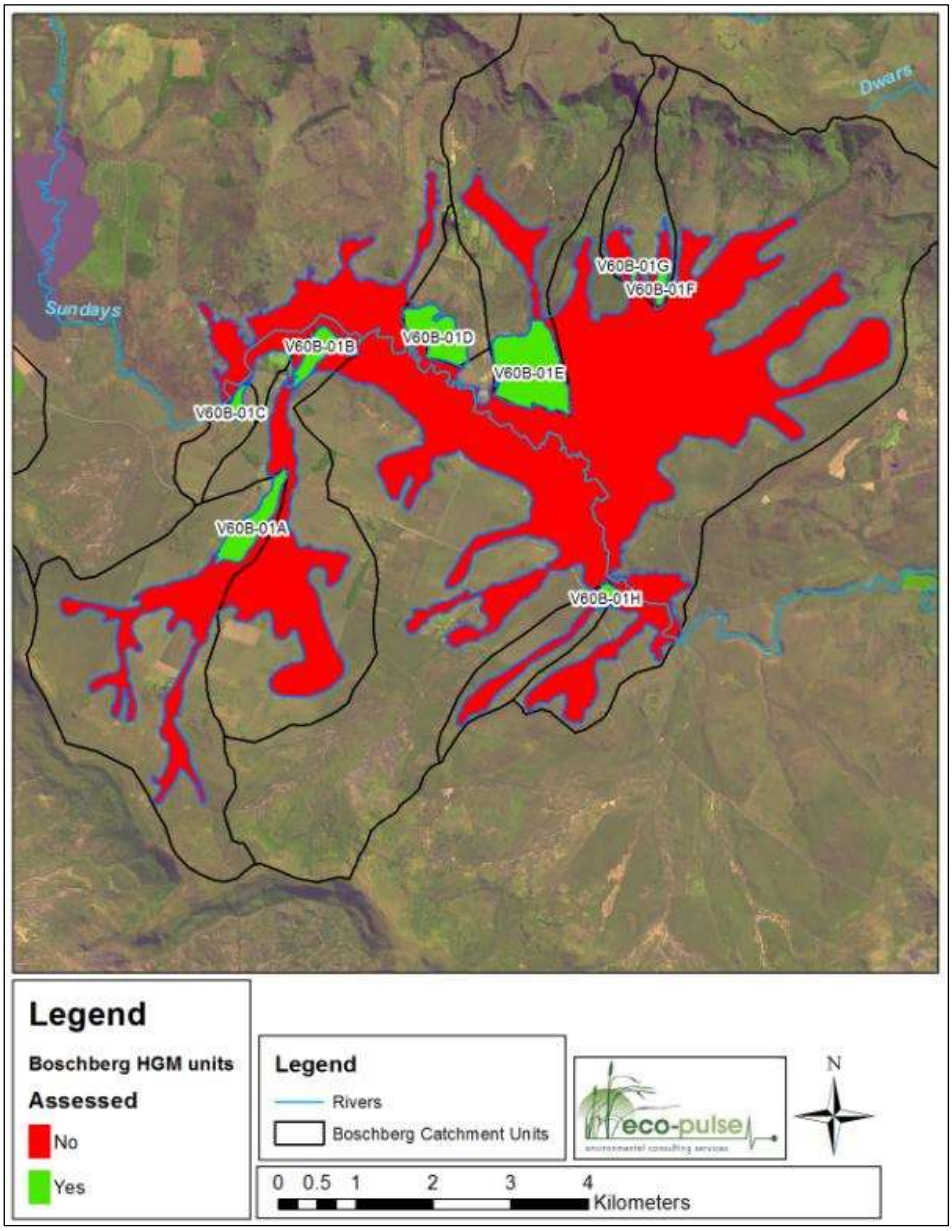

Figure 5: Target areas identified within wetland V60B-01

4.1 Wetland details

The Boschberg Vlei wetland is located in quaternary catchment V60B near the towns of Wasbank and Elandslaagte in the KwaZulu-Natal Province (refer **Figure 3** in **Section 3** of this report). The wetland can be accessed from the district roads 263 S and the 314 S which are good secondary roads leading from the R23 (the main Ladysmith-Newcastle road) to Collin's pass. Boschberg vlei is surrounded by privately owned land and can only be accessed directly with permission from these landowners. **Table 9** provides a summary of the wetland details.

Table 9: Summary of the wetland details

Wetland Name	Boschberg Vlei
Wetland Number	V60B-01
River System Name	Sundays River
Land Use in Catchment	Agriculture/Grassland/Bushveld
Land Use in Wetland	Grassland/agriculture
No. of Properties Intersecting Wetland Area	Multiple
Date of Planning Site Visit	November 2013
Wetland Assessor(s)	Doug Macfarlane and Ross van Deventer
Wetland size	2318 Ha

4.1.1 Motivation for selection

The Boschberg Vlei wetland system V60B-01 has been selected for rehabilitation based on its size and position in the landscape, its ability to maintain base flows and improve water quality in the area, and its biodiversity value. From a conservation perspective, it is important to note that both the Sundays River running through the wetland and the wetland itself are recognised National Freshwater Ecosystem Priority Areas (NFEPA's). The wetland is also recognised as a crane priority (Priority 2: Wattled Crane Nesting Site/Current Crowned Crane Nesting Site) by the Endangered Wildlife Trust. It is therefore not surprising that the majority of the wetland is also classified as a Biodiversity Priority Area 1 (MINSET, EKZNW 2010). The system is therefore considered critical in terms of habitat provision for wetland-dependant species. Boschberg Vlei is a SANBI Category 2 wetland project which refers to projects where wetlands have been prioritised for rehabilitation.

4.1.2 Description

Boschberg Vlei is a large (2318 ha) floodplain wetland which is fed by a number of smaller channelled valley bottom and hillslope seeps systems. The wetland is located in the headwaters of the Sundays River (approximately 20km downstream of the source).

Catchment: The catchment is largely untransformed, with grassland occupying most of the catchment and forest and bushland occurring on steeper south-facing slopes. The extent of settlement is limited, as are areas of cultivation and alien plantations. A large dam has been created just upstream of the main floodplain. Most of the focal wetland areas assessed are fed by smaller sub-catchments which vary in terms of Landcover and hydrological impacts. Most local catchments are still largely untransformed although over-grazing is clearly identifiable in most areas. Other common local impacts include farm dams, areas of wattle encroachment and erosion.

Climate: The local climate is characterised by a low mean annual precipitation of 855mm and a much higher mean annual potential evapotranspiration of 1815mm. This gives a MAP to PET ratio of 0.47 (vulnerability index of 1.), which means that the wetland has a relatively high sensitivity to hydrological impacts (i.e. changes in water input volumes and patterns). The control on the formation and the dynamics of the system is linked to the local topography and the presence of a dolerite dyke at the toe of the wetland which acts as the local base level and has led to its upstream formation. The system is largely surface water driven with the exception of the hillslope seeps which receive both surface and sub-surface water inputs.

Vegetation: According to Mucina and Rutherford (2006) the natural vegetation type in the vicinity of the wetland is the Northern KwaZulu-Natal Moist Grassland (Gs4) falling within the Grassland Biome. This vegetation type is classified as Vulnerable. This grassland is located almost entirely within the catchment of the Thukela River of the KwaZulu-Natal Province. The landscape features of this vegetation type are hilly and rolling topographies supporting tall tussock grassland usually dominated by *Themeda triandra* and *Hyparrhenia hirta.* Open savanoid woodlands encroach up the valleys on disturbed (strongly eroded) sites. This vegetation type has a conservation target of 24%, and 73.7% remains, although only 2% is statutorily conserved. More than a quarter has been transformed for cultivation, plantations, or infrastructure. Alien invasives and bush encroachment are other threats.

The wetland itself covers a large area, however the vegetation across the wetness zones are largely homogenous. Permanent and seasonal zones are dominated by *Juncus spp*., *Carex spp., Typha capensis, Phragmites australis, Pycreus spp., cyperus spp., Fimbristylis spp., Eleocharis spp., Isolepis spp.* and *Imperata spp*. The temporary zone is largely grass dominated including species such as P*anicum maximum, Themeda triandra, Hetropogen contortus,* and *Eragrostis spp*. Unfortunately large areas of seasonal and temporary wetland habitat have been disturbed through historical and current farming practices including cropping and pasture cultivation.

Geology and soils: According to Mucina and Rutherford (2006) the geology and soils in the area consists of mudstones, sandstones and shales of the Beaufort and Ecca groups of the Karoo Supergroup. These are intruded by dolerites of Jurassic age. A dolerite dyke at the toe of the wetland acts as the local base level and has led to its upstream formation.

Overview & Assessment: An overview of this wetland is provided by Luvuno and Walters (in Macfarlane *et al.*, 2011) and was used to help identify focal areas for rehabilitation planning. Rehabilitation is largely concentrated on eight of the arms feeding the main floodplain wetland. Details of these focal areas, described as HGM units, are presented in **Table 10**.

Table 10: Details of HGM units assessed

HGM Code	HGM Type	HGM Details
V60B-01A	Unchannelled Valley Bottom	This unchannelled valley bottom wetland is located directly downstream of a farm dam which intercepts flows from the upstream catchment. Within the wetland itself, the upper portion is largely un-impacted with reeds and hydrophilic vegetation occurring along weak channels and areas of permanent saturation. Some erosion is evident in the mid-reaches of this unit, with headcut advancement threatening intact wetland habitat below the dam. Historic drainage has impacted the mid and lower reaches, which has been exacerbated by recent drainage upstream of the district road. These actions have served to stimulate further erosion whilst deflecting water away from wetland areas downstream of the road.
V60B-01B	Unchannelled Valley Bottom	This previously unchannelled valley bottom is affected by a drain that effectively diverts flow away from areas previously used for cultivation. The wetland is now largely dominated by terrestrial grasses rather than typical wetland species.
V60B-01C	Hillslope Seep	This small seepage area has a large cut-off berm running across the slope which was previously constructed to divert flows from the main Sundays River to dams in the neighbouring valley. While this berm has failed in places, a road and drains have been created to improve access for the farmer which has affected local wetland characteristics.
V60B-01D	Floodplain	This portion of the wetland occurs on the elevated floodplain of the Sundays River and is maintained by hillslope seepage and occasional flooding. This area was previously drained to facilitate cultivation. Whilst the area is no longer being cultivated and is recovering well, minor drains still affect local water distribution and retention patterns.

V60B-01E	Unchannelled Valley Bottom	This wetland unit is fed by a steep catchment and is located where the stream discharges onto the main floodplain. A large drain has effectively altered the location of the influent stream which now deflects flows into an earthern dam. Overflows are captured by a drain that deflects flows away from historically irrigated pastures towards the main floodplain area. Secondary drains are present within old pasture areas which whilst slowly recovering, are still largely dominated by pasture species.
V60B-01F	Unchannelled Valley Bottom	This narrow unchannelled valley bottom wetland is located on a steep incline and feeds into an incised stream that drains onto the main floodplain. Headward erosion is evident in the lower reaches and will result in further wetland loss and increased sediment deposition in the downstream wetland if not addressed.
V60B-01G	Hillslope Seep	This is small seepage area threatened by over grazing and headward erosion.
V60B-01H	Hillslope Seep	This area is fed by an eroded channel which appears to have developed in response to road construction. Flows are now deflected laterally away from the downstream floodplain via a deep, incised erosion gully. This has resulted in considerable desiccation of this wetland unit with sediment laden water being deposited in the Sundays River.

4.1.3 Rehabilitation

The main aim of the rehabilitation work in the Boschberg Vlei wetland for the 2014/2015 planning cycle is to address the problems associated with historic cultivation, drainage, erosion and headcut advancement within the area.

The proposed rehabilitation interventions will not only affect the ecological integrity of the broader wetland system but will also have a number of positive impacts on the supply of goods and services provided by the wetland.

4.1.4 Site photos

View north of a large drain diverting channel into dam

View east of main floodplain wetland channel (Sundays River).

Eroded drain to be deactivated by upstream intervention, looking south-west

Active drain to be blocked and redirected upstream to rewet dried areas, looking west

View north north-west of old shallow drain used for cultivation

Figure 6: Site Photos of the Boschberg Vlei

4.2 Wetland problems

The large dam just upstream of the main floodplain has served to increase base flows and is likely to have a regulating/dampening effect on flood peaks reaching this wetland system. The wetland has been subjected to a number of impacts (**Figure 7**) associated with the modification of the system's hydrology. Dominant impacts within the wetland include artificial drainage, headward erosion, alien plants, grazing and cattle trampling, informal river crossings, diversions, cultivation and damming. The specific problems associated with each wetland unit for the Boschberg Vlei are as follows:

Table 10: Summary of the problems identified per wetland unit for wetland V60B-01

Wetland Unit	Problems Identified
V60B-01A	The main impacts to this wetland unit are associated with road drainage, historic cultivation and active headward erosion. These impacts are affecting natural wetland functioning and threaten to further undermine existing wetland values.
V60B-01B	The main impacts to this wetland unit are associated with historic cultivation, upstream damming and drainage.
V60B-01C	The main impacts to this wetland unit are associated with berms, drainage and road crossings. These impacts have affected water distribution and retention patterns in the wetland.
V60B-01D	The main impacts to this wetland unit are associated with historic cultivation and drainage. These impacts are affecting water distribution and retention patterns in the wetland.
V60B-01E	A range of impacts have affected the overall functioning of this wetland and include: overgrazing and resultant erosion of catchment areas; channel diversion and drainage within the wetland; a dam within the wetland unit; and historic pasture production.
V60B-01F	The main impacts to this wetland unit are active erosion and headcut advancement.
V60B-01G	The main impacts to this wetland unit are active erosion with headcut advancement threatening remaining largely intact wetland areas.
V60B-01H	The main impacts to this wetland unit are associated with diversion and drainage. These impacts are affected water distribution and retention patterns in the wetland.

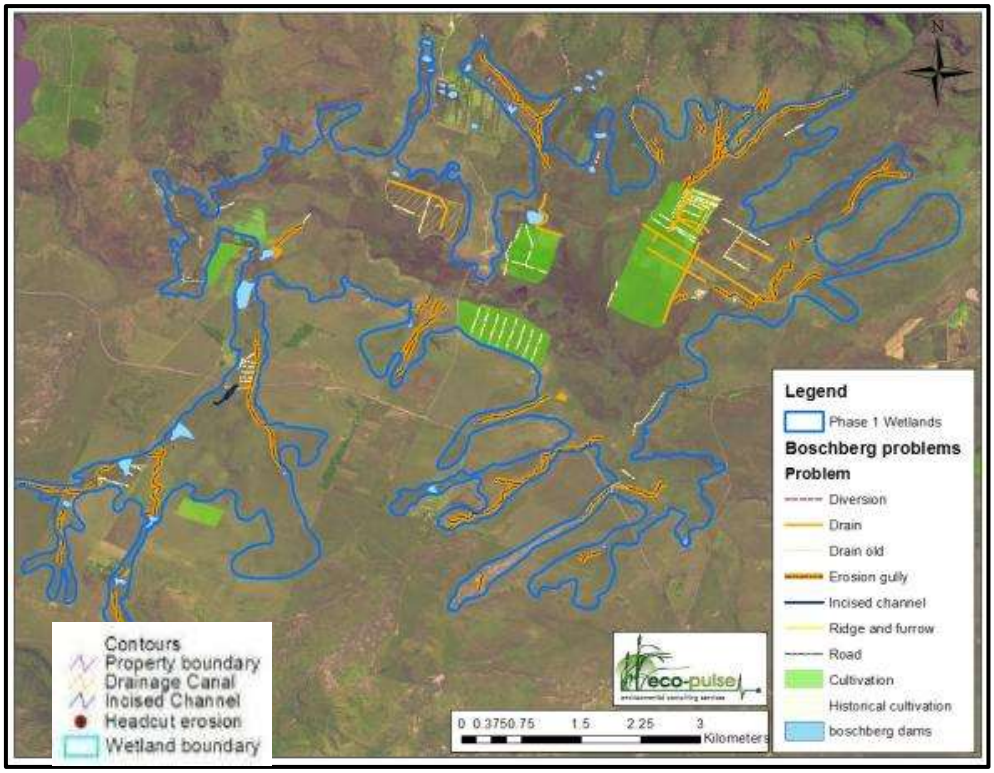

Figure 7: Problems identified within wetland V60B-01.

4.3 Rehabilitation objectives

The specific rehabilitation objectives and accompanying rehabilitation strategies associated with each wetland unit for the Boschberg Vlei are shown in **Table 11**.

Table 11: Rehabilitation objectives for wetland units in wetland V60B-01

Wetland Unit	Rehabilitation Objectives	Rehabilitation Strategy
V60B-01A	To re-instate more natural water distribution and retention patterns in order to improve the overall functioning of the wetland and associated habitat for important wetland-dependant biota.	To effectively block existing drains and remove berms to promote recharge of adjacent wetland areas.
	Secure areas of intact wetland habitat currently threatened by headward erosion.	Stabilise erosion headcuts to avoid further loss of wetland habitat.
V60B-01B	To re-activate a portion of the valley bottom in order to improve available wetland habitat.	To block the lower section of the drain and deflect flows onto the adjoining wetland area.
V60B-01C	To re-instate more natural water distribution and retention patterns in order to improve the overall functioning of the wetland.	To effectively block the existing drains and create a more appropriate crossing point for the farmer.
V60B-01D	To re-instate more natural water distribution and retention patterns in order to improve the overall functioning of the wetland.	Effectively block drains allowing natural flow patterns within the unit.
V60B-01E	To re-instate more natural water distribution and retention patterns in order to improve the overall functioning of the wetland and associated habitat for important wetland-dependant biota.	Divert flows away from dam and into historic wetland areas; Deactivate functional drains to promote more natural water distribution and retention patterns.
V60B-01F	To safeguard relatively intact wetland habitat from active headcut advancement.	To effectively stabilise headcuts through appropriate interventions.
V60B-01G	To safeguard relatively intact wetland habitat from active headcut advancement.	To effectively deactivate existing headcuts.
V60B-01H	To re-instate more natural water distribution and retention patterns in order to improve the overall functioning of the wetland.	To effectively block the main drain and deflect flows onto down-slope wetland area. To deactivate areas impacted by minor drain to encourage diffuse flows

4.4 Summary of proposed interventions

The table below (**Table 12**) provides a summary of the new interventions that are discussed in detail in the subsequent sections of this report. The "implementation order" as depicted in the table indicates the timing order in which interventions should be implemented within the wetland (number 1 first). The "priority" as depicted in the table indicates the relative importance of each intervention across the project as a whole – if interventions have to be omitted for any reason, those with the lowest priority (highest number) across the whole project should be omitted first.

*Please note that the location of the interventions described in **Sections 3.5** and **4.5** may change as a result of changes in the landscape (due to continued erosion, for example) during the time period that has lapsed between the initial planning site visit and the actual implementation thereof.*

Table 12: Summary of proposed new interventions, V60B-01

Intervention Number	Intervention Structure Type	Implementation Order	Priority	Structure Cost (Excl. Vat)
V60B-01-201-00	Earthen Berm	3	3	R 257 886.00
V60B-01-202-00	Concrete Road Strips (100m)	5	5	R 164 208.00
V60B-01-203-00	Concrete Weir	3	3	R 117 595.80
V60B-01-204-00	Concrete Weir	3	3	R 73 256.40
V60B-01-205-00	Gabion Control Wall	3	3	R 234 574.00
V60B-01-206-00	Gabion Deflection Wall	2	2	R 195 739.00
V60B-01-207-00	Concrete Weirs, Wingwalls, Sloping and Biojute	1	1	R 470 935.00
V60B-01-208-00	Geocell Covered Earthen Berm	2	2	R 52 788.20
V60B-01-209-00	Earthworks (Backfill Drain - 120m long)	4	4	R 54 600.00
V60B-01-210-00	Concrete Road Strips (22m)	4	4	R 36 262.60
V60B-01-211-00	Earthworks and	5	5	R 247 400.00

Intervention Number	Intervention Structure Type	Implementation Order	Priority	Structure Cost (Excl. Vat)
	Earthen Plugs			
V60B-01-212-00	Earthworks and Earthen Plugs	4	4	R 195 880.00
V60B-01-213-00	Earthen Plugs	2	2	R 34 994.00
V60B-01-214-00	Geocell Covered Earthen Berm	2	2	R 153 251.00
V60B-01-215-00	Concrete Wall Incorporating a Pipe with Gate Valve	2	2	R117 902.84
V60B-01-216-00	Lined Rock Drain	2	2	R 171 844.00
V60B-01-217-00	Rockpack with Sack Gabion Toe	2	2	R 48 159.00
V60B-01-218-00	Concrete Road Strips (45m)	5	5	R 73 893.60
V60B-01-219-00	Rockpack with Sack Gabion Toe	3	3	R 157 489.00
V60B-01-220-00	Lined Rock Drain	3	3	R 22 111.00
Total				**R 2 880 769.44**

The following intervention points were identified at the Boschberg wetland (V60B-01) as potential future interventions.

Intervention Number	Intervention Structure Type	Latitude (DºM'S")	Longitude (DºM'S")
V60B-01-221-00	Earthworks and Earthen Plugs	28°16'19.88"S	29°49'17.72"E
V60B-01-222-00	Geocell Covered Earthen Berm	28°16'23.45"S	29°49'12.83"E

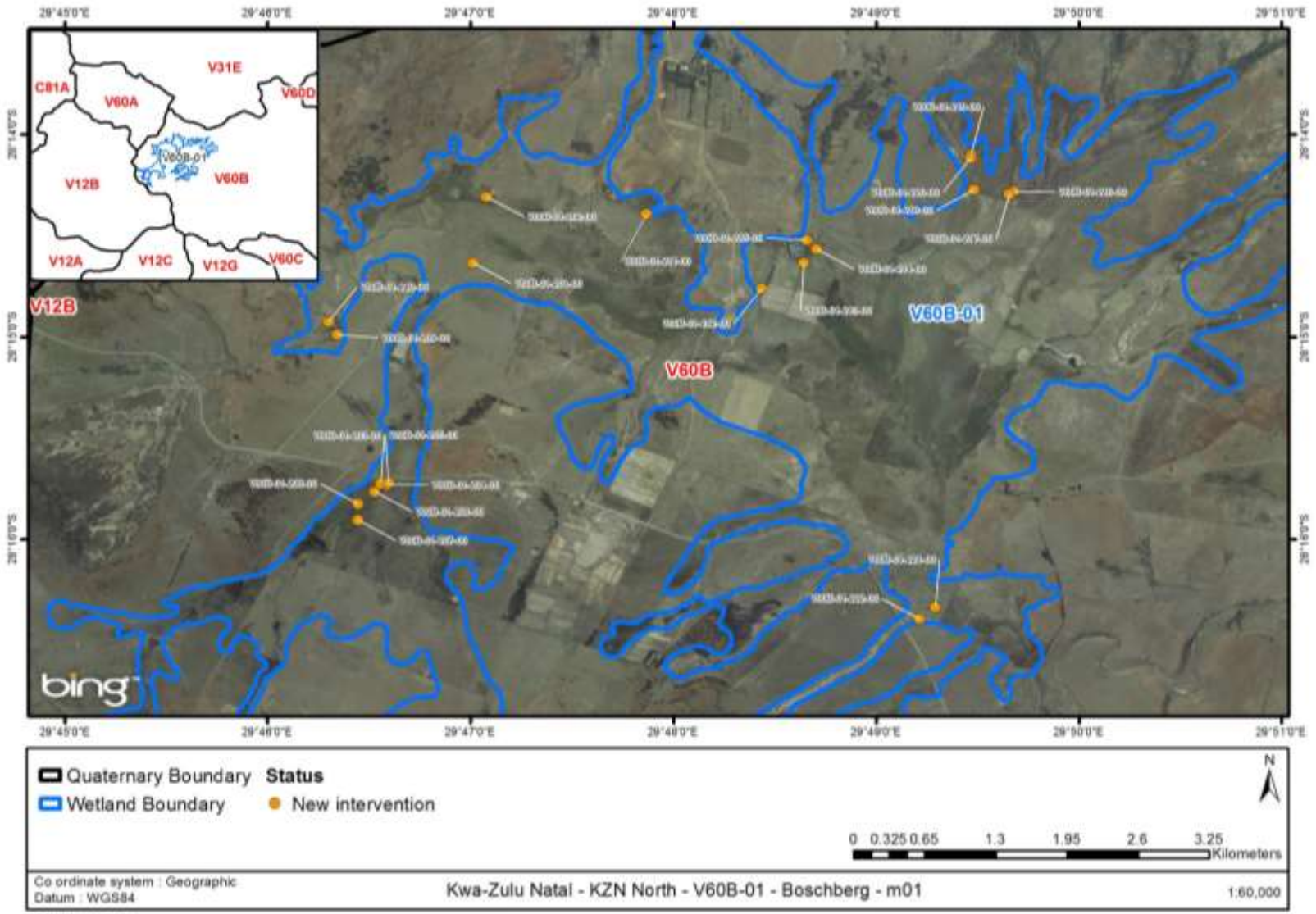

Figure 8: Wetland map, V60B-01 with proposed new wetland interventions indicated.

4.4.1 Design selection and sizing

The objectives of the interventions are to deactivate drains and diversions, prevent damage to the wetland as a result of vehicle movement and to deactivate headcut erosion. The most appropriate and cost effective method of doing this was considered to involve:

- The construction of hard structures (concrete or gabion weirs) were specified in high energy areas, with concrete specified in areas where impermeable intervention were required e.g. headcut stabilisation;
- Earthen diversions were specified in areas of low energy and will be vegetated to increase their stability;
- Removal of existing berms and utilising the material for the construction of plugs was specified where possible to increase person days;
- Concrete road strips were specified to reduce the impact of vehicles on the wetlands.

4.5 Intervention designs

4.5.1 Intervention: V60B-01-201-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Earthen Berm
Rehabilitation Objective	To divert flows out of a channel in order to re-activate adjacent wetland area.
Latitude (DºM'S")	28°14'37.97"S
Longitude (DºM'S")	29°47'00.82"E
Engineering Drawings	V60B-01-201-00

Figure 9: Photo of proposed site for Earthen berm, intervention V60B-01-201-00

4.5.1.1 Bill of quantities: V60B-01-201-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	191	R 860.00	R 164 260.00
Excavation Volume	m^3	191.00	R 416.00	R 79 456.00
Revegetation Area	m^2	280.00	R 34.00	R 9 520.00
Biojute Area	m^2	310.00	R 15.00	R 4 650.00
			Total	**R 257 886.00**

4.5.1.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)

b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.2 Intervention: V60B-01-202-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Concrete Road Strips (100m)
Rehabilitation Objective	Prevent damage to the wetland by vehicles.
Latitude (DºM'S")	28°14'18.31"S
Longitude (DºM'S")	29°47'04.74"E
Engineering Drawings	V60B-01-202-00

Figure 10: Photo of proposed site for Concrete Road Strips (100m), intervention V60B-01-202-00

4.5.2.1 Bill of quantities: V60B-01-202-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete (30MPa) Volume	m^3	24.00	R 6 426.00	R 154 224.00
Excavation Volume	m^3	24.00	R 416.00	R 9 984.00
			Total	**R 164 208.00**

4.5.2.2 Construction Notes:

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.3 Intervention: V60B-01-203-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Weir
Rehabilitation Objective	Stabilise existing drain to reduce risk of incision and allow controlled entry into lateral drain.
Latitude (DºM'S")	28°15'43.27"S
Longitude (DºM'S")	29°46'33.42"E
Engineering Drawings	V60B-01-203-00

Figure 11: Photo of proposed site for Concrete Weir, intervention V60B-01-203-00

4.5.3.1 Bill of quantities: V60B-01-203-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	18.30	R 6 426.00	R 117 595.80
			Total	**R 117 595.80**

4.5.3.2 Construction Notes:

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.4 Intervention: V60B-01-204-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Weir
Rehabilitation Objective	Stabilise existing drain to reduce risk of incision and allow controlled entry into lateral drain.
Latitude (DºM'S")	28°15'43.78"S
Longitude (DºM'S")	29°46'35.29"E
Engineering Drawings	V60B-01-204-00

Figure 12: Photo of proposed site for Concrete Weir, intervention V60B-01-204-00

4.5.4.1 Bill of quantities: V60B-01-204-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	11.40	R 6 426.00	R 73 256.40
			Total	**R 73 256.40**

4.5.4.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.5 Intervention: V60B-01-205-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Gabion Cut Off Wall
Rehabilitation Objective	To stabilise the channel
Latitude (DºM'S")	28°15'43.18"S
Longitude (DºM'S")	29°46'35.83"E
Engineering Drawings	V60B-01-205-00

Figure 13: Photo of proposed site for Gabion Cut Off Wall, intervention V60B-01-205-00

4.5.5.1

4.5.5.2 Bill of quantities: V60B-01-205-00

Item	Units	Quantity	Unit Cost	Item Cost
Gabion Rock Volume	m^3	21.00	R 10 670.00	R 224 070.00
Excavation Volume	m^3	21.00	R 416.00	R 8 736.00
Revegetation Area	m^2	52.00	R 34.00	R 1 768.00
			Total	**R 234 574.00**

4.5.5.3 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.6 Intervention: V60B-01-206-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Gabion Deflection Wall
Rehabilitation Objective	To divert flows out of a channel to promote re-wetting of downstream wetland.
Latitude (DºM'S")	28°15'49.39"S
Longitude (DºM'S")	29°46'26.69"E
Engineering Drawings	V60B-01-206-00

Figure 14: Photo of proposed site for Gabion Deflection Wall, intervention V60B-01-206-00

4.5.6.1 Bill of quantities: V60B-01-206-00

Item	Units	Quantity	Unit Cost	Item Cost
Gabion Rock Volume	m^3	16.50	R 10 670.00	R 176 055.00
Excavation Volume	m^3	20.00	R 416.00	R 8 320.00
Earth Structures Volume	m^3	11.00	R 860.00	R 9 460.00
Revegetation Area	m^2	56.00	R 34.00	R 1 904.00
			Total	**R 195 739.00**

4.5.6.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).

c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.7 Intervention: V60B-01-207-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Weirs, Wingwalls, Sloping and Biojute
Rehabilitation Objective	To deactivate multiple headcut erosion to prevent loss of upstream wetland habitat.
Latitude (DºM'S")	28°15'54.14"S
Longitude (DºM'S")	29°46'26.80"E
Engineering Drawings	V60B-01-207-00

Figure 15: Photo of proposed site for Concrete Weirs, Wingwalls, Sloping and Biojute, intervention V60B-01-207-00

4.5.7.1 Bill of quantities: V60B-01-207-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	65.00	R 6 426.00	R 417 690.00
Earth Structure Volume	m^3	61.25	R 860.00	R 52 675.00
Biojute Area	m^2	38.00	R 15.00	R 570.00
			Total	**R 470 935.00**

4.5.7.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.8 Intervention: V60B-01-208-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Geocell Covered Earthen Berm
Rehabilitation Objective	To divert flows out of a channel onto adjacent wetland area.
Latitude (DºM'S")	28°15'45.68"S
Longitude (DºM'S")	29°46'31.58"E
Engineering Drawings	V60B-01-208-00

Figure 16: Photo of proposed site for Geocell Covered Earthen Berm, intervention V60B-01-208-00

4.5.8.1 Bill of quantities: V60B-01-208-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	16.00	R 860.00	R 13 760.00
Excavation Volume	m^3	16.00	R 416.00	R 6 656.00
Concrete (30MPa) Volume	m^3	4.70	R 6 426.00	R 30 202.20
75mm Geocells Area	m^2	62.00	R 35.00	R 2 170.00
			Total	**R 52 788.20**

4.5.8.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).

c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.9 Intervention: V60B-01-209-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Earthworks (backfill drain - 120m long)
Rehabilitation Objective	To promote diffuse flows across seepage zone.
Latitude (DºM'S")	28°14'59.10"S
Longitude (DºM'S")	29°46'20.57"E
Engineering Drawings	V60B-01-209-00

Figure 17: Photo of proposed site for Earthworks (backfill drain - 120m long), intervention V60B-01-209-00

4.5.9.1 Bill of quantities: V60B-01-209-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure (backfill drain) Volume	m^3	54.00	R 860.00	R 46 440.00
Revegetation Area	m^2	240.00	R 34.00	R 8 160.00
			Total	**R 54 600.00**

4.5.9.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.

e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.10 Intervention: V60B-01-210-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Concrete Road Strips (22m)
Rehabilitation Objective	To prevent damage to the wetland by vehicles.
Latitude (DºM'S")	28°14'55.39"S
Longitude (DºM'S")	29°46'18.05"E
Engineering Drawings	V60B-01-210-00

Figure 18: Photo of proposed site for Concrete Road Strips (22m), intervention V60B-01-210-00

4.5.10.1 Bill of quantities: V60B-01-210-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete (30MPa) Volume	m^3	5.30	R 6 426.00	R 34 057.80
Excavation Volume	m^3	5.30	R 416.00	R 2 204.80
			Total	**R 36 262.60**

4.5.10.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.11 Intervention: V60B-01-211-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Earthworks and Earthen Plugs
Rehabilitation Objective	To deactivate a drain to encourage diffuse flows.
Latitude (DºM'S")	28°14'23.42"S
Longitude (DºM'S")	29°47'52.08"E
Engineering Drawings	V60B-01-211-00

Figure 19: Photo of proposed site for Earthworks and Earthen Plugs, intervention V60B-01-211-00

4.5.11.1 Bill of quantities: V60B-01-211-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	160.00	R 860.00	R 137 600.00
Excavation Volume	m^3	210.00	R 416.00	R 87 360.00
Revegetation Area	m^2	660.00	R 34.00	R 22 440.00
			Total	**R 247 400.00**

4.5.11.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.12 Intervention: V60B-01-212-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Earthworks and Earthen Plugs
Rehabilitation Objective	To deactivate a berm and drains to promote water retention and flows to down-slope wetland area.
Latitude (DºM'S")	28°14'45.60"S
Longitude (DºM'S")	29°48'26.17"E
Engineering Drawings	V60B-01-212-00

Figure 20: Photo of proposed site for Earthworks and Earthen Plugs, intervention V60B-01-212-00

4.5.12.1 Bill of quantities: V60B-01-212-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	70.00	R 860.00	R 60 200.00
Excavation Volume	m^3	300.00	R 416.00	R 124 800.00
Revegetation Area	m^2	320.00	R 34.00	R 10 880.00
			Total	**R 195 880.00**

4.5.12.2 Construction Notes

The diversion is to be constructed at an angle across the channel to divert flows to the right hand side.

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

c. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
d. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

f. Remove soil in the form of sods (20- 40 x20x20cm)
a. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
b. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

c. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
d. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.13 Intervention: V60B-01-213-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Earthen Plugs
Rehabilitation Objective	To divert flows out of a channel into downstream wetland area.
Latitude (DºM'S")	28°14'37.93"S
Longitude (DºM'S")	29°48'38.66"E
Engineering Drawings	V60B-01-213-00

Figure 21: Photo of proposed site for Earthen Plugs, intervention V60B-01-213-00

4.5.13.1 Bill of quantities: V60B-01-213-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	25.00	R 860.00	R 21 500.00
Excavation Volume	m^3	25.00	R 416.00	R 10 400.00
Revegetation Area	m^2	91.00	R 34.00	R 3 094.00
			Total	R 34 994.00

4.5.13.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.14 Intervention: V60B-01-214-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Geocell Covered Earthen Berm
Rehabilitation Objective	To divert flows out of a channel and re-activate downstream wetland area.
Latitude (DºM'S")	28°14'33.76"S
Longitude (DºM'S")	29°48'42.44"E
Engineering Drawings	V60B-01-214-00

Figure 22: Photo of proposed site for Geocell Covered Earthen Berm, intervention V60B-01-214-00

4.5.14.1 Bill of quantities: V60B-01-214-00

Item	Units	Quantity	Unit Cost	Item Cost
Earth Structure Volume	m^3	70.00	R 860.00	R 60 200.00
Concrete (30MPa for Geocells) Volume	m^3	13.50	R 6 426.00	R 86 751.00
75mm Geocells Area	m^2	180.00	R 35.00	R 6 300.00
			Total	**R 153 251.00**

4.5.14.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).

c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.15 Intervention: V60B-01-215-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Wall Incorporating a Pipe with Gate Valve
Rehabilitation Objective	To prevent high flows from exiting a channel and entering the dam
Latitude (DºM'S")	28°14'31.24"S
Longitude (DºM'S")	29°48'39.53"E
Engineering Drawings	V60B-01-215-00

Figure 23: Photo of proposed site for Concrete Wall Incorporating a Pipe with Gate Valve, intervention V60B-01-215-00

4.5.15.1 Bill of quantities: V60B-01-215-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	18.34	R 6 426.00	R 117 852.84
Pipe and Components Area	m^2	1.00	R 50.00	R 50.00
			Total	**R 117 902.84**

4.5.15.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.

e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.16 Intervention: V60B-01-216-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Lined Rock Drain
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°14'16.69"S
Longitude (DºM'S")	29°49'40.94"E
Engineering Drawings	V60B-01-216-00

Figure 24: Photo of proposed site for Proposed Lined Rock Drain, intervention V60B-01-216-00

4.5.16.1 Bill of quantities: V60B-01-216-00

Item	Units	Quantity	Unit Cost	Item Cost
Excavation Volume	m^3	129.00	R 416.00	R 53 664.00
Geofabric Volume	m^3	600.00	R 35.00	R 21 000.00
Rockpack Volume	m^3	129.00	R 500.00	R 64 500.00
Earth Structure Volume	m^3	38.00	R 860.00	R 32 680.00
			Total	**R 171 844.00**

4.5.16.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).

c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.17 Intervention: V60B-01-217-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Rockpack with Sack Gabion Toe
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°14'17.59"S
Longitude (DºM'S")	29°49'39.54"E
Engineering Drawings	V60B-01-217-00

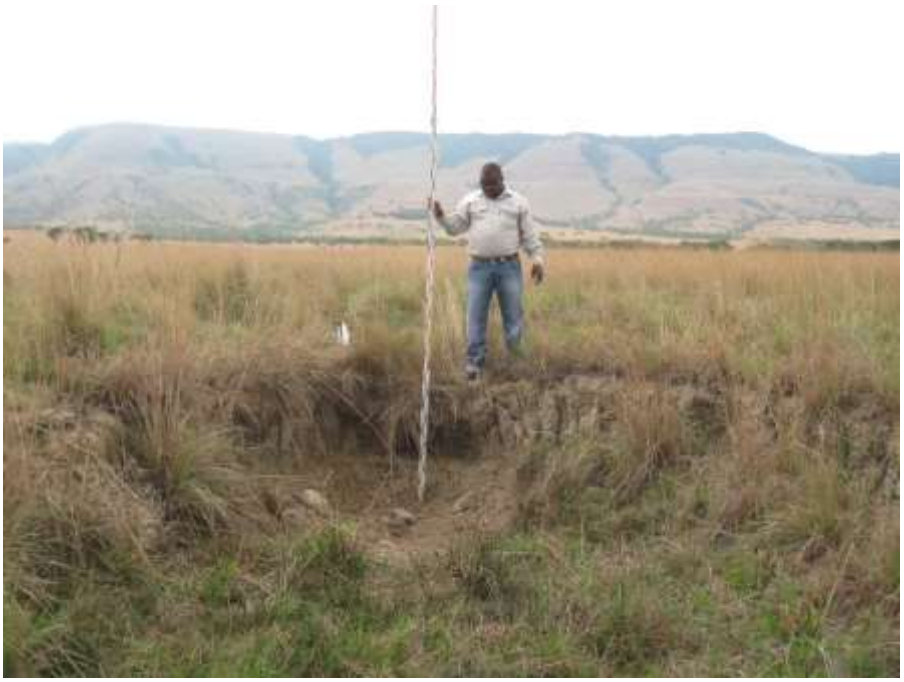

Figure 25: Photo of proposed site for Rockpack with Sack Gabion Toe, intervention V60B-01-217-00

4.5.17.1 Bill of quantities: V60B-01-217-00

Item	Units	Quantity	Unit Cost	Item Cost
Excavation Volume	m^3	8.00	R 416.00	R 3 328.00
Geofabric Area	m^2	32.00	R 35.00	R 1 120.00
650mm Diameter Sack Gabions Volume	m^3	10.00	R 550.00	R 5 500.00
Gabion Rock Volume	m^3	3.30	R 10 670.00	R 35 211.00
Rockpack Volume	m^3	6.00	R 500.00	R 3 000.00
			Total	**R 48 159.00**

4.5.17.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.18 Intervention: V60B-01-218-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Concrete Road Strips (45m)
Rehabilitation Objective	To prevent damage to the wetland by vehicles.
Latitude (DºM'S")	28°14'16.30"S
Longitude (DºM'S")	29°49'29.06"E
Engineering Drawings	V60B-01-218-00

Figure 26: Photo of proposed site for Concrete Road Strips (45m), intervention V60B-01-218-00

4.5.18.1 Bill of quantities: V60B-01-218-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete (30MPa) Volume	m^3	10.80	R 6 426.00	R 69 400.80
Excavation Volume	m^3	10.80	R 416.00	R 4 492.80
			Total	**R 73 893.60**

4.5.18.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.

e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.19 Intervention: V60B-01-219-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Rockpack with Sack Gabion Toe
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°14'05.86"S
Longitude (DºM'S")	29°49'28.27"E
Engineering Drawings	V60B-01-219-00

Figure 27: Photo of proposed site for Rockpack with Sack Gabion Toe, intervention V60B-01-219-00

4.5.19.1 Bill of quantities: V60B-01-219-00

Item	Units	Quantity	Unit Cost	Item Cost
Excavation Volume	m^3	9.00	R 416.00	R 3 744.00
Geofabric Area	m^2	93.00	R 35.00	R 3 255.00
650mm dia. 2m Sack Gabions Volume	m^3	36.00	R 550.00	R 19 800.00
Gabion Rock Volume	m^3	12.00	R 10 670.00	R 128 040.00
Rockpack Volume	m^3	5.00	R 500.00	R 2 500.00
Biojute Area	m^2	10.00	R 15.00	R 150.00
			Total	**R 157 489.00**

4.5.19.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.

b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.5.20 Intervention: V60B-01-220-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Lined Rock Drain
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°14'06.83"S
Longitude (DºM'S")	29°49'28.02"E
Engineering Drawings	V60B-01-220-00

Figure 28: Photo of proposed site for Lined Rock Drain, intervention V60B-01-220-00

4.5.20.1 Bill of quantities: V60B-01-220-00

Item	Units	Quantity	Unit Cost	Item Cost
Excavation Volume	m^3	15.00	R 416.00	R 6 240.00
Geofabric Area	m^2	77.00	R 35.00	R 2 695.00
Rockpack Volume	m^3	15.00	R 500.00	R 7 500.00
Earth Structure Volume	m^3	6.60	R 860.00	R 5 676.00
			Total	**R 22 111.00**

4.5.20.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)

b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post-construction

a. Use sods to revegetate the berm and disturbed areas affected by construction.
b. Place sods in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

4.6 Construction Environmental Management Plan issues

The proposed rehabilitation is to be undertaken on privately owned land and the project team should access the site and manage the site in accordance with the WfWetlands Best Management Practices and specific requirements of the landowner. The implementation of these interventions must also take into account all relevant provisions of WfWetlands Best Management Practices and the Construction Environmental Management Plan (CEMP), the recommendations of the approved Basic Assessments and Environmental Authorisation for the project.

The general construction notes, the Construction phase EMP (CEMP) are included as **Appendix B and F**.

4.7 Wetland management recommendations

Management of agricultural lands in the wetlands catchment

- Agricultural use of herbicides, pesticides and fertilizers in the vicinity of the wetland should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetland.
- A buffer of at least 20m should be maintained between any agricultural lands and wetland areas as far as possible so as to limit impacts associated with sedimentation and pollutant runoff.

Fire management

- With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm p. a.) an area of wetland should be burnt every 4 to 5 years.
- Cool and patchy burns should be promoted where possible by burning when relative humididy is high and air temperatures are low, preferably after rain.
- Preference should be given to burning of areas with abundant dead (moribund) stem and leaf material that limits new growth.

Control of alien invasive plants

- While efforts have been made to eradicate areas of alien invasive plants, this work should be maintained to ensure that impacts to wetland areas are limited.

Livestock management

- The wetland is used extensively for livestock grazing. Care should be taken to ensure that stocking rates are in line with accepted norms to prevent overgrazing and associated loss of sensitive, palatable wetland species.
- Monitoring of livestock impacts around intervention sites is important to ensure that structures are not undermined. Where necessary, interventions should be fenced off to limit the risk of livestock damage.

Management of upstream dams

- It is important to note that dams negatively affect flows reaching wetland areas. As such, no new dams in the wetlands catchment are recommended without due consideration of the ecological reserve requirements for this wetland system.

Road crossings

- Existing road crossings associated with the district road have had a significant negative effect on the wetland. It will be important to ensure that the roads department are made aware of their impacts and that they do not destroy interventions during future road maintenance activities.

Erosion control

- Whilst interventions have been designed to address key areas affected by erosion, there is still a need to monitor these areas. Where necessary, reactive maintenance may be required to ensure that interventions continue to perform in an optimal manner.

4.8 Baseline M&E data

The collection of baseline information was carried out to show changes in the system associated with the wetland rehabilitation activities.

4.8.1 Erosion problems

The erosional features within the wetland are generally limited to channel incision and headcut erosion, and will therefore require monitoring. As such, a number of head-cuts have been targeted for rehabilitation. The effectiveness of rehabilitation efforts to halt erosion and secure upstream wetland areas can be monitored informally by checking that erosion has been appropriately de-activated.

4.8.2 Fixed point photography

In order to provide the ability to visually determine the degree of change within the wetland system photography of the wetland system has been taken prior to the implementation of wetland rehabilitation activities.

Locations

FPP Number	01	
GPS Location (DMS)	Latitude	28°16'19.27"S
	Longitude	29°49'17.00"E
Description of Photography Point		
Fixed point photograph showing the view east along a shallow drain and berm. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	02	
GPS Location (DMS)	Latitude	28°16'23.44"S
	Longitude	29°49'12.67"E
Description of Photography Point		
Fixed point photograph showing the view east from below intervention point V60B-01-222-00 along a heavily eroded drain. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	03	
GPS Location (DMS)	Latitude	28°16'24.06"S
	Longitude	29°49'15.33"E
Description of Photography Point		
Fixed point photograph showing the panoramic view north over area to be rewet by intervention V60B-01-222-00. A change in vegetation following rehabilitation activities is expected in this zone. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	04	
GPS Location (DMS)	Latitude	28°14'45.58"S
	Longitude	29°48'26.32"E
Description of Photography Point		
Fixed point photograph showing the view north of berm to be removed along the western edge of old pastures. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	05	
GPS Location (DMS)	Latitude	28°14'37.23"S
	Longitude	29°48'44.77"E
Description of Photography Point		
Fixed point photograph showing the view north-west towards intervention point V60B-01-214-00 of area to be rewet though rehabilitation. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	06	
GPS Location (DMS)	Latitude	28°14'40.76"S
	Longitude	29°48'48.10"E
Description of Photography Point		
Fixed point photograph showing the view north-west towards intervention point V60B-01-214-00 of area to be rewet though rehabilitation. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	07	
GPS Location (DMS)	Latitude	28°14'39.54"S
	Longitude	29°48'43.89"E
Description of Photography Point		
Fixed point photograph showing the view north north-west towards intervention point V60B-01-214-00 of area to be rewet though rehabilitation. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	08	
GPS Location (DMS)	Latitude	28°14'38.73"S
	Longitude	29°48'41.53"E
Description of Photography Point		
Fixed point photograph showing the view north towards intervention point V60B-01-214-00 of area to be rewet though rehabilitation. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	09A	
GPS Location (DMS)	Latitude	28°14'32.29"S
	Longitude	29°47'1.22"E
Description of Photography Point		
Fixed point photograph showing the panoramic view south towards intervention point V60B-01-201-00 of area to be rewet. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	09B	
GPS Location (DMS)	Latitude	28°14'32.29"S
	Longitude	29°47'1.22"E
Description of Photography Point		
Fixed point photograph showing the view north of area to be rewet through upstream intervention. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	10	
GPS Location (DMS)	Latitude	28°15'43.38"S
	Longitude	29°46'34.08"E
Description of Photography Point		
Fixed point photograph showing the view south-west along shallow channel of what appears to be historical drainage. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	11	
GPS Location (DMS)	Latitude	28°15'47.53"S
	Longitude	29°46'28.17"E
Description of Photography Point		
Fixed point photograph showing the view south-west towards intervention point of area to be rewet. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	12	
GPS Location (DMS)	Latitude	28°15'45.72"S
	Longitude	29°46'31.59"E
Description of Photography Point		
Fixed point photograph showing the view south south-west of shallow channel from what appears to be historic drainage. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	13	
GPS Location (DMS)	Latitude	28°14'17.73"S
	Longitude	29°49'25.80"E
Description of Photography Point		
Fixed point photograph showing the view north of headcut to be stabilised through planned interventions. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	14	
GPS Location (DMS)	Latitude	28°14'17.03"S
	Longitude	29°49'40.71"E
Description of Photography Point		
Fixed point photograph showing the view north of headcut to be stabilised through planned interventions. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	15	
GPS Location (DMS)	Latitude	28°14'6.28"S
	Longitude	29°49'28.14"E
Description of Photography Point		
Fixed point photograph showing the view north of headcut to be stabilised through planned interventions. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	16	
GPS Location (DMS)	Latitude	28°14'7.34"S
	Longitude	29°49'27.91"E
Description of Photography Point		
Fixed point photograph showing the view north north-east of headcut to be stabilised through planned interventions. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	17A	
GPS Location (DMS)	Latitude	28°14'59.26"S
	Longitude	29°46'18.31"E
Description of Photography Point		
Fixed point photograph showing the view east of recently excavated drainage above farm access road. Drain to be deactivated through planned interventions. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

FPP Number	17B	
GPS Location (DMS)	Latitude	28°14'59.26"S
	Longitude	29°46'18.31"E
Description of Photography Point		
Fixed point photograph showing the view south towards large berm of wetland area above active drainage. (Refer to photographs in Annexure 1B of the Wetland Report, Annexure A of this Report).		

Fixed Point Photographs

Refer to Annexure 1A of the Wetland Report found in Annexure A of this Report.

4.8.3 Baseline WET-Health data for Wetland Units A - H

The assessment of the current level of ecological integrity of the wetland system provides a baseline assessment for comparative assessments that would be carried out for monitoring purposes 3 years after completion of the wetland rehabilitation activities. The following WET-Health information was collected for each of the wetland units comprising the Boschberg Vlei (Refer to **Appendix A**):

Table 13: Summary of present wetland health of unit V60B-01A based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01A	28.4	3.0	-1	1.0	-1	3.8	-1
PES Category		**C**	↓	**B**	↓	**C**	↓
Wetland Impact Score		**2.68**					
Wetland PES		**C**					

Table 14: Summary of present wetland health of unit V60B-01B based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01B	23	5.2	0	1.8	0	5.4	0
PES Category		D	→	B	→	D	→
Wetland Impact Score		4.28					
Wetland PES		D					

Table 15: Summary of present wetland health of unit V60B-01C based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01C	10	3.0	0	0.2	0	3.3	0
PES Category		C	→	A	→	C	→
Wetland Impact Score		2.30					
Wetland PES		C					

Table 16: Summary of present wetland health of unit V60B-01D based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01D	42	2.0	0	0.1	0	3.6	0
PES Category		C	→	A	→	C	→
Wetland Impact Score		1.19					
Wetland PES		B					

Table 17: Summary of present wetland health of unit V60B-01E based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01E	83	4.0	0	3.7	0	5.1	0
PES Category		**D**	→	**C**	→	**D**	→
Wetland Impact Score		**4.23**					
Wetland PES		**D**					

Table 18: Summary of present wetland health of unit V60B-01F based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01F	7	0.7	-2	0.5	-2	2.9	-2
PES Category		**A**	↓↓	**A**	↓↓	**C**	↓↓
Wetland Impact Score		**1.28**					
Wetland PES		**B**					

Table 19: Summary of present wetland health of unit V60B-01G based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01G	2	2.0	-1	1.1	-1	3.8	-1
PES Category		**C**	↓	**B**	↓	**C**	↓
Wetland Impact Score		**2.26**					
Wetland PES		**C**					

Table 20: Summary of present wetland health of unit V60B-01H based on the Wet-Health assessment

Wetland Unit	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60B-01H	8	6.5	0	0.7	0	5.1	0
PES Category		**E**	→	**A**	→	**D**	→
Wetland Impact Score		**4.44**					
Wetland PES		**D**					

5 PADDA VLEI 1 –V60D-01

The assessment of the Padda Vlei 1 wetland V60D-01, its problems, and the development of the rehabilitation objectives are described in detail in **Appendix A**: Wetland Reports. The following subsections provide a brief summary for this wetland.

5.1 Wetland details

The Padda Vlei wetland is located in quaternary catchment V60D north of Wasbank in the KwaZulu-Natal Province (refer **Figure 3** in **Section 3** of this report). For the purposes of rehabilitation, the Padda Vlei wetland has been separated into two Wetland Projects: Padda Vlei 1 (V60D-01) is the main body of the wetland and Padda Vlei 2 (V60D-02) is a side arm of the weland that joins the main body of the wetland from the south. The wetland is privately owned, covering eight (8) different properties. The main upper reaches of the wetland occur on the farms “Uitzicht” and “Langiaagde” while the main body of the wetland occurs on the farm “Amalida”. The lower-most section of the wetland, where much of the impacts have taken place is on the farm “Padda Vlei”, with the toe of the wetland passing through the farm “Davels Berg”. **Table 22** provides a summary of the wetland details.

Table 21: Summary of the wetland details

Wetland Name	Padda Vlei 1
Wetland Number	V60D-01
River System Name	KwaMahlaba / Wasbank
Land Use in Catchment	Dominated by commercial livestock grazing
Land Use in Wetland	Livestock grazing
No. of Properties Intersecting Wetland Area	Multiple
Date of Planning Site Visit	6-7 June 2012
Wetland Assessor(s)	Doug Macfarlane
Wetland size	691 Ha

5.1.1 Motivation for selection

Padda Vlei 1 wetland V60D-01 has been selected for rehabilitation based on its size and position in the landscape, its ability to maintain base flows and improve water quality in the area, and its biodiversity value in terms of the wetland system being recognised as a National Freshwater Ecosystem Priority Area (NFEPA).

In previous years, the WfWetlands Programme identified work in the KZN North Wetland Project, specifically in the Blood River Wetland which is located in quaternary catchment V32G near the town of Vryheid, KwaZulu-Natal. After work in the Blood River Wetland

complex was complete, the focus shifted to the Padda Vlei wetland system as the next priority. This wetland has already received attention in previous planning cycles with the main focus of re-distributing water across the lower body of the wetland in order to re-wet the area and re-create wetland habitat. The wetland rehabilitation interventions proposed in this report will involve the completion of any outstanding wetland rehabilitation in the Padda Vlei wetland system. Padda Vlei is a SANBI Category 3 wetland project which refers to projects where wetlands have been prioritised for rehabilitation.

5.1.2 Description

Padda Vlei is a large (788ha) valley-bottom wetland located north of Glencoe in the upper reaches of the Wasbank River System. The KwaMahlaba River flows out of this wetland area and joins the Wasbank River near Glencoe. From here, it flows south past Wasbank before joining the Sundays and later the Tugela River. Padda Vlei 1 (V60D-01) encompasses the main body of the greater wetland and is approximately 691ha in extent.

Catchment: The catchment is relatively small given the extent of the wetland area. It is very steep in the upper reaches where the land rises steeply to the Biggaarsberg at a height of over 17oom. Most of the catchment is untransformed and dominated by grassland. A few wooded areas do occur in the catchment, but most are associated with alien plant (particularly A.mearnsii) encroachment. Catchment landuse is principally commercial livestock grazing with limited dryland agriculture. While a number of areas have clearly been used for cropping, there is little evidence of current use, with only limited maize lands along the eastern border of the catchment which were noted during field inspections.

Climate: The local climate is characterised by a mean annual precipitation of 846.8mm (summer rainfall region with thunderstorms) and a mean annual potential evapotranspiration of 1804.3mm. Mist occurs frequently on hilltops in spring and early summer but summer draughts are also frequent. Summers are warm to hot, with maximum temperatures typically recorded during January.

Vegetation: According to Mucina and Rutherford (2006) the natural vegetation type in the vicinity of the wetland is the Northern KwaZulu-Natal Moist Grassland (Gs4) falling within the Grassland Biome. This grassland is located almost entirely within the Thukela basin of the KwaZulu-Natal Province. The landscape features of this vegetation type are hilly and rolling topographies supporting tall tussock grassland usually dominated by *Themeda triandra* and *Hyparrhenia hirta*. Open savanoid woodlands encroach up the valleys on disturbed sites. This vegetation type has a conservation target of 24%, and 73.7% remains, although only 2% is statutorily conserved. More than a quarter has been transformed for cultivation, plantations, or infrastructure. Alien invasives and bush encroachment are other threats.

The wetland unit itself is dominated by hygrophilous grassland communities which occur in the drier (temporary and seasonal) zones of the wetland. Bulrushes (*Typha capensis*) occur in dense stands in permanently wet areas where water stands. Some areas of the wetland have however been altered through historic cultivation. Although cultivation is no longer

practiced in wetland areas, drains from historic attempts to lower the water table have had a significant effect on wetland hydrology and associated vegetation, particularly in the lower reaches of the wetland.

Geology and soils: According to Mucina and Rutherford (2006) the geology and soils in the area consists of mudstones, sandstones and shales of the Beaufort and Ecca groups of the Karoo Supergroup. These are intruded by dolerites of Jurassic age. An erosion resistant dyke of "Davelsberg" dolerite runs north-south directly across the toe of the wetland (Begg, 1989, and this is assumed to have controlled the formation and dynamics of the wetland system. It appears that the intrusion of this erosion resistant rock formation prevented down-cutting of the KwaMahlaba River thereby promoting sediment deposition and the detention of water in the shallow basin, which has contributed to wetland formation.

Overview & Assessment: Most of the wetland is un-channelled, although a channel has developed along certain sections of the wetland. The head of the wetland is located at an altitude of 1380m a.s.l, and from here it extends some 8km in a south-easterly direction to its oulet below a district road crossing at 1335m a.s.l. The average slope of the wetland (taken from top to toe) is 0.56%, however the main body of the wetland has a very gentle slope of <0.1%. The generally low gradient, small catchment area and low anticipated discharges suggest that this wetland is likely to have a generally low vulnerability to erosion.

Very minor reductions in flow through the wetland could be attributed to alien plant infestations which cover an estimated 5% of the catchment, and plantations which cover less than 2% of the catchment. Although cultivation is no longer practiced in the wetland areas, the agricultural drains from historic attempts to lower the water table have had a significant effect on wetland hydrology and associated vegetation, especially in the lower reaches. The greater wetland area therefore only has a moderate vulnerability to hydrological impacts (changes in water input volumes and patterns) associated with the catchment activities.

The catchment of Padda Vlei 1 (V60D-01) is largely intact wetland with limited impacts to wetland integrity. The wetland unit has been altered through historic cultivation, agricultural drains and commercial livestock activities, and the unit can be described as being in a Moderately Modified state. The unit is currently used for grazing and livestock watering purposes. The most obvious impacts are to wetland vegetation and wetland hydrology whilst impacts to geomorphology processes are not as significant. Although threats are limited, there is likely to be a slow deterioration in present state if no rehabilitation measures are implemented:

- **Hydrology:** The wetland report indicates that the Padda Vlei 1 wetland unit hydrology is categorised as Moderately Modified. The major impacts to the hydrological integrity of the system are associated with artificial drainage channels constructed through sections to reduce flooding and to allow for crop production. Channel incision is also a concern. Historical overgrazing may have contributed to a moderate reduction in basal cover and localised compaction and erosion. This is likely to have contributed to some increase in runoff, resulting in slightly elevated

flood peaks. Current threats to the hydrological integrity of the wetland unit are limited, with very few anticipated changes in catchment landuse.

- **Geomorphology:** The wetland report indicates that the Padda Vlei 1 wetland unit has a Moderate Vulnerability to geomorphological impacts, although current impacts are apparent but limited. The main causes of changes are associated with drainage and erosion in the wetland system. A number of active head-cuts are present and threats associated with these features are evident. Change is likely to proceed slowly and dissipate a relatively short distance upstream of the head-cuts identified. Geomorphic threats are generally regarded as low, but with a potential for slow deterioration in geomorphic integrity if no rehabilitation is undertaken.
- **Vegetation:** The current state of vegetation is regarded as Moderately Modified. Livestock grazing is the dominant form of landuse in the Padda Vlei 1 wetland unit. While there is evidence that this landuse may have some impact on the wetland vegetation (e.g. at drinking and crossing points), this use appears to be reasonably well managed. Infrastructure (dams, roads) and historic actions such as the construction of drains through sections of the wetland have however had a notable effect on wetland vegetation. The main impact is therefore associated with areas of the wetland that were previously cultivated, where agricultural drains have transformed these sections into what is now effectively terrestrial habitat.

5.1.3 Rehabilitation

The main aims of the rehabilitation work in the Padda Vlei wetland system to date have been the re-distribution of water across the lower body of the wetland in order to re-wet the area and re-create wetland habitat. The 2014/2015 planning cycle addresses the problems related to drainage and associated cultivation in the wetland area, transformation of natural vegetation, habitat transformation as well as headcut erosion and associated erosion at the site.

5.1.4 Site photos

View towards secondary head-cut threatening upstream wetland area, northern region of the site area

View towards main head-cut in the northern region of the site area. Note intact wetland vegetation upstream

Another secondary head-cut developing in the northern region of the site area

View along cattle access path (considered for vehicular access)

Figure 29: Site Photos of the Padda Vlei 1 Wetland

5.2 Wetland problems

The entire wetland, comprising the main body of the wetland (Padda Vlei 1) and the side-arm of the wetland (Padda Vlei 2), has been subjected to a number of impacts (**Figure 30**) associated with the modification of the system's hydrology. As such, the ecological integrity of the Padda Vlei 1 and 2 wetland system has been impacted by several factors including:

- Drainage by artificial drainage channels (furrows) and associated cultivation;
- Head-cut formation and associated erosion and/or channel incision;
- Transformation of natural vegetation by historic cultivation and alien plant infestation; and
- Habitat transformation and alteration of natural hydrological processes by dams and roads.

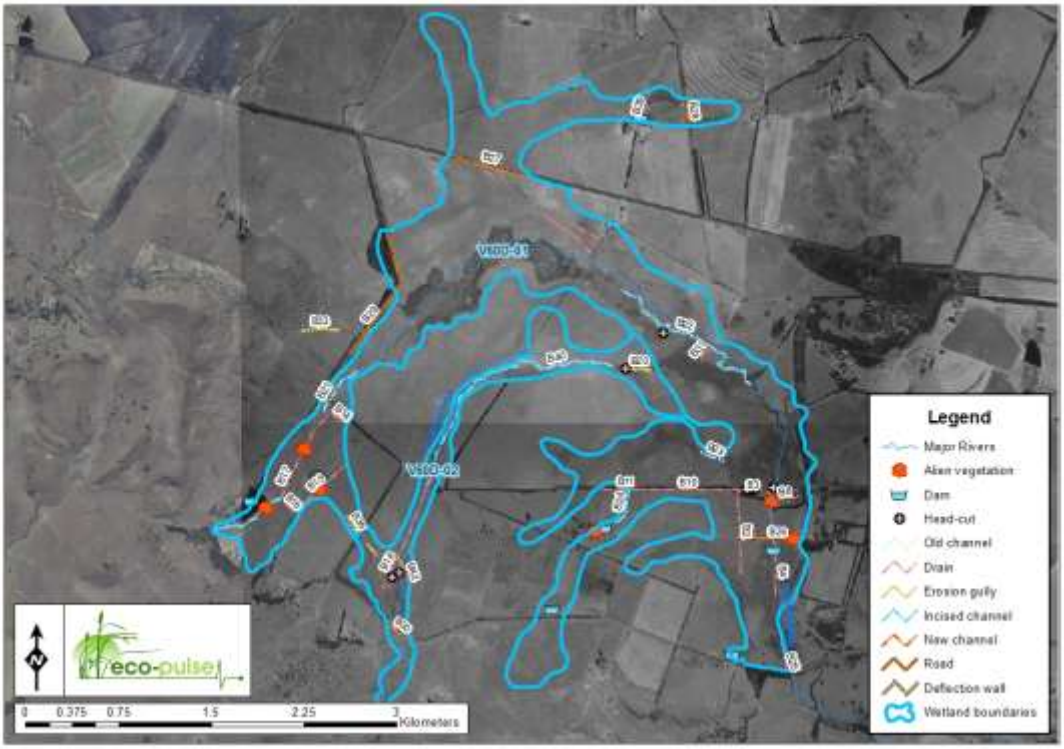

Figure 30: Problems identified within wetland V60D-01 and 02.

5.3 Rehabilitation objectives

The primary objective of the rehabilitation is to re-distribute water across the lower body of the wetland in order to re-wet the area and re-create wetland habitat. The secondary objective is to remove alien invasive vegetation to encourage colonisation by natural vegetation.

5.4 Summary of proposed interventions

The table below (**Table 22**) provides a summary of the new interventions. The "implementation order" as depicted in the table indicates the timing order in which interventions should be implemented within the wetland (number 1 first). The "priority" as depicted in the table indicates the relative importance of each intervention across the project as a whole – if interventions have to be omitted for any reason, those with the lowest priority (highest number) across the whole project should be omitted first.

Please note that the location of the interventions described in **Sections 3.5** and **5.5** may change as a result of changes in the landscape (due to continued erosion, for example) during the time period that has lapsed between the initial planning site visit and the actual implementation thereof.

Table 22: Summary of proposed new interventions, V60D-01

Intervention Number	Intervention Structure Type	Implementation Order	Priority	Structure Cost (Excl. Vat)
V60D-01-206-00	Concrete Buttress Weir with Sack Gabion Protection	1	1	R 816 109.80
V60D-01-207-00	Reno Mattress Chute with Sack Gabion Protection	1	1	R 95 222.70
V60D-01-209-00	Access Road, Dish Drains and Concrete Strips	5	5	R 673 522.00
Total				**R 1 584 854.50**

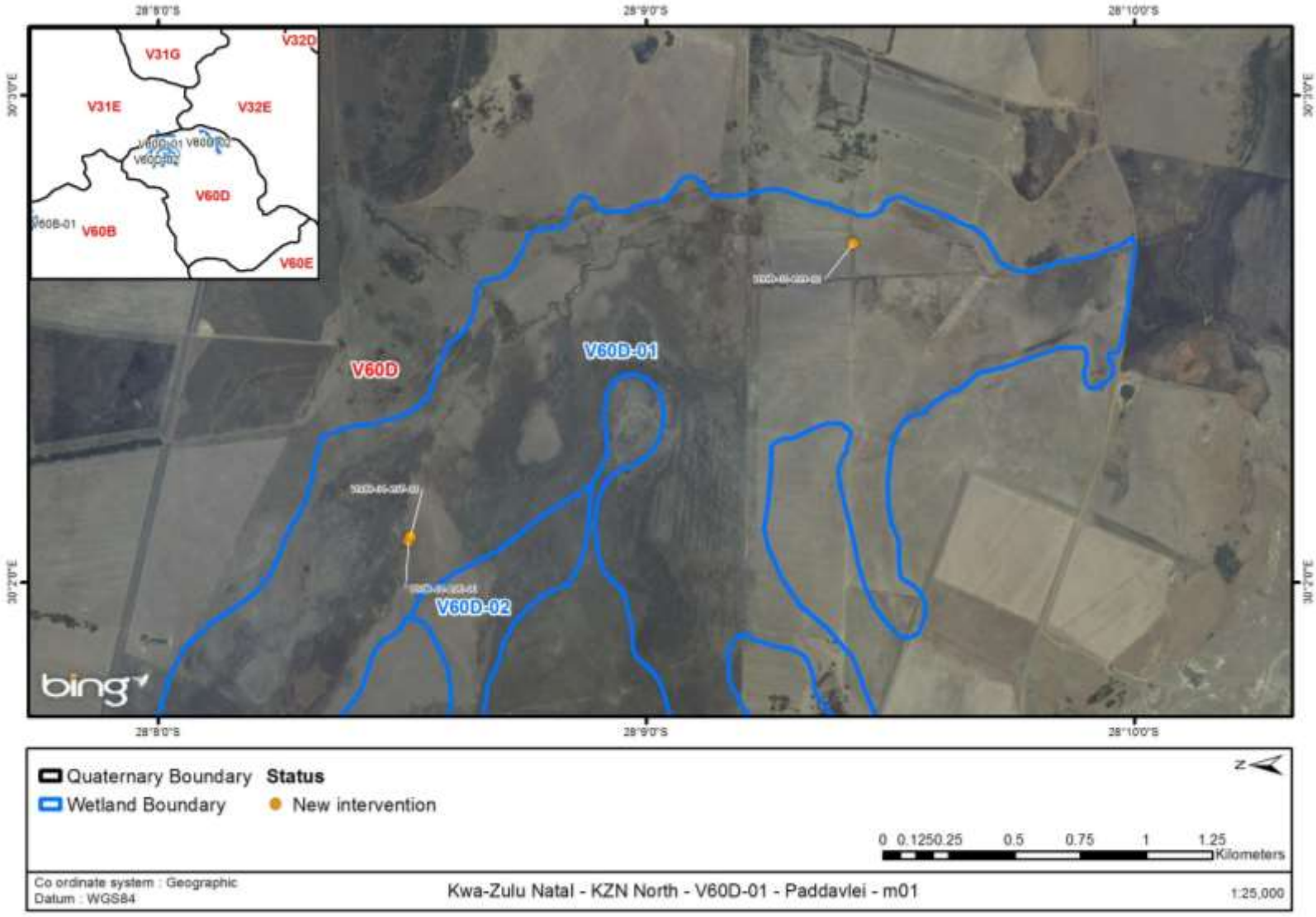

Figure 31: Wetland map, V60D-01 with proposed new wetland interventions indicated.

5.4.1 Design selection and sizing

The design type was selected for the following reasons:

- Earthen plugs and vegetation were specified where appropriate to increase the labour component on the project.
- Weirs were selected to provide stability to the channel and headcuts
- Concrete interventions were specified where robust structures were required to stabilise and deactivate headcut erosion.
- Concrete structures were specified where water is to flow over a central spillway of the structure since the construction material must be hard enough to withstand a constant flow of water.
- Earthern berms/plugs were also selected to deactivate the side channel, since the natural/original flow of water would be at right angles to the plug, therefore minimising the risk of failure of the berm.
- Gabion weirs were selected to stabilise the channels in areas where impermeable interventions were not required

and sized for the following reasons:

- For practical purposes, the spillway width of concrete weirs will be that of the incised channel. This is to avoid unnecessary earth works.
- The structures/interventions were sized in order to address the problems as measured on site during the design site visit and to achieve the desired objectives based on the hydrological and structural analysis.

5.5 Intervention designs

5.5.1 Intervention: V60D-01-206-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Concrete Buttress Weir with Sack Gabion Protection
Rehabilitation Objective	To deactivate multiple headcut erosion
Latitude (DºM'S")	28°08'30.80"S
Longitude (DºM'S")	30°02'05.21"E
Engineering Drawings	V60D-01-206-00

Figure 32: Photo of proposed site for Concrete Buttress Weir with Sack Gabion Protection, intervention V60D-01-206-00

5.5.1.1 Bill of quantities: V60D-01-206-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	47.30	R 6 426.00	R 303 949.80
Sack Gabion Volume	m^3	48.00	R 10 670.00	R 512 160.00
			Total	**R 816 109.80**

5.5.1.2

5.5.1.3 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

5.5.2 Intervention: V60D-01-207-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Reno Mattress Chute with Sack Gabion Protection
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°08'30.98"S
Longitude (DºM'S")	30°02'05.71"E
Engineering Drawings	V60D-01-207-00

Figure 33: Photo of proposed site for Reno Mattress Chute with Sack Gabion Protection, intervention V60D-01-207-00

5.5.2.1 Bill of quantities: V60D-01-207-00

Item	Units	Quantity	Unit Cost	Item Cost
2x1x0.3 Reno Mattress Volume	m^3	6.00	R 10 670.00	R 64 020.00
650mm diameter Sack Gabion Volume	m^3	2.00	R 10 670.00	R 21 340.00
Concrete (30MPa) Volume	m^3	0.75	R 6 426.00	R 4 819.50
Excavation Volume	m^3	8.20	R 416.00	R 3 411.20
Revegetation Area	m^2	48.00	R 34.00	R 1 632.00
			Total	**R 95 222.70**

5.5.2.2 Construction Notes:

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

5.5.3 Intervention: V60D-01-209-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Access Road, Dish Drains and Concrete Strips
Rehabilitation Objective	To prevent vehicle disturbance to the wetland.
Latitude (DºM'S")	28°09'25.45"S
Longitude (DºM'S")	30°02'41.75"E
Engineering Drawings	V60D-01-209-00

Figure 34: Photo of proposed site for Access Road, Dish Drains and Concrete Strips, intervention V60D-01-209-00

5.5.3.1 Bill of quantities: V60D-01-209-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete (30MPa) Volume	m^3	80.00	R 6 426.00	R 514 080.00
Excavation Volume	m^3	202.00	R 416.00	R 84 032.00
Earth Structures Volume	m^3	78.00	R 860.00	R 67 080.00
Revegetation Area	m^2	245.00	R 34.00	R 8 330.00
			Total	**R 673 522.00**

5.5.3.2 Construction Notes:

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

5.6 Construction Environmental Management Plan issues

The proposed rehabilitation is to be undertaken on privately owned land and the project team should access the site and manage the site in accordance with the WfWetlands Best Management Practices and specific requirements of the landowner. The implementation of these interventions must also take into account all relevant provisions of WfWetlands Best Management Practices and the Construction Environmental Management Plan (CEMP), the recommendations of the approved Basic Assessments and Environmental Authorisation for the project.

The general construction notes, the Construction phase EMP (CEMP) are included as **Appendix B and F**.

5.7 Wetland management recommendations

The following management recommendations are relevant to this wetland unit:

Management of agricultural lands in the wetlands catchment

- Agricultural use of herbicides, pesticides and fertilizers in the vicinity of the wetland should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetland.
- A buffer of at least 20m should be maintained between any agricultural lands and wetland areas as far as possible so as to limit impacts associated with sedimentation and pollutant runoff.

Fire management

- With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm p. a.) an area of wetland should be burnt every 4 to 5 years.
- Cool and patchy burns should be promoted where possible by burning when relative humidity is high and air temperatures are low, preferably after rain.
- Preference should be given to burning of areas with abundant dead (moribund) stem and leaf material that limits new growth.
- While most species are summer breeders, crane species are winter to early-spring breeders. The location of breeding areas should therefore be noted and careful planning of burning should then be undertaken to ensure that burning does not take place while birds are nesting or before chicks have fledged and can vacate the area. If burning is required during the breeding season, the Endangered Wildlife Trust - African Crane Conservation Programme should be contacted for further advice / assistance. Where cranes breed, it is vitally important to ensure that sufficient tall vegetation areas remain un-burnt for chicks to hide from predators.
- Autumn/early winter breeding species such as the marsh owl and marsh harrier may be negatively impacted by early winter burning. Where these species occur, burn rotationally through block burning and check before burning by having 'beaters' 10 m apart walking through the area and then closely examining all localities where these birds are flushed. Leave areas un-burnt where chicks have still not fledged, or, if possible, delay burning for that year.

Control of alien invasive plants

- Alien invasive plants, specifically wattle (*Acacia mearnsii*) occurring in the wetland have been cleared during rehabilitation activities. Follow-up and maintenance will be required to ensure that these areas are effectively controlled.

Livestock management

Livestock can have a significant impact on wetland vegetation and the species that utilise wetland areas. In response to these concerns, the following guidelines should be followed:

- During the rehabilitation phase, there may be a need to keep livestock away from areas that are busy recovering (e.g. areas where vegetation has been replanted).
- Berms should be monitored to ensure that these are not being negatively impacted by cattle trampling – if necessary, protective fences should be placed around these structures to prevent damage by livestock.
- Livestock numbers should be maintained within acceptable carrying capacities to ensure that species composition is not compromised and trampling does not lead to further erosion of wetland areas.
- If necessary, the Department of Agriculture should be called upon to determine the grazing capacity for the bioclimatic region in which the wetland is located. As a general rule, grazing capacity in temporary wetland areas can be estimated as 1.5 times that of dryland areas, while grazing within seasonal and permanently wet areas should be restricted to 0.5AU/ha during the spring months. Where important biota occur, further advice should be sought by an Agricultural Extension Officer.
- Where cattle trampling is causing significant disturbance near drinking points, alternative water sources should be provided or the area hardened to reduce the potential for erosion.

Road crossings

- No further roads should be permitted to be constructed across wetland areas.
- Further drainage to lower the water levels adjacent to existing roads should be avoided.

5.8 Baseline M&E data

The collection of baseline information was carried out to show changes in the system associated with the wetland rehabilitation activities.

5.8.1 Baseline WET-Health data

The assessment of the current level of ecological integrity of the wetland system provides a baseline assessment for comparative assessments that would be carried out for monitoring purposes 3 years after completion of the wetland rehabilitation activities. The following WET-Health information was collected for the Padda Vlei 1 wetland (Refer to **Appendix A**):

Table 23: Summary of present wetland health of V60D-01 based on the Wet-Health assessment

Wetland No	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60D-01	700	2.3	-1	1.5	-1	3.0	-1
PES Categories		**B**	↓	**B**	↓	**C**	↓
Wetland Impact Score		**2.26**					
Wetland PES		**C**					

6 PADDA VLEI 2 –V60D-02

The assessment of the Padda Vlei 2 wetland V60D-02, its problems, and the development of the rehabilitation objectives are described in detail in Appendix A: Wetland Reports. The following sections provide a brief summary for this wetland.

6.1 Wetland details

The Padda Vlei wetland is located in quaternary catchment V60D north of Wasbank in the KwaZulu-Natal Province (refer **Figure 3** in **Section 3** of this report). For the purposes of rehabilitation, the Padda Vlei wetland has been separated into two Wetland Projects: Padda Vlei 1 (V60D-01) is the main body of the wetland and Padda Vlei 2 (V60D-02) is a side arm of the weland that joins the main body of the wetland from the south. The wetland is privately owned, covering eight (8) different properties. The main upper reaches of the wetland occur on the farms “Uitzicht” and “Langiaagde” while the main body of the wetland occurs on the farm “Amalida”. The lower-most section of the wetland, where much of the impacts have taken place is on the farm “Padda Vlei”, with the toe of the wetland passing through the farm “Davels Berg”. **Table 24** provides a summary of the wetland details.

Table 24: Summary of the wetland details

Wetland Name	Padda Vlei 2
Wetland Number	V60D-02
River System Name	KwaMahlaba / Wasbank
Land Use in Catchment	Dominated by commercial livestock grazing
Land Use in Wetland	Livestock grazing
No. of Properties Intersecting Wetland Area	Multiple
Date of Planning Site Visit	6-7 June 2012
Wetland Assessor(s)	Doug Macfarlane
Wetland size	97 Ha

6.1.1 Motivation for selection

Padda Vlei 2 wetland V60D-02 has been selected for rehabilitation as it is the side arm of the main wetland body (V60D-01) that joins the wetland from the south. In addition, it is a priority wetland in terms of its ability to maintain base flows and improve water quality in the area, as well as its biodiversity value in terms of the wetland system being recognised as a National Freshwater Ecosystem Priority Area (NFEPA).

In previous years, the WfWetlands Programme identified work in the KZN North Wetland Project, specifically in the Blood River Wetland which is located in quaternary catchment V32G near the town of Vryheid, KwaZulu-Natal. After work in the Blood River Wetland complex was complete, the focus shifted to the Padda Vlei wetland system as the next priority. This wetland has already received attention in previous planning cycles with the main focus of re-distributing water across the lower body of the wetland in order to re-wet the area and re-create wetland habitat. The wetland rehabilitation interventions proposed in this report will involve the completion of any outstanding wetland rehabilitation in the Padda Vlei wetland system. Padda Vlei is a SANBI Category 3 wetland project which refers to projects where wetlands have been prioritised for rehabilitation.

6.1.2 Description

Padda Vlei is a large (788ha) valley-bottom wetland located north of Glencoe in the upper reaches of the Wasbank River System. The KwaMahlaba River flows out of this wetland area and joins the Wasbank River near Glencoe. From here, it flows south past Wasbank before joining the Sundays and later the Tugela River. Padda Vlei 2 (V60D-02) is the side arm of the wetland and is approximately 97ha in extent.

Catchment: The catchment is relatively small given the extent of the wetland area. It is very steep in the upper reaches where the land rises steeply to the Biggaarsberg at a height of over 17oom. Most of the catchment is untransformed and dominated by grassland. A few wooded areas do occur in the catchment, but most are associated with alien plant (particularly *A.mearnsii*) encroachment. Catchment landuse is principally commercial livestock grazing with limited dryland agriculture. While a number of areas have clearly been used for cropping, there is little evidence of current use, with only limited maize lands along the eastern border of the catchment which were noted during field inspections.

Climate: The local climate is characterised by a mean annual precipitation of 846.8mm (summer rainfall region with thunderstorms) and a mean annual potential evapotranspiration of 1804.3mm. Mist occurs frequently on hilltops in spring and early summer but summer draughts are also frequent. Summers are warm to hot, with maximum temperatures typically recorded during January.

Vegetation: According to Mucina and Rutherford (2006) the natural vegetation type in the vicinity of the wetland is the Northern KwaZulu-Natal Moist Grassland (Gs4) falling within the Grassland Biome. This grassland is located almost entirely within the Thukela basin of the KwaZulu-Natal Province. The landscape features of this vegetation type are hilly and rolling topographies supporting tall tussock grassland usually dominated by *Themeda triandra* and *Hyparrhenia hirta*. Open savanoid woodlands encroach up the valleys on disturbed sites. This vegetation type has a conservation target of 24%, and 73.7% remains, although only 2% is statutorily conserved. More than a quarter has been transformed for cultivation, plantations, or infrastructure. Alien invasives and bush encroachment are other threats.

The wetland unit itself is dominated by hygrophilous grassland communities which occur in the drier (temporary and seasonal) zones of the wetland. Bulrushes (*Typha capensis*) occur in dense stands in permanently wet areas where water stands. Some areas of the wetland have however been altered through historic cultivation. Although cultivation is no longer practiced in wetland areas, drains from historic attempts to lower the water table have had a significant effect on wetland hydrology and associated vegetation, particularly in the lower reaches of the wetland.

Geology and soils: According to Mucina and Rutherford (2006) the geology and soils in the area consists of mudstones, sandstones and shales of the Beaufort and Ecca groups of the Karoo Supergroup. These are intruded by dolerites of Jurassic age. An erosion resistant dyke of "Davelsberg" dolerite runs north-south directly across the toe of the wetland (Begg, 1989, and this is assumed to have controlled the formation and dynamics of the wetland system. It appears that the intrusion of this erosion resistant rock formation prevented down-cutting of the KwaMahlaba River thereby promoting sediment deposition and the detention of water in the shallow basin, which has contributed to wetland formation.

Overview & Assessment: Most of the wetland is un-channelled, although a channel has developed along certain sections of the wetland. The head of the wetland is located at an altitude of 1380m a.s.l, and from here it extends some 8km in a south-easterly direction to its oulet below a district road crossing at 1335m a.s.l. The average slope of the wetland (taken from top to toe) is 0.56%, however the main body of the wetland has a very gentle slope of <0.1%. The generally low gradient, small catchment area and low anticipated discharges suggest that this wetland is likely to have a generally low vulnerability to erosion.

Very minor reductions in flow through the wetland could be attributed to alien plant infestations which cover an estimated 5% of the catchment, and plantations which cover less than 2% of the catchment. Although cultivation is no longer practiced in the wetland areas, the agricultural drains from historic attempts to lower the water table have had a significant effect on wetland hydrology and associated vegetation, especially in the lower reaches. The greater wetland area therefore only has a moderate vulnerability to hydrological impacts (changes in water input volumes and patterns) associated with the catchment activities.

The catchment of Padda Vlei 2 (V60D-02) is largely intact, with limited impacts to wetland integrity. Historical landuse practices within the wetland system, particularly drainage has however had a significant negative impact on this wetland unit such as considerable erosion and loss in functioning. The unit is currently used for grazing and livestock watering purposes. The unit can be described as being in a Largely Modified state. The most obvious impacts are to wetland vegetation and hydrology while those to wetland geomorphology are regarded as less intense:

- **Hydrology:** The wetland report indicates that the Padda Vlei 2 wetland unit hydrology is categorised as Largely Modified. The major impacts to the hydrological integrity of the system are associated with extensive erosion (head-cuts) in the central reaches of the wetland. Historical overgrazing may have contributed to a moderate reduction in basal cover and localised compaction and erosion. This is

likely to have contributed to some increase in runoff, resulting in slightly elevated flood peaks. Alien invasive plant encroachment is also an issue. A large dam is located in the upper reaches of this wetland unit, but does not appear to be used for irrigation purposes. It is likely to have a small impact on flows. Given that much of the wetland unit is already affected by channel incision, current threats to the hydrological integrity of the wetland unit are limited, with very few anticipated changes in catchment landuse. The main area of concern from a rehabilitation perspective is a number of head-cuts which do threaten certain areas of the wetland.

- **Geomorphology:** The wetland report indicates that the Padda Vlei 2 wetland unit has a Moderately Low Vulnerability to geomorphological impacts, although current impacts are apparent but limited. The main causes of changes are associated with drainage and erosion in the wetland system. Three active head-cuts are present and threats associated with these features are evident. The head-cut erosion of gullies leads to the transportation and deposition of sediment within the wetland unit. Although the system has a Moderately Low Vulnerability to geomorphological impacts, threats associated with the head-cuts are considerably higher, particularly for those located in the upper reaches of the wetland unit. While current planning is focused on the lower head-cut, future efforts will be required to prevent further erosion in the upper wetland areas.
- **Vegetation:** The current state of vegetation is regarded as Largely Modified. Livestock grazing is the dominant form of landuse in the Padda Vlei 2 wetland unit. While there is evidence that this landuse may have some impact on the wetland vegetation (e.g. at drinking and crossing points), this use appears to be reasonably well managed. Channel incision and drainage has however had a very clear impact on wetland vegetation. The dam in the upper reaches of the wetland unit is also likely to have had some impact on the wetland vegetation downstream by altering water inputs to the downstream wetland area.

6.1.3 Rehabilitation

The main aims of the rehabilitation work in the Padda Vlei wetland system to date have been the re-distribution of water across the lower body of the wetland in order to re-wet the area and re-create wetland habitat. The 2014/2015 planning cycle addresses the problems related to drainage and associated cultivation in the wetland area, transformation of natural vegetation, habitat transformation as well as headcut erosion and associated erosion at the site.

6.1.4 Site photos

View over largely intact wetland area but heavily overgrazed by livestock

View over largely intact wetland area upstream of advancing head-cut

View over large head-cut developing upstream of main erosion gully

View over large erosion gully that has significantly impacted on this upper wetland system

Head-cut advancing up a man-made drain. Unless halted, it will continue to erode upstream, threatening intact wetland habitat

Upper reaches of drain with some evidence of head-cut development

Figure 35: Site Photos of the Padda Vlei 2 Wetland

6.2 Wetland problems

The entire wetland, comprising the main body of the wetland (Padda Vlei 1) and the side-arm of the wetland (Padda Vlei 2), has been subjected to a number of impacts (**Figure 36**) associated with the modification of the system's hydrology. As such, the ecological integrity of the Padda Vlei 1 and 2 wetland system has been impacted by several factors including:

- Drainage by artificial drainage channels (furrows) and associated cultivation;
- Head-cut formation and associated erosion and/or channel incision;
- Transformation of natural vegetation by historic cultivation and alien plant infestation; and
- Habitat transformation and alteration of natural hydrological processes by dams and roads.

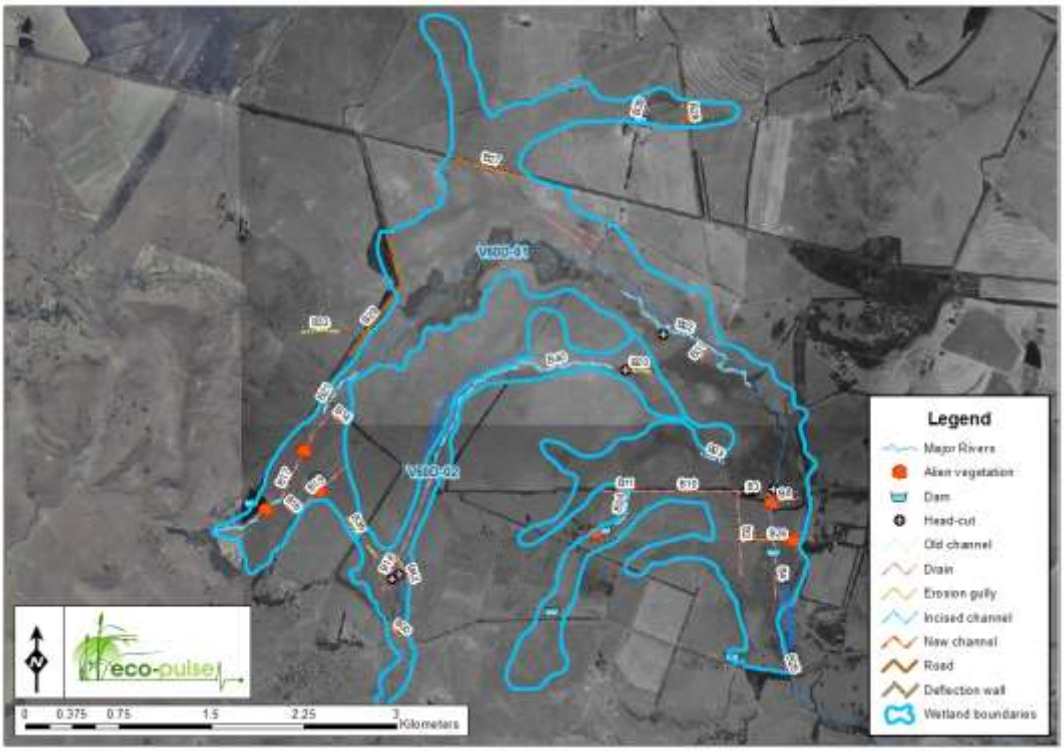

Figure 36: Problems identified within wetland V60D-01 and 02.

6.3 Rehabilitation objectives

The primary objective of the rehabilitation is to deactivate head-cuts threatening upper intact wetland area and contributing to sediment loads downstream. Other objectives are to deactivate head cuts threatening lower intact reaches of the wetland and to re-distribute water across area affected by erosion in order to re-instate natural wetness regimes.

6.4 Summary of proposed interventions

The table below (**Table 25**) provides a summary of the new interventions. The "implementation order" as depicted in the table indicates the timing order in which interventions should be implemented within the wetland (number 1 first). The "priority" as depicted in the table indicates the relative importance of each intervention across the project as a whole – if interventions have to be omitted for any reason, those with the lowest priority (highest number) across the whole project should be omitted first.

Please note that the location of the interventions described in **Sections 3.5** and **6.5** may change as a result of changes in the landscape (due to continued erosion, for example) during the time period that has lapsed between the initial planning site visit and the actual implementation thereof.

Table 25: Summary of proposed new interventions, V60D-02

Intervention Number	Intervention Structure Type	Implementation Order	Priority	Structure Cost (Excl. Vat)
V60D-02-201-00	Concrete Buttress Weir	1	1	R89,964.00
V60D-02-202-00	Reno Mattress Chute	2	2	R 428 400.00
V60D-02-203-00	Concrete Drop Inlet Weir with Extended Concrete Wing Wall	2	2	R658,022.40
V60D-02-206-00	Gabion Wall with Reno Mattress Downstream Protection	3	3	R 218 421.00
V60D-02-207-00	Gabion Wall with Reno Mattress Downstream Protection	3	3	R 219 696.00
V60D-02-208-00	Concrete Drop Inlet Weir	3	3	R134,946.00
Total				**R 1 749 449.40**

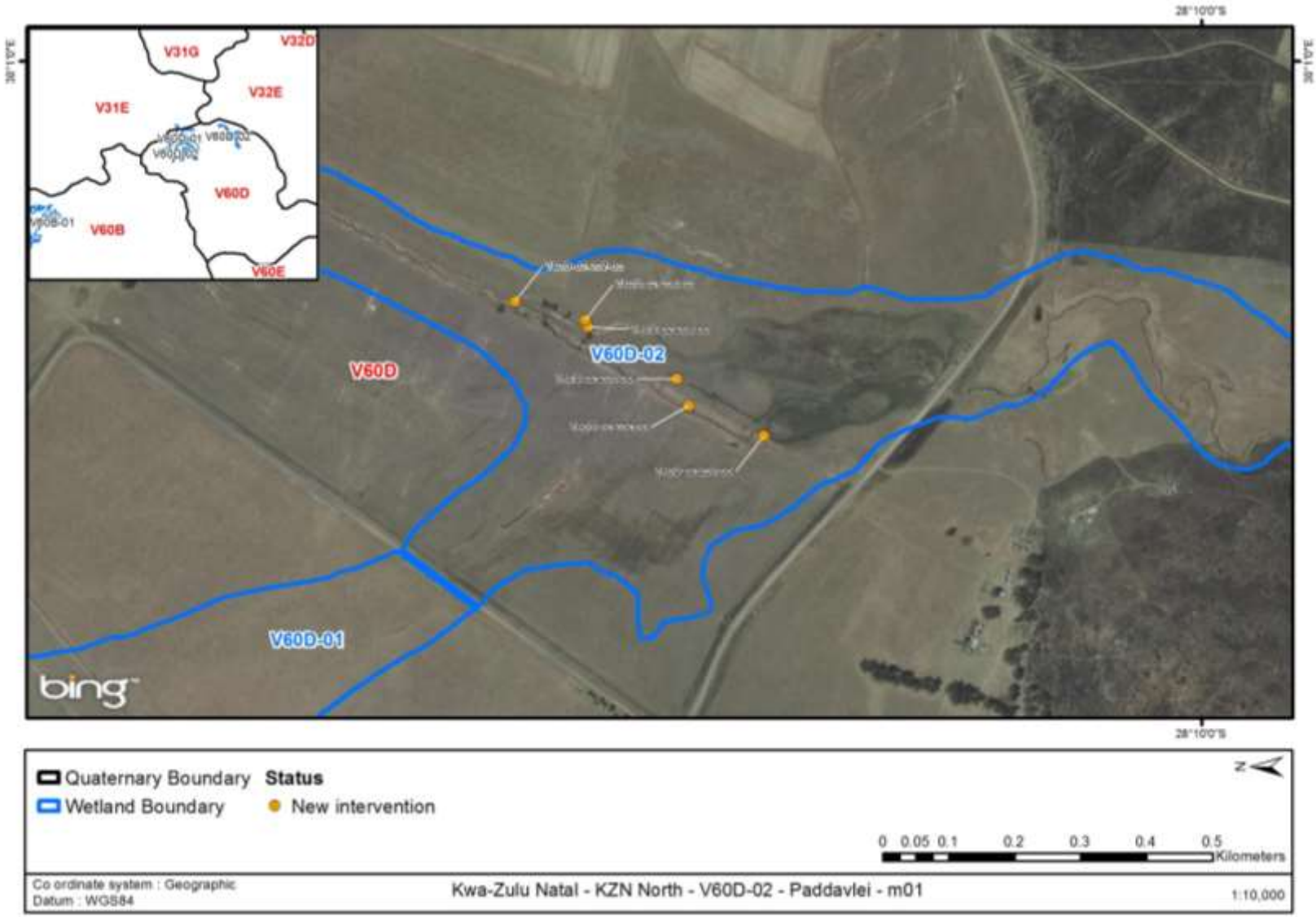

Figure 37: Wetland map, V60D-02 with proposed new wetland interventions indicated.

6.4.1 Design selection and sizing

The design type was selected for the following reasons:

- Concrete interventions were selected to deactivate headcut erosion where a robust and impermeable intervention was required;
- Concrete diversion walls were specified in high flow and high energy environments;
- Earthen diversion berms were selected in low energy environments;
- Gabion interventions were specified to stabilise the channel and prevent vertical incision.

Furthermore, the design was sized for the following reasons:

- The structures/interventions were sized in order to address the problems as measured on site during the design site visit and to achieve the desired objectives based on the hydrological and structural analysis.

6.5 Intervention designs

6.5.1 Intervention: V60D-02-201-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Buttress Weir
Rehabilitation Objective	To stabilise the channel and prevent vertical incision.
Latitude (DºM'S")	28°09'38.52"S
Longitude (DºM'S")	30°00'41.62"E
Engineering Drawings	V60D-02-201-00

Figure 38: Photo of proposed site for Concrete Buttress Weir, intervention V60D-02-201-00

6.5.1.1 Bill of quantities: V60D-02-201-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	14.00	R 6 426.00	R 89 964.00
			Total	**R 89 964.00**

6.5.1.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:

    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.5.2 Intervention: V60D-02-202-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Reno Mattress Chute
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°09'34.81"S
Longitude (DºM'S")	30°00'43.09"E
Engineering Drawings	V60D-02-202-00

Figure 39: Photo of proposed site for Reno Mattress Chute, intervention V60D-02-202-00

6.5.2.1 Bill of quantities: V60D-02-202-00

Item	Units	Quantity	Unit Cost	Item Cost
Gabion Rock Volume	m^3	38.40	R 10 670.00	R 409 728.00
Excavation Volume	m^3	39.00	R 416.00	R 16 224.00
Revegetation Area	m^2	72.00	R 34.00	R 2 448.00
			Total	**R 428 400.00**

6.5.2.2 Construction Notes:

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).

c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.5.3 Intervention: V60D-02-203-00

Designer	Trevor Pike
Design Date	December 2013
Intervention Description	Concrete Drop Inlet Weir with Extended Concrete Wing Wall
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°09'34.24"S
Longitude (DºM'S")	30°00'44.42"E
Engineering Drawings	V60D-02-203-00

Figure 40: Photo of proposed site for Concrete Drop Inlet Weir with Extended Concrete Wing Wall, intervention V60D-02-203-00

6.5.3.1 Bill of quantities: V60D-02-203-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	102.40	R 6 426.00	R 658 022.40
			Total	**R 658 022.40**

6.5.3.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:

    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.5.4 Intervention: V60D-02-206-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Gabion Wall with Reno Mattress Downstream Protection
Rehabilitation Objective	To deactivate headcut erosion and create an artificial control to prevent vertical channel incision.
Latitude (DºM'S")	28°09'29.74"S
Longitude (DºM'S")	30°00'47.34"E
Engineering Drawings	V60D-02-206-00

Figure 41: Photo of proposed site for Gabion Wall with Reno Mattress Downstream Protection, intervention V60D-02-206-00

6.5.4.1 Bill of quantities: V60D-02-206-00

Item	Units	Quantity	Unit Cost	Item Cost
Gabion Rock Volume	m^3	19.50	R 10 670.00	R 208 065.00
Excavation Volume	m^3	19.50	R 416.00	R 8 112.00
Revegetation Area	m^2	66.00	R 34.00	R 2 244.00
			Total	**R 218 421.00**

6.5.4.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.5.5 Intervention: V60D-02-207-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Gabion Wall with Reno Mattress Downstream Protection
Rehabilitation Objective	To create an artificial control to prevent vertical channel incision.
Latitude (DºM'S")	28°09'26.28"S
Longitude (DºM'S")	30°00'48.24"E
Engineering Drawings	V60D-02-207-00

Figure 42: Photo of proposed site for Gabion Wall with Reno Mattress Downstream Protection, intervention V60D-02-207-00

6.5.5.1 Bill of quantities: V60D-02-207-00

Item	Units	Quantity	Unit Cost	Item Cost
Gabion Rock Volume	m^3	19.60	R 10 670.00	R 209 132.00
Excavation Volume	m^3	20.00	R 416.00	R 8 320.00
Revegetation Area	m^2	66.00	R 34.00	R 2 244.00
			Total	**R 219 696.00**

6.5.5.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)

d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.
e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:
    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.5.6 Intervention: V60D-02-208-00

Designer	Trevor Pike
Design Date	November 2013
Intervention Description	Concrete Drop Inlet Weir
Rehabilitation Objective	To deactivate headcut erosion.
Latitude (DºM'S")	28°09'29.88"S
Longitude (DºM'S")	30°00'46.98"E
Engineering Drawings	V60D-02-208-00

Figure 43: Photo of proposed site for Concrete Drop Inlet Weir, intervention V60D-02-208-00

6.5.6.1 Bill of quantities: V60D-02-208-00

Item	Units	Quantity	Unit Cost	Item Cost
Concrete Volume	m^3	21.00	R 6 426.00	R 134 946.00
			Total	**R 134 946.00**

6.5.6.2 Construction Notes

General construction notes as set out in **Appendix B** apply, along with all construction notes shown on design drawings.

The Engineer will include site specific instructions in the site instructions to be issued prior to construction of this intervention.

The following is guidance for working within an area with soils with high organic matter content.

General:

a. Work only in low rainfall periods,
b. Prevent compaction of the soil,
c. Prevent draining, drying and desiccation of soil,
d. Use the general BMP of the WfWetlands manual for working within wetlands, and
e. Do not bring in any foreign vegetable matter (e.g. mulch) into the wetland area (especially from alien species).

Entering the wetland:

a. Prevent compaction (and thus potential channelling and erosion) of by not driving into the wetland.
b. However if required to drive into the wetland, then spread the weight of traffic (using walkways, boardwalks, geotextiles etc.). Construction workers and wheelbarrows should use these enforced paths as well.

Excavations (pre-construction):

a. Remove soil in the form of sods (20- 40 x20x20cm)
b. 1st sod layer must include the Rhizome layer (20cm intervals might be a bit too thin for *Phragmites*, but then it might be too difficult to work on thicker sods so keep it at 20cm increments).
c. Cut vegetation short if it will make handling easier. Use cut vegetation as mulch (see next point)
d. Store soil of different layers in different spots (stockpile soils according to the different soil layers as per the soil profile), in order not to mix layers of profile.
e. Cover with mulch or cloth (geotextile) and keep at least 40% moisture If possible, stockpile soils in piles as high as possible (to retain moisture).

Construction – maintain moisture (if work continues into wet season make sure stockpiled soil will not be flooded – removes top rhizome layer at least).

Post- construction

a. Use sods to rehabilitate any disturbed areas.
b. Place back into the system in the same order/ layers as to what is naturally occurring (according to the profile).
c. i.e. replace deeper layers 1st with rhizospheres layer on top.
d. If sods are not at 90%+ moisture then peg them with wooden stakes.

e. Mulch the site (or use cloth/geotextile).
f. Fence livestock out for at least 2 seasons (or brush pack).
g. If compaction took place then:

    - on flat surfaces, loosen the soil with a fork, and
    - on paths with slopes, put/ create small contour berms.

Draining/pumping

a. If any draining was done during construction, ensure that no preferential flow takes place in the drain after infilling.
b. All decanting points should have energy dissipaters.

6.6 Construction Environmental Management Plan issues

The proposed rehabilitation is to be undertaken on privately owned land and the project team should access the site and manage the site in accordance with the WfWetlands Best Management Practices and specific requirements of the landowner. The implementation of these interventions must also take into account all relevant provisions of WfWetlands Best Management Practices and the Construction Environmental Management Plan (CEMP), the recommendations of the approved Basic Assessments and Environmental Authorisation for the project.

The general construction notes, the Construction phase EMP (CEMP) are included as **Appendix B and F**.

6.7 Wetland management recommendations

Management of agricultural lands in the wetlands catchment

- Agricultural use of herbicides, pesticides and fertilizers in the vicinity of the wetland should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetland.
- A buffer of at least 20m should be maintained between any agricultural lands and wetland areas as far as possible so as to limit impacts associated with sedimentation and pollutant runoff.

Fire management

- With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm p. a.) an area of wetland should be burnt every 4 to 5 years.
- Cool and patchy burns should be promoted where possible by burning when relative humidity is high and air temperatures are low, preferably after rain.
- Preference should be given to burning of areas with abundant dead (moribund) stem and leaf material that limits new growth.

Control of alien invasive plants

- Alien invasive plants, specifically wattle (*Acacia mearnsii*) occurring in the eroded drainage line that runs through this wetland unit pose a threat to wetland functioning and need to be removed by the landowner/WFWetlands as part of future rehabilitation activities.

Livestock management

- Livestock can have a significant impact on wetland vegetation and the species that utilise wetland areas. This is clearly evident in the upper reaches of the wetland where heavy use by livestock is reducing vegetation cover and promoting headward erosion into areas of intact wetland vegetation. In response to these concerns, the following guidelines should be followed:
- Withdrawal of livestock from the upper section of the wetland (below the district road) is encouraged until rehabilitation of this area has been undertaken. This may necessitate the fencing off of this area until the site has been effectively stabilised.
- Livestock numbers should be maintained within acceptable carrying capacities to ensure that species composition is not compromised and trampling does not lead to further erosion of wetland areas.

- If necessary, the Department of Agriculture should be called upon to determine the grazing capacity for the bioclimatic region in which the wetland is located. As a general rule, grazing capacity in temporary wetland areas can be estimated as 1.5 times that of dryland areas, while grazing within seasonal and permanently wet areas should be restricted to 0.5AU/ha during the spring months. Where important biota occurs, further advice should be sought by an Agricultural Extension Officer.
- Intensive use of the wetland by livestock during wet season should be avoided to prevent excessive disturbance of wetland soils and associated vegetation.

Management of upstream dams

A large dam is located upstream of this wetland unit and excessive abstraction could have significant negative consequences for the downstream wetland areas. In response to the need to maintain flows to the downstream wetland area, the following management recommendation should be followed as far as possible:

- Minimise abstraction from dams as far as possible, particularly during winter months;
- Maintain a steady release from the dams even during the winter months;
- Ensure that dam wall and spillway are appropriately maintained to reduce risk of dam failure.

Road crossings

- No further roads should be permitted to be constructed across wetland areas.
- Further drainage to lower the water levels adjacent to existing roads should be avoided.

Erosion control

Given the extent of erosion evident in this wetland, there is a real risk that structural failure could occur if interventions are not appropriately monitored and maintained. Regular inspection of interventions (particularly after heavy rains) is encouraged so that any concerns are noted before structural failure occurs.

6.8 Baseline M&E data

The collection of baseline information was carried out to show changes in the system associated with the wetland rehabilitation activities.

6.8.1 Baseline WET-Health data

The assessment of the current level of ecological integrity of the wetland system provides a baseline assessment for comparative assessments that would be carried out for monitoring purposes 3 years after completion of the wetland rehabilitation activities. The following WET-Health information was collected for the wetland (Refer to **Appendix A**):

Table 26: Summary of present wetland health of V60D-02 based on the Wet-Health assessment

Wetland No	Ha	Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
V60D-02	97	4.2	-1	2.0	-1	4.5	-1
PES Categories		**D**	↓	**C**	↓	**D**	↓
Wetland Impact Score		**3.66**					
Wetland PES		**D**					