Wetland Mitigation Strategy for Belfast Opencast Coal Mine, Mpumalanga Province

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DECLARATION OF INDEPENDENCE

Declaration

Independent Specialist Consultant

I, Bhuti Dlamini, registration number SACNASP 100138/13 representing Wetland Consulting Services (Pty) Ltd in my capacity as a director, declare that we:

- Act as independent specialist consultants, in this application, in the field of wetland and riparian ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006; and
- Will provide the competent authority with access to all the information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Wetland Consulting Services (Pty) Ltd
Name of Company

Bhuti Dlamini
Name of Specialist Consultant

Signature of Specialist Consultant

6 December 2013
Date

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EXECUTIVE SUMMARY

Wetland Consulting Services (Pty) Ltd is assisting Exxaro Coal Mpumalanga (Pty) Ltd (referred to as Exxaro) - Belfast Opencast Coal Mine Project with the evaluation of wetlands in the upper Inkomati River catchment in the Mpumalanga Province. The aim is to evaluate potential sites for offsetting wetland losses associated with the proposed Belfast Opencast Coal Mine, which traverses two quaternary catchments (X11C - Witkloofspruit and X11D – Klein Komati). The goal is to find offset sites which are situated in the same quaternary catchments; however, the majority of the planned activities are within the Klein Komati sub-catchment area. It is hoped that in addition to the protection and conserving of wetlands, rehabilitation and restoration of suitable candidate wetlands in the identified area will ecologically counterbalance the wetlands removed through the mining activities associated with the proposed Belfast Opencast Coal Mine Operations. This forms the primary aim of the offsite mitigation strategy.

The primary landuse in the study area is agriculture and this is reflected in the nature of the most widespread issues within the wetland systems, namely erosion and drying out of the wetlands associated with extensive alien vegetation stands and impoundment of flows. Of significant value in rehabilitating the wetlands will be removal of alien vegetation, improvement of flows through the wetlands and control of channel erosion and head-cutting. In addition, without effective livestock management, other interventions are less likely to be effective in achieving their restoration goals.

The results of the onsite rehabilitation study indicated that the functional area of wetlands to be removed from the landscape is approximately 83 hectare-equivalents (ha-eq). Onsite optimisation through mitigation and rehabilitation interventions is expected to yield approximately 43.5ha-eq. of functional area out of a total remaining wetland area of 446 ha onsite. This is within the proposed Phase 1 mining area, although this is a conservative estimate, and it may be possible to increase this further.
In order to achieve the no-net-loss in wetland functioning offset target advocated by the Department of Water Affairs (DWA), a minimum gain of approximately 38.85ha-eq. of wetland functional area will be required at candidate offsite offset sites.

It should be noted that recently SANBI has finalised the first draft of offset calculators. For the purpose of this study the threat status multiplier to establish the biodiversity offset target is calculated using this tool, as was indicated within the onsite mitigation strategy report. In order to achieve the protection based offset hectare equivalents required as advocated by the SANBI offset calculator, an approximately 727.23 ha-eq. within the candidate sites will be required.

Should one of the pans currently expected to be lost within the mine plan (Pan 7), as well as its catchment, be excluded from the mine plan this will reduce the required overall functional offset target to 74.22 ha/eq. and ecosystem conservation targets to 668.68 ha/eq. Based on

this, the required hectare equivalents to satisfy no-net-loss will change from approximately 38.85ha-eq. to 30.74ha/eq. and this will be required within the candidate offsite offset sites.

The upper reaches of the Inkomati catchment forms a meaningful offset area from both a biodiversity and water resources management perspective. This is due to the position of the candidate sites in the upper reaches of the Inkomati water management area and that:

- It has been minimally affected by mining activities;
- It has landuses consisting mainly of open veld and agricultural activities with limited mining activities;
- It forms part of the head waters of the strategic river system with minimum disturbances and thus provides clean water to downstream areas already heavily impacted by mining activities.

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1.1 Introduction

Wetland Consulting Services (Pty) Ltd is assisting Exxaro Coal Mpumalanga (Pty) Ltd (referred to as Exxaro) - Belfast Opencast Coal Mine Project with the evaluation of wetlands in the upper Inkomati River catchment in the Mpumalanga Province. The aim is to evaluate potential sites for offsetting wetland losses associated with the proposed Belfast Opencast Coal Mine, which traverses two quaternary catchments (X11C - Witkloofspruit and X11D – Klein Komati). The goal is to find offset sites which are situated in the same quaternary catchments; however, the majority of the planned activities are within the Klein Komati sub-catchment area. It is hoped that in addition to the protection and conserving of wetlands, rehabilitation and restoration of suitable candidate wetlands in the identified area will ecologically counterbalance the wetlands removed through the mining activities associated with the proposed Belfast Opencast Coal Mine Operations. This forms the primary aim of the offsite mitigation strategy.

The wetland types that are to be affected are pans, hillslope seepage wetlands and channelled valley bottom wetlands. Each hydrogeomorphic (HGM) type is characterised by particular dominant hydrological drivers, and these translate into the provision of varying sets of ecological goods and services, at a range of different levels. The broad objectives of the study are:

1. The identification of potential areas in the immediate catchments of the Inkomati River catchment, where there is sufficient remaining wetland areas available to potentially compensate for the loss of wetlands in the areas earmarked for mining;
2. *Verification of the hydro-geomorphic classification of the wetlands within the study sites that was undertaken by Golder Associates, and, where necessary, an update of the present ecological status (PES) of these systems*;
3. To evaluate and quantify the potential gains in wetland functional area and ecological integrity associated with restoring and rehabilitating the wetland habitat within the candidate sites; and
4. To develop a suitable rehabilitation strategy for candidate wetlands within the identified candidate sites, highlighting the ecological problems underpinning wetland functioning and the types of interventions required to address them.

The candidate wetlands will form part of the functional and protection based offset proposed for the planned mining areas within the Proposed Belfast Opencast Coal Mine operations. An additional goal of this assessment is therefore to provide guidance in the selection and prioritisation of properties within the target area that would be purchased or otherwise acquired for the purposes of wetland rehabilitation and protection as part of the offset strategy.

2. APPROACH

2.1 Desktop Assessment and Site Selection

The first phase of the project identified areas within the upper Inkomati catchment that had sufficient wetland habitat remaining to potentially offer a suitable offset. These were identified as candidate sites for further investigation. An important criterion for offset site selection is that the candidate wetlands are situated in the same catchment and ideally in the same quaternary catchment as the wetlands to be removed. The rationale being that the ecological benefits added to the landscape by rehabilitation efforts will manifest themselves on the same water resource that has been affected by the loss of wetlands. The identification of these specific catchments followed a process that included an initial desktop survey to identify:

- The positions of existing mines, urban development, cultivation and other areas of disturbance; and
- The distribution of wetlands in relation to the proposed mining areas within the Upper Inkomati catchment.

Our proposed approach, a high-level desktop assessment, was as follows:

1. Identify least impacted watersheds within the Upper Inkomati sub-catchments that could possibly be used for offset site investigations, based on landuse as highlighted above;
2. Identify areas with similar characteristics to those being removed by mining according to the following hierarchical categories:
   a. The same sub-catchment areas as the wetlands to be offset i.e. Inkomati River catchment. This is aimed at ensuring that the restoration of wetland functioning is kept as close to the development as possible, so that the people and ecosystems directly affected may also gain the benefits of the rehabilitation measures;
   b. The same geological formations as those underlying the wetland areas to be offset. The rationale behind this is that wetland types which share similar landscape settings and geological formations tend to respond in the same way to changes in the catchment characteristics. They also perform similar ecological functions in the landscape;
   c. The same vegetation types i.e. have similar species compositions as those of the wetlands to be lost. This is likely to ensure a no-net-loss of wetland biodiversity from the local landscape;
   d. The extent of similar wetland types, according to their hydro-geomorphic (HGM) classification, as those to be lost within the proposed Belfast Opencast Coal Mine, i.e. to maintain the principle of a like for like offset. Approximately fifteen ecological services have been attributed to wetlands. There is evidence that wetland function can be linked to wetland type (Kotze *et. al*., 2004), with the biophysical characteristics of the different wetland types, together with conditions in the surrounding catchments, determining the magnitude and importance of the various wetland functions they are able to perform. With different wetland types being more effective at performing certain ecological

functions than others, the removal of one wetland type from the landscape, and its replacement with another, may result in a change in the types of important eco-services provided to the landscape. It was assumed that the rehabilitation and protection of required areas of similar wetland types within selected catchments would be most likely to appropriately compensate for the loss of functionality of the wetlands in the new mining areas.

The above hierarchical criteria were proposed as the first order of selection for candidate offset wetlands. Once completed the selected wetlands were further investigated by conducting more detailed ecological assessments of the candidate sites. The objective being to ensure that their rehabilitation would potentially produce gains in wetland hectare equivalents that would satisfy the various multiplier requirements. Additionally, that candidate sites would appropriately replace the hectare equivalents of functional wetland area within the affected/threatened, or lost, systems.

2.2 Wetland Ecological Integrity Assessment

The wetlands within the Belfast Coal Mine Phase 1 area have been delineated and assessed (PES, EIS and Functionality) as part of the NBC Belfast Ecological Baseline and Impact Assessment (Golder, 2011, Report No - 12135-9383-2). The wetland PES assessments produced as part of the ecological study were used as the basis for the offset calculations. However, during the site assessment, several additional wetland areas, which were previously overlooked, were identified within the Belfast Coal Mine Phase 1 area, delineated and assessed (PES and EIS). A number of the wetlands assessed as part of the 2011 study (Golder, 2011, Report No - 12135-9383-2) were found to have deviated from the PES scores determined in 2011 due to the systems changing over time as a response to on-going impacts. In such cases, the PES for these wetlands was recalculated used the same methodology used to determine PES in the 2011 study.

According to Golder (2011, Report No - 12135-9383-2), the Present Ecological Status (PES) of each wetland hydrogeomorphic unit was assessed using the method developed by DWAF (1999a) which is based on the modified Habitat Integrity approach developed by Kleynhans (DWAF, 1999a). The three components of wetland ecological integrity, namely: hydrology; geomorphology; and vegetation, all form part of the PES assessment, as well as considering factors such as water quality and landuse and utilization of the wetlands.

The PES assessment assisted in identifying the current impacts that are undermining the integrity of each wetland HGM unit, and in so doing directing the objectives of the subsequent rehabilitation plan.

The PES categories for each of the wetlands were used to assign the wetlands a score out of 10 as per the scoring used in the WET-Health tool (Macfarlane *et. al.* 2008). These scores were then used to calculate the current functional area, or number of hectare equivalents, of the wetlands in the target area. Rapid assessments were also undertaken of the wetlands under the hypothetical post-rehabilitation scenario, and the gain in hectare equivalents calculated to estimate whether the rehabilitation measures will satisfy the no-net-loss of wetland habitat principle stipulated as the primary goal of offsetting.

2.3 Calculation of Hectare Equivalents

A hectare equivalent (ha-eq) is a quantitative expression of the ecological integrity of a wetland hydro-geomorphic (HGM) unit under a given landuse. It represents the common currency that enables the wetland functional area restored to the landscape by restoration, rehabilitation and artificial creation to be compared to that removed from the landscape by a development. Most environmental authorities advocate a no-net-loss of resources approach, be it to biodiversity or wetland functioning, and the hectare equivalent provides the conceptual means of judging whether these rehabilitation objectives have been satisfied. This document seeks to calculate the potential wetland hectare equivalents restored to the landscape.

2.4 Offsite Rehabilitation Strategy

The rehabilitation strategy, which serves as a precursor to a rehabilitation plan, comprises a description of the types of measures to be investigated once the authorities are satisfied that the approach has the potential to appropriately offset the wetland losses associated with the development. A subsequent rehabilitation plan would entail detailed and complimentary input from a suitably qualified environmental engineer and a wetland ecologist. The wetland ecologist would be responsible for identifying problems undermining the hydrological, geomorphological and vegetative integrity of the habitat on the site and deciding on appropriate measures to address these. The engineer would be responsible for designing appropriate earthen, gabion and/or concrete interventions to achieve the objectives outlined by the wetland ecologist. A conceptual rehabilitation plan for the suitable candidate wetlands is provided in this report.

3. ASSUMPTIONS AND LIMITATIONS

The following considerations are relevant to this study.

- The target area identified accommodates a number of property owners, several of whom were not in favour of the initiative. Access to approximately 40% of the area was not granted, and the wetlands on these properties could not be assessed.

- The assessments were undertaken during the early wet season (November 2013). The vegetation was still in an early growth stage and this limited species identification. However, it is not felt that this compromised the evaluation of the vegetation component of wetland health.

- It is necessary to draw the distinction between rehabilitation and restoration, the definitions being:
  - Rehabilitation: the planned intervention in a system that aims at improving selected aspects within the system, recognising that some key ecological drivers cannot be altered.
  - Restoration: the manipulation of the physical, chemical or biological characteristics of a site with the goal of returning it to its historical (pristine?) state.

- According to the recently released SANBI wetland biodiversity offset document (MacFarlane *et al*, 2012), the target offset should consist of two components, namely:
  1. The wetland functioning offset. This is aimed at satisfying the no-net-loss of wetland functioning requirement and carries a 1:1 multiplier. The target objective should hence be a gain in wetland hectare equivalents equal to those lost to the development.
  2. A protection-based, or conservation, offset. This is aimed at a no-net-loss or, preferably, a net-gain in wetland biodiversity for the landscape and adds a threat-status multiplier to the hectare equivalents lost to the development.

The concept of the latter offset target is sound, but the method of calculating the magnitude of the multiplier is still under debate. This study hence ***concentrates only on evaluating the potential for the target site to satisfy the functional area offset***, until such time as there is consensus on the determination of the protection-based offset.

4. FINDINGS

4.1 Site Description

The study area assessed as part of this study lies within the boundaries of the Belfast Mineral Rights Area and covers approximately 2800 ha, of which 588 ha (21%) is defined as wetlands. The study area is located to the southwest of the town of Belfast and extends across Quaternary Catchments X11C and X11D. Flows from the study area feed into the Klein-Komatie River and the Leeubankspruit.

The study area is located primarily across the Dwyka and Ecca Geological Formations within the Karoo Sequence which is comprised primarily of sedimentary rocks, including shale, sandstone, conglomerate, tillite and coal in places. The geological distribution within the study site is shown in **Figure 1**.

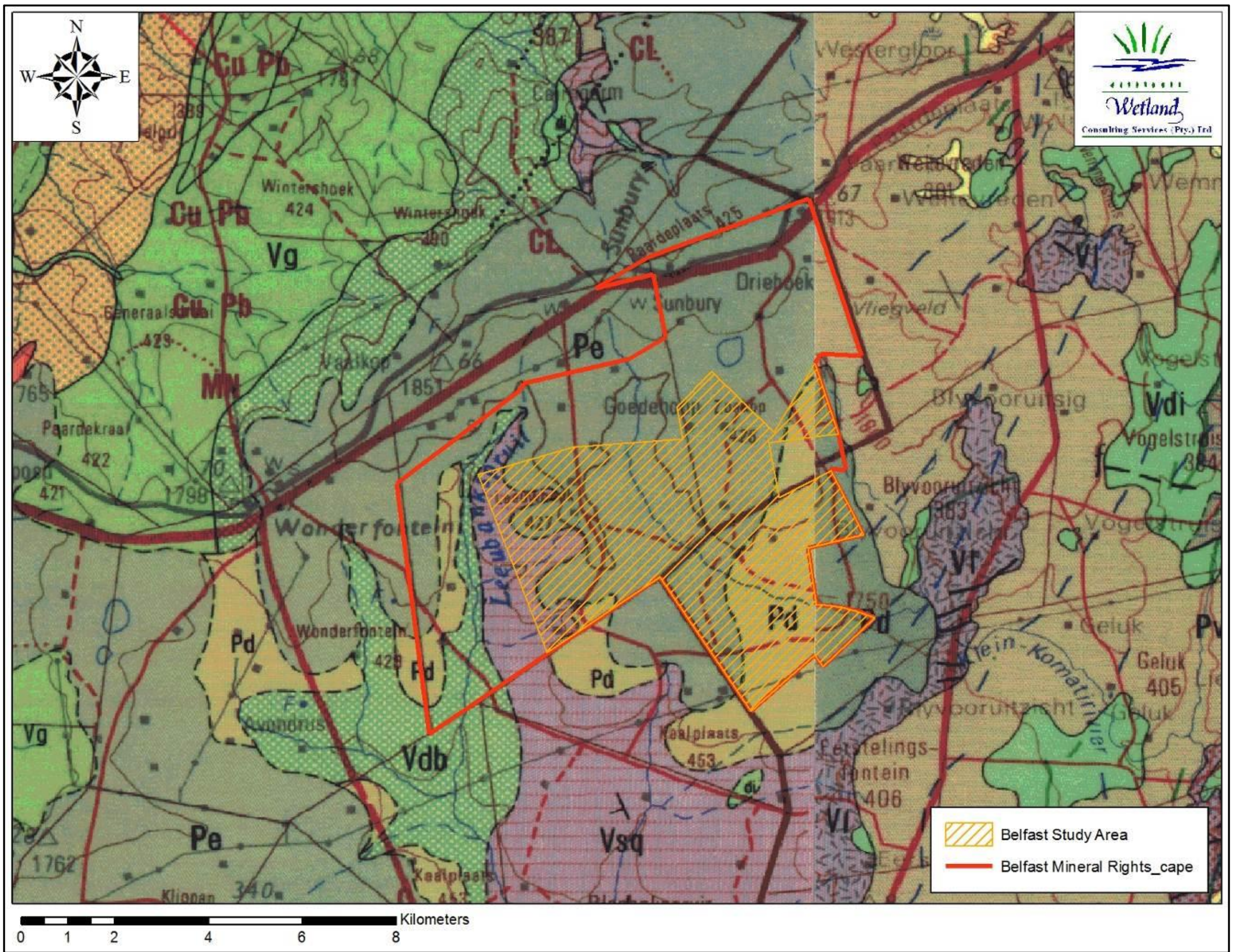

Figure 1: A section of the 1:250 000 Geological maps 2529 and 2530 showing the location of the study site in relation to the regional geology.

The dominant landuses in the area are:

- Commercial cultivation (Intense row crops);
- Commercial cultivation (Dryland pastures);
- Alien plant infestation (Primarily Black Wattle);
- Secondary grassland;
- Livestock grazing within the wetlands and secondary grassland.

4.2 Wetland Delineation and Classification

The wetlands within the study area were delineated as part of the previous study, and refined further during the course of this survey. As part of this study, the existing wetland delineations and hydro-geomorphic (HGM) classifications were used, with limited verification of wetland boundaries in the field to ensure accuracy.

Where verification of the wetland boundaries was undertaken, the following approach was used. Use was made of 1:50 000 topographic maps, 1:10 000 black and white orthophotos and geo-referenced Google Earth images to generate digital base maps of the study area onto which the wetland boundaries were delineated using ArcGis 9.1. A desktop delineation of suspected wetlands and riparian zones was undertaken by identifying drainage lines and wetness signatures from the digital base maps. All identified areas suspected of being wetlands or riparian zones were then further investigated in the field. The wetlands and riparian zones were then delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as published by DWAF (2005). These guidelines consider the following wetland indicators:

- Terrain unit indicator. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope, and valley bottom;
- Soil form indicator;
- Soil Wetness indicator
- The vegetation indicator.

The wetlands were subsequently classified according to their hydro-geomorphic determinants based on a modification of the system proposed by Brinson (1993), and modified for use in South Africa by Marneweck and Batchelor (2002) and subsequently revised by Kotze, Marneweck, Batchelor, Lindley and Collins (2004) and SANBI (2009). Notes were made on the levels of impact in the wetlands based on field experience and a general understanding of the types of systems present. In order to provide continuity with the wetland PES assessment tool used (WET-Health), the hydro-geomorphic (HGM) classification applied to the wetlands was as follows:

- Valley bottom with a channel (CVB);
- Valley bottom without a channel (UCVB);
- Hillslope seepage linked to a stream channel (HS);
- Isolated hillslope seepage (HS-ISOLATED); and
- Pans and Depressions, the distinction being that a pan has a discernible basin.

The distribution of the wetlands in the study site is shown in **Figure 2**.

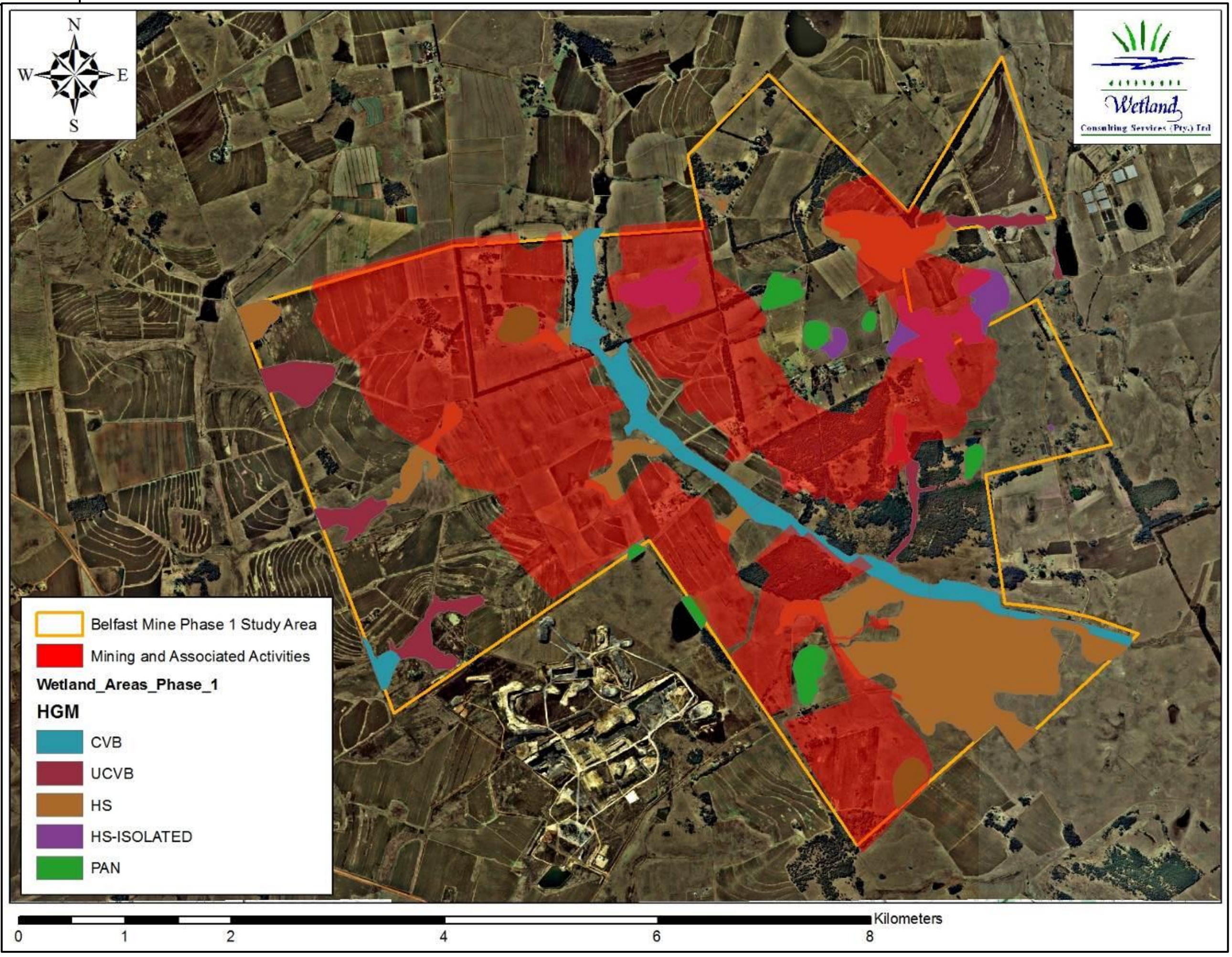

Figure 2: Wetlands within the study site, indicating the distribution of the respective HGM units.

There are approximately 588 ha of wetland habitat within the area available for the survey, spread across five HGM units.

4.3 Present Ecological Status Assessment (PES)

Wetlands are an expression of water moving through the landscape, and occur in the landscape where water is slowed down and appears close enough to, or on the surface of, the land for a sufficiently long time to enable wetland conditions to develop. Activities that alter the movement or quality of water moving through the landscape will thus undoubtedly have a significant influence on the wetlands. The main impacts identified within the site are:

- Cultivation;
- Alien tree plantations;
- Impoundments such as earthen dam walls and roads;
- Confined flow through spillways and culverts;
- Soil erosion and eroding surfaces such as headcuts and knick-points; and
- Livestock grazing and trampling.

The general pattern of disturbance is that of small, localised disturbances spreading to impact on the entire HGM unit, primarily along the channels. An example would be a dam wall that introduces confined surface flow through the spillway to the downstream wetland, which subsequently erodes from its base. Dams also result in a drop in base level with the excavation of the basin, which also tends to introduce head-cut erosion to the wetland upstream of the dam.

The PES of the majority of wetlands within the site reflects the identified impacts, and is considered to be ***Moderately Modified*** **(C)** (refer to **Figure 3**).

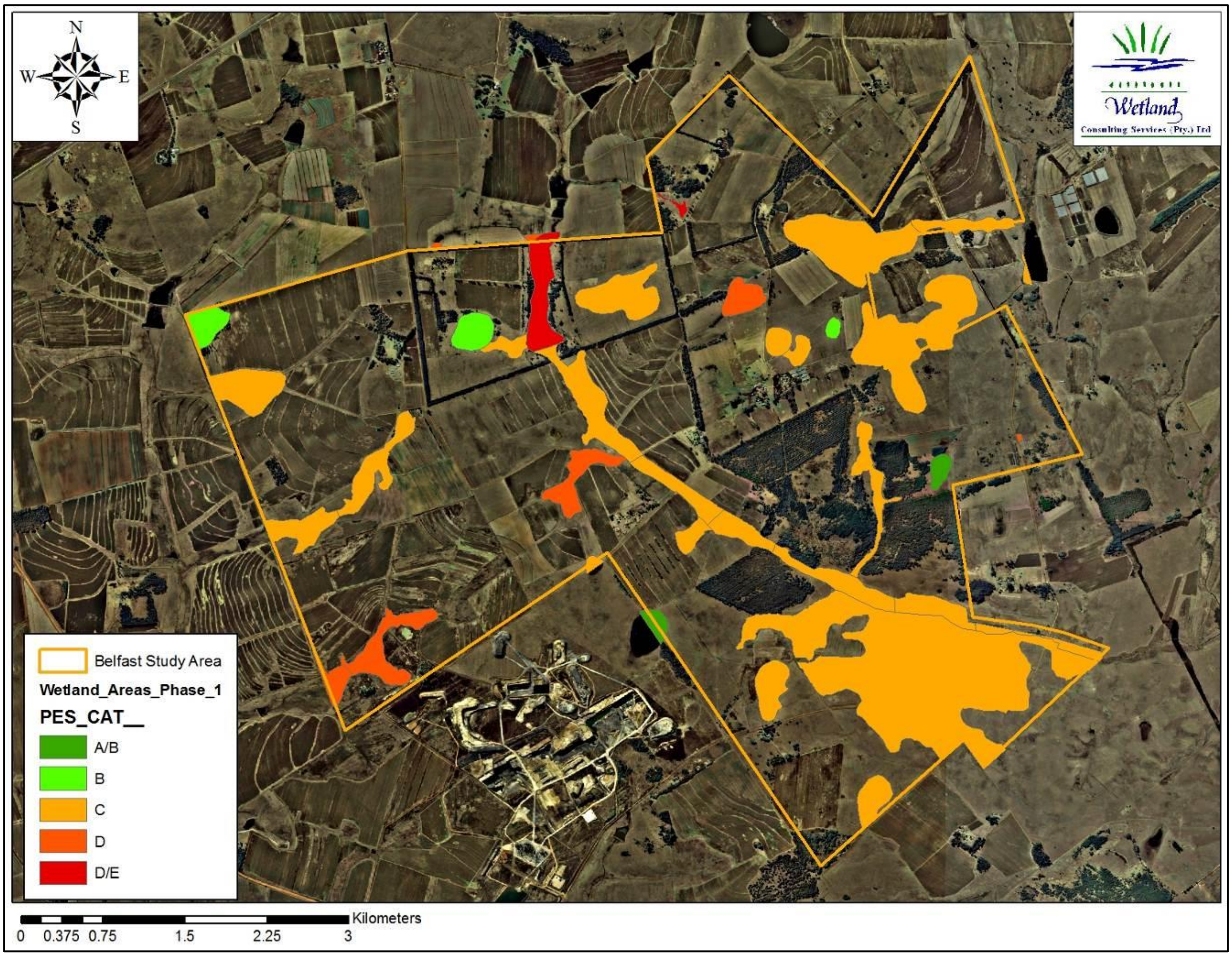

Figure 3: The current Present Ecological Status of the wetlands within the study site.

5. WETLAND FUNCTIONAL AREA OFFSET

Following the field assessment, those wetlands lying within the currently proposed opencast mine and infrastructure footprints were excluded from further consideration. The wetlands eligible for rehabilitation work are shown in **Figure 4**, and represent approximately 446 ha of actual wetland habitat.

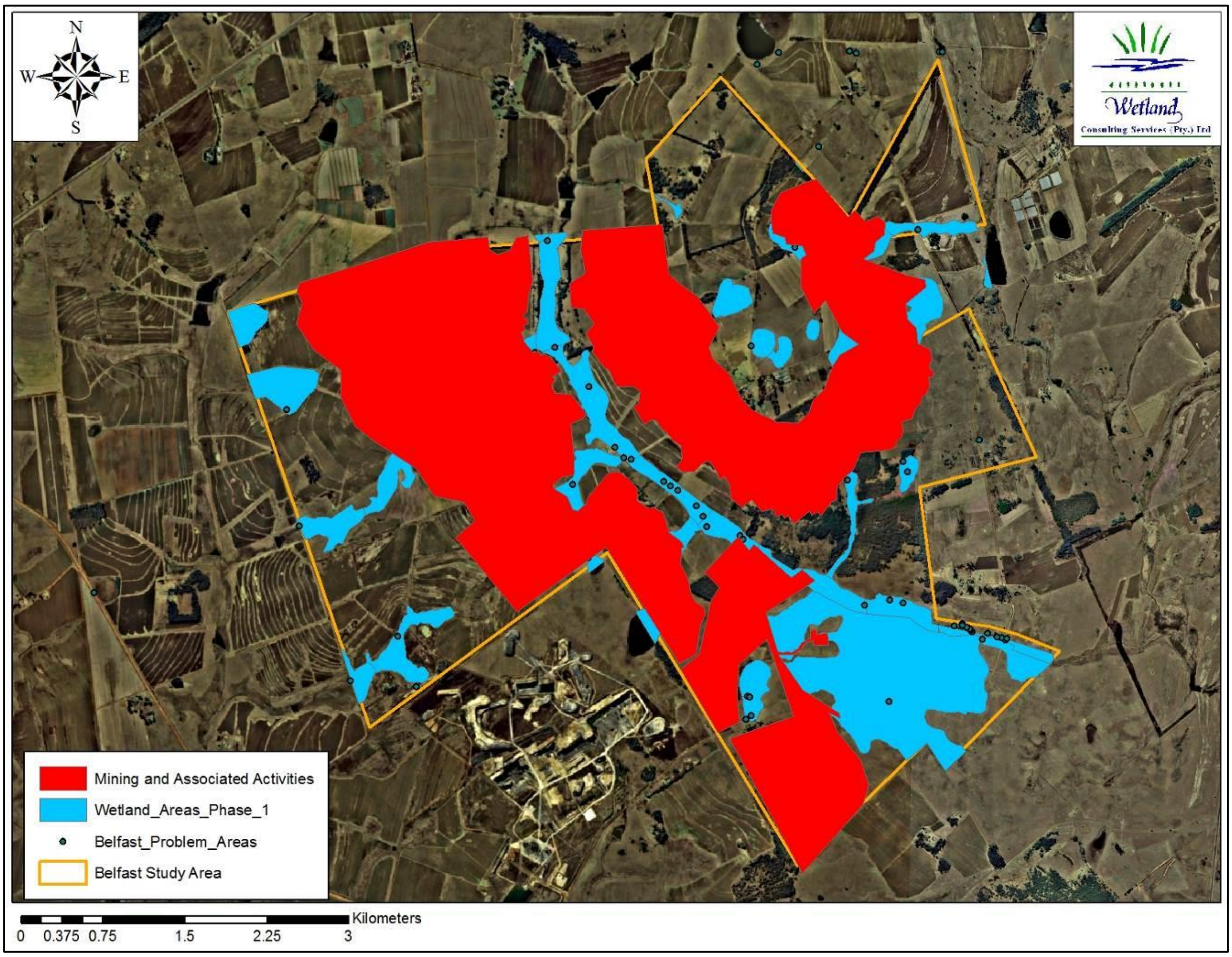

Figure 4: Wetlands suitable for rehabilitation work.

The current PES scores were used to calculate the current functional area of wetland hectare equivalents within the study site. Rapid PES assessments were conducted under hypothetical post-rehabilitation conditions to anticipate the potential gains in functional area brought about by rehabilitation measures. Within the study area the catchment hydrology is largely intact, and the objective of rehabilitation is therefore to restore the wetlands to as close to their historical natural state as possible, and in so doing maximise the gains in functional area.

The results of the onsite rehabilitation study indicated that the functional area of wetlands to be removed from the landscape is approximately 83ha-eq. Onsite optimisation through mitigation and rehabilitation interventions is expected to yield approximately 43.5ha-eq. of functional area out of a total remaining wetland area of 446 ha onsite. This is within the proposed Phase 1 mining area, although this is a conservative estimate, and it may be possible to increase this further.

In order to achieve the no-net-loss in wetland functioning offset target advocated by the Department of Water Affairs (DWA), a minimum gain of approximately 38.85ha-eq. of wetland functional area will be required at the candidate sites.

It should be noted that recently SANBI has finalised the first draft of offset calculators. For the purpose of this study the threat status multiplier to establish the biodiversity offset target is calculated using this tool, as was indicated within the onsite mitigation strategy report. In order to achieve the protection based offset hectare equivalents required as advocated by the SANBI offset calculator, an approximately 727.23 ha-eq. within the candidate sites will be required.

Table 1: Summary of the hectare equivalents calculations using the SANBI offset calculator

HGM Unit	Current/Pre-mining					Functional Offset Target	Ecosystem Conservation Target		
	Type	Area (ha)	PES	EIS	Hectare equivalents	Functional Hectare Equivalents	Habitat Hectare Equivalent	Offset multiplier (SANBI)	Ecosystem Conservation Target
PAN6	PAN	1.18	C	B	0.83	0.83	0.71	8.81	6.23
PAN5	PAN	9.61	B	C	7.69	7.69	6.73	9.11	61.25
PAN7	PAN	12.51	B	C	8.13	8.13	9.38	6.24	58.55
LS13	Hillslope seepage	7.35	C	B	4.41	4.41	3.68	9.62	35.34
KS16	Hillslope seepage	5.97	C	C	2.99	2.99	2.99	9.53	28.43
KS19	Unchannel VB	6.02	C	B	3.01	3.01	1.20	10.04	12.08
DS13	Hillslope seepage	37.80	C	B	18.90	18.90	15.12	9.74	147.19
SD_PAN1	Pan	8.76	C	B	6.13	6.13	7.01	11.93	83.57
SD_HS2	Isolated HS	37.56	C	B	18.78	18.78	22.54	8.90	200.46
SD_HS5	Hillslope seepage	2.57	C	C	1.80	1.80	1.29	14.04	18.04
SD_HS3	Isolated HS	21.03	C	B	10.52	10.52	8.41	9.05	76.09
TOTAL		150.36			82.35	**82.35**	79.04	10.70	**727.23**

Figure 7 below indicates the remaining and affected wetland areas within the surveyed Phase 1 mining area on site.

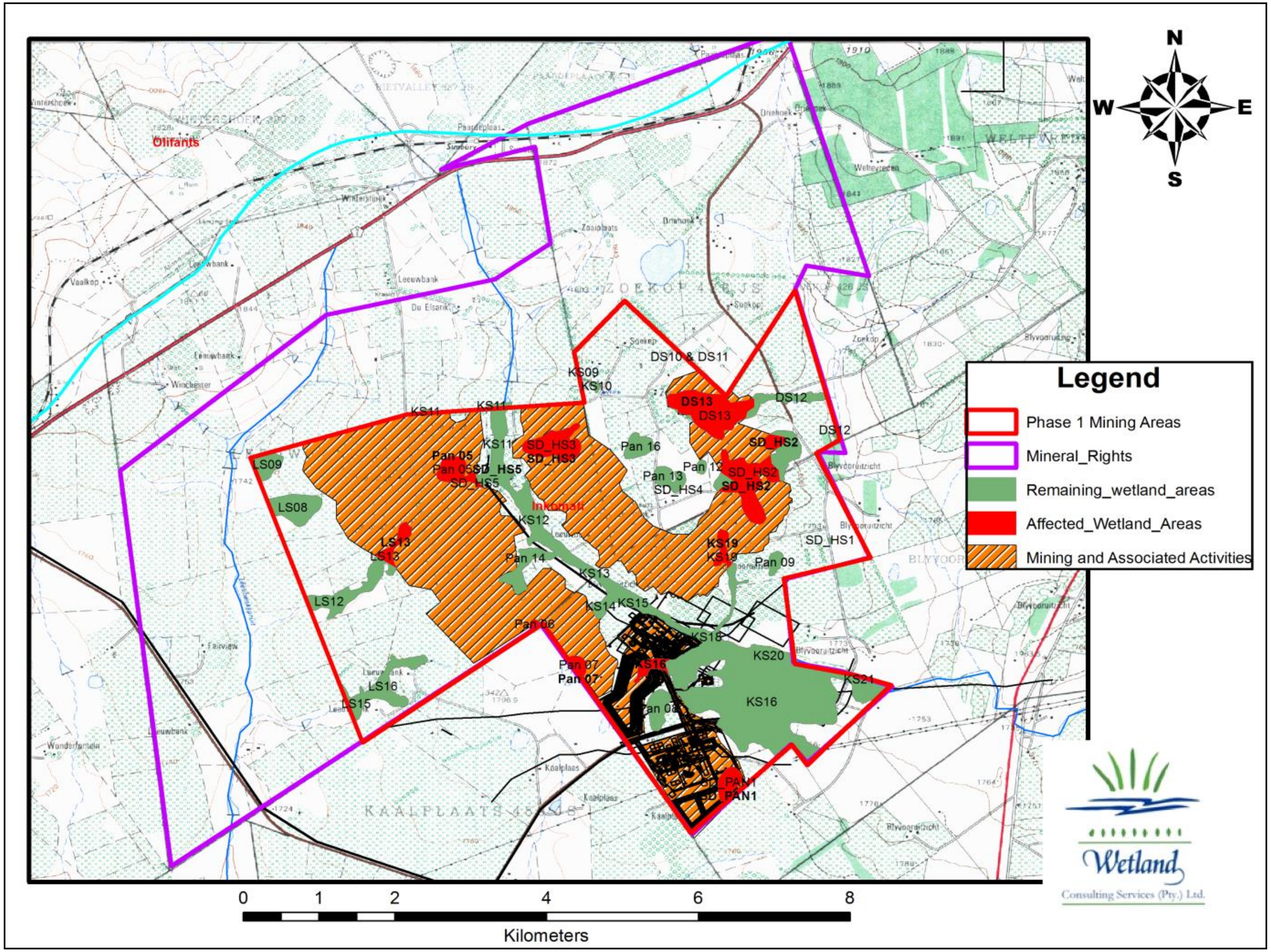

Figure 5: Map indicating remaining and affected wetland areas within the proposed mining area on site.

6. WETLAND RESTORATION PLANNING

Planning a wetland restoration strategy is a three-phase process involving:

1. The identification of the problems compromising wetland ecological integrity;
2. Setting restoration objectives based on an analysis of the problems and the feasible extent of addressing them in order to make ecological gains;
3. Formulating solutions aimed at achieving the set objectives.

6.1 Broad Ecological Problems Identified Within Offset Sites

A range of problems undermining wetland ecological integrity were identified during the site visit, and are discussed below. Neutralising these features forms the underlying goal of the proposed wetland restoration strategy. The problems identified within the wetland systems are grouped according to the wetland health component upon which they have the greatest influence, namely geomorphology, hydrology and vegetation. It should be noted that while the types of problems arise from similar impacts, the scale and threat of each problem will vary according to the environmental setting (topography, soils, hydrology, state) of the wetland. Rehabilitation and restoration therefore is highly site-specific, and involves either addressing the problem directly, or addressing the impact that is causing the problem, or a combination of both.

The primary landuse in the study area is agriculture and this is reflected in the nature of the most widespread issues within the wetland systems, namely erosion and drying out of the wetlands associated with extensive alien vegetation stands and impoundment of flows. Drying out of the wetlands will have knock-on impacts, such as loss of functionality, changing species compositions and biodiversity loss. Of significant value in rehabilitating the wetlands will be removal of alien vegetation, improvement of flows through the wetlands and control of channel erosion and head-cutting, all of which will contribute to improved functionality of the wetlands which is an important goal of the restoration process. In addition, without effective livestock management, other interventions are less likely to be effective in achieving their restoration goals.

6.1.1 Hydrological Impacts

6.1.1.1 Flow Impoundment

Structures such as dams, berms and raised roads act as impounding features to wetland and channel flows. Within the study area this has led to back flooding upstream of the impounding features and reduced saturation of wetland soils downstream. The impoundment of longitudinal flow by dams has had a significant impact on the downstream wetland habitat, simply by starving it of water. In systems where longitudinal flow is an important driver, this impact extends along the entire length of the wetland below the dams.

Flow confinement occurs most often at dam spillways as the concentrated release of peak surface flow may result in an increase in flow velocity and volume at outlet points. This increased erosive potential often results in channel formation and further erosion of existing channels. Alteration of

the wetness regime and the lowering of the water table induced by channel formation within many of the wetlands has resulted in the drying out of the wetland soils and subsequent encroachment by terrestrial vegetation. Pipe culverts beneath road crossings often have the same impact if they are too narrow.
The formation of channels within the wetlands can lead to reduced residence times of flows within the wetlands and an associated loss of functionality in terms of water quality improvement, drying out of areas of the wetlands, encroachment of terrestrial vegetation, and transport of eroded soils out of the catchment.

Rehabilitation often involves the following options:

- Removal of the obstacle;
- Redesign of the impoundment to maintain longitudinal flows;
- Management of the discharge point to prevent channel erosion and spread the water across the width of the wetland.

Impoundment of flow upstream of dams

6.1.1.2 Flow Concentration or Confinement

Flow concentration occurs most often at wetland road crossings and other linear infrastructure crossings, and downstream of dam spillways. The concentration of flows often leads to channel formation and further erosion of existing channels due to increases in flow velocity and volume at outlet points. The formation of channels within the wetlands can lead to reduced residence times of flows within the wetlands and an associated loss of functionality in terms of water quality improvement, drying out of areas of the wetlands and encroachment of terrestrial vegetation.

Land transformation and linear developments in the catchment may alter the pattern of water delivery to wetlands. Roads intercept surface flow that would enter the wetland diffusely, and direct them to certain areas before discharging them as a point-source. This creates confined surface flow outside the wetland which usually manifests itself within the wetland, culminating in channel erosion.


Confinement of longitudinal flow resulting in scouring (right) and channel incision (left)

6.1.1.3 Formation of Preferential Flow Paths

Within the study area, agriculture is the primary landuse, and grazing by cattle occurs throughout the study area. Wetlands are utilised by livestock as grazing because they provide a source of drinking water, usually support higher primary production and support an extended grazing season. Livestock movement across the wetlands and to and from watering points (typically in dams within the wetlands) has created trampled pathways through the wetlands which, particularly in the valley bottom wetlands which lie on expansive clays, has led to the formation of preferential flow pathways and resulted in head-cuts eroding. The formation of channels within the wetlands can lead to reduced residence times of flows within the wetlands, drying out of areas of the wetlands and encroachment of terrestrial vegetation.

Preferential flow path resulting from cattle movement leading to head-cut formation.

6.1.1.4 Drain (Trench) Excavation and Contouring

Drains have been excavated in certain areas to facilitate crop cultivation and livestock grazing. They are serving to increase the rate of passage of water through the wetlands, decreasing retention time, and lower the water table. This leads to wetland desiccation and transformation of wetland vegetation to terrestrial habitat.

Contour berms and roads outside wetlands intercept diffuse surface flow and convert it into confined point-source discharge. This may change the patterns of saturation in the wetland, as well as result in longitudinal erosion inside the wetland, and lateral erosion extending outside the wetland. Contour berms within hillslope seepage wetlands may also lead to a degree of flow impoundment upslope and reduced saturation in the wetlands downslope.

6.1.1.5 Extensive Alien Tree Stands

Large areas of the study area have been colonised by stands of alien trees, such as *Acacia mearnsii* and *Eucalyptus* sp.. The water requirements of these species tends to exceed that of indigenous grassland vegetation, and as such, can lead to a decrease in the supply of water to the wetlands and a resultant drying out of areas of the wetlands and encroachment of terrestrial vegetation.

6.1.2 Geomorphological Impacts

6.1.2.1 Infilling

Infilling is associated with activities or structures which lead to burial of the natural wetland sediments, such as dams, berms and raised roads. The geomorphological impact entailed in these feature relates to the confinement of flow through culverts, or generated by partial constriction of the wetland. This confinement of surface flow increases the erosive force of water moving past the feature, resulting in increased soil erosion, head-cut initiation and sediment mobilisation. Dams are also points of sediment deposition and accumulation.

A noticeable impact of the excavation of dams in this environment is the drop in base level in the wetland. The impact is minimal if the dam is full. However, if the dam is empty, water entering it from upstream flows over a drop, which initiates head-cut erosion that erodes upstream forming a channel. This affects the hydrology in this region of the wetland.

Infilling within wetland habitat

6.1.2.2 Head-cut Erosion

Erosion was found to be widespread impact affecting the wetlands within the study area. The primary causes of erosion with the wetlands appear to be associated within man-made structures such as dams and roads leading to flow concentration, and the impact of cattle trampling. Erosion has typically occurred on site at flow concentration points downstream of dams and roads and in areas with high livestock traffic, particularly surrounding watering points. Erosion and channel formation leads to a lowering of the water table and drying out of the surrounding wetland soils. The vegetation responds to the drop in water table. Eroded sediments are transported downstream where they affect water quality and, when deposited, can lead to a change in the geomorphology of wetlands and rivers downstream.

Channel incision (top) and head-cut erosion (bottom)

6.1.2.3 Overgrazing and Trampling

Cattle grazing is evident in many of the wetland systems on site. Although the stocking density does not appear to be causing severe overgrazing, trampling within the wetlands has led to the formation of preferential flow pathways, and in turn head-cut erosion points and channel formation.

6.1.3 Vegetation Impacts

6.1.3.1 Cultivation

Agriculture is the dominant land use within the study area, and in many areas of the study site cultivated fields and pastures encroach into the wetlands, leading to a complete loss of the wetland vegetation. As a result, the biodiversity of these areas has been reduced, and the value of remaining wetland areas in terms of biodiversity support is also negatively affected.

Cultivation in and surrounding wetland habitat

6.1.3.2 Encroachment of Exotic and Terrestrial Plant Species

The replacement of indigenous wetland species with weed and/exotic species can have a negative effect on the biodiversity support function of the wetlands. Exotic vegetation was most obvious within the study site along road margins, surrounding homesteads and dams, as well as in dense stands in the catchments of many of the wetlands. The presence of exotic species affects not only the biodiversity of the wetlands, but also the hydrology of the wetlands where the alien vegetation has high water uptake demands. Encroachment of terrestrial species has occurred in areas where impoundments and erosion have led to drying out of the wetland soils, leading to a change in the wetland extent and providing favourable conditions for the establishment of these species.

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Encroachment of *Acacia mearnsii* (left) and *Eucalyptus* sp.

6.1.3.3 Overgrazing and Trampling

Moderate overgrazing and trampling of wetland vegetation was observed in several of the wetlands, particularly surrounding dams. This may be a consequence of overstocking or other management practices which are not compatible with the prevailing climate, vegetation or soil conditions. Overgrazing has a direct impact on the wetland vegetation biomass, and can lead to reduced diversity of wetland plant species. Other important biodiversity-related impacts are:

- The homogenisation of the habitat available for wetland flora and fauna; and
- The reduction in cover, depriving wetland fauna of the refugia on which they depend to avoid predation.

Cattle utilisation in the wetlands

6.2 Restoration/Rehabilitation Objectives

Restoration of the wetland habitat is the overarching goal of this project. Rehabilitation implies that there is a concession that it will not be possible to reinstate all of the driving ecological processes within the wetlands because:

- The hydrology of the catchment has been fundamentally altered; or
- The physical impact within the wetland will be too costly to reverse.

Those processes that are realistically achievable within the confines of these constraints are therefore selected and form the basis of rehabilitation objectives.

Under the current scenario, the goal of restoring the wetlands to their more natural states is considered to be realistic. The aim will be to improve the PES scores of the wetlands considered suitable by at least a category. For example, the goal of restoration would be to improve a wetland HGM currently considered Largely Modified (D) to Moderately Modified (C) or better.

The recommended restoration objectives are as follows:

- Deactivate all eroding head-cuts and knick-points, preventing their migration into intact wetland habitat;
- Deactivate all channels through historically unchannelled systems, reinstating diffuse longitudinal flow and raising the water table;
- Stabilise dam spillways, preventing incision. Redesign to spread water across the width of the wetland below the wall, reinstating diffuse longitudinal flow;
- Redesign the dam wall to release more water to downstream wetland habitat. This will be coupled with providing safe, stable access for cattle to the water;
- Redesign road crossings to remove confined flow;
- Remove berms and redesign roads that intercept sheet flow in the catchment;
- Apply appropriate grazing and burning management to both the wetlands and the catchments;
- Removal of alien tree plantations to improve the integrity of the wetland vegetation and to increase flows to the wetlands from the catchments.

1. Rehabilitation Strategy development

A summary of the generic rehabilitation objectives, together with the rationale behind their implementation, is presented in **Table 2**. The scope of the study did not allow any conceptual or detailed design of the proposed interventions to be included. However, the types of interventions are described, hopefully providing insight into the nature of the rehabilitation envisioned for these wetlands. A detailed investigation of the proposed interventions would form the point of departure for a subsequent rehabilitation plan should this strategy meet with approval from Exxaro and ultimately the authorities. **Table 3** provides the calculation of the hectare equivalent gains anticipated as a consequence of the suggested rehabilitation activities.

Note: The table below does not reflect all the problem areas on site. Only a selected few are shown as most of the problems and required interventions are the same in most areas. This is only done to avoid repetition of similar problems and proposed interventions rather than to indicate that some areas do not require interventions.

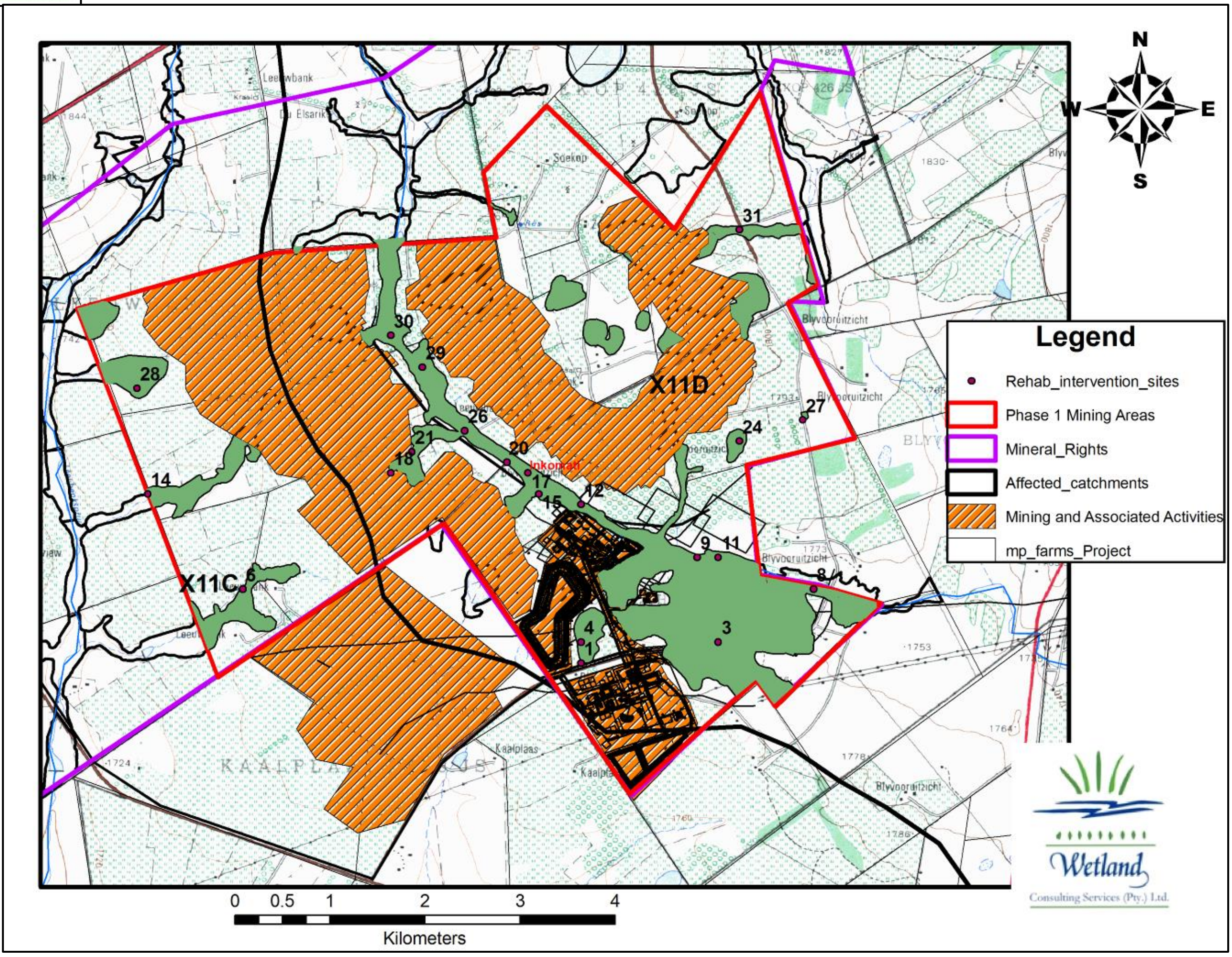

Figure 6: A map indicating remaining wetland areas onsite and positions of some of the recorded problems that will require rehabilitation intervention as per proposed strategy (numbers on the map reference the ID Numbers in Table 2).

Table 2: Summary of the rehabilitation activities, their rationale and the proposed interventions for the respective remaining wetlands on site

ID	LAT	LONG	Description and nature of the problems	Rehabilitation objectives	Expected Outcome	Type of Intervention likely to be required
1	-25.835	29.983	Existing Impoundment (dam) that impedes the flow and it has been recently excavated to increase its capacity, Alien invasive vegetation, drainage furrow to pan.	Deactivate furrow/trenches, removal of the dam and alien invasive vegetation	Promote water distribution, increase wetness signature, promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland and decrease rate of passage of water through the wetland	Plug drainage furrow using series of plugs and backfill with soil. Remove alien vegetation. Potentially remove dam and limit abstraction. Levelling and re-vegetation of filled areas
3	-25.833	29.996	Alien invasive vegetation	Removal of alien invasive vegetation	Improve species richness and vegetation composition within the wetland and its catchment areas	Physical removal of alien vegetation using Working for Water guidelines. Development of monitoring and evaluation plans to accompany this activity
4	-25.833	29.983	Encroachment of agricultural activities within the wetland area and its catchment area and agricultural associated trenches through the wetland areas	Deactivate trenches, increase buffer and/or corridor around the wetland on site	Promote water distribution, increase wetness signature and promote natural vegetation establishment and re-colonisation and improve species richness.	Plug drainage trenches using series of plugs and backfill with soil. Ripping and re-vegetation of the buffer areas
6	-25.828	29.951	Road crossing and flow impedance structure in the form of single damaged pipe culvert.	Removal of the impeding structure i.e. road and associated single damaged culvert	Promote water distribution, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland and decreased rate of passage of water through the wetland.	Earthworks removal of the road, disc ploughing and replacing of the single culvert with multiple culverts and re-vegetation of all disturbed areas

ID	LAT	LONG	Description and nature of the problems	Rehabilitation objectives	Expected Outcome	Type of Intervention likely to be required
8	-25.828	30.005	Preferential flow path created by the furrow running parallel to channel	Deactivate furrow/trenches	Promote water distribution, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland	Plug furrow using series of plugs and backfill with soil. Remove alien vegetation. Levelling and re-vegetation of filled areas
9	-25.825	29.994	Channel incision and erosion	Deactivate incision, stabilise erosion and raise water level	Raise water level, prevent sediment loss and promote even distribution of water increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland	Plug incised channel allow for sedimentation upstream of the structures, using series of erosion control structures gabions and/or rock masonry
11	-25.825	29.996	Lateral erosion and channel widening	Deactivate incision, stabilise erosion and raise water level	Raise water level, prevent sediment loss and promote even distribution of water, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland	Plug incised channel allow for sedimentation upstream of the structures, using series of erosion control structures gabions and/or rock masonry
12	-25.820	29.983	Headcutting	Deactivate headcuts	Raise water level, prevent sediment loss and promote even distribution of water increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland	Stabilise headcut using erosion control structures gabions and/or rock masonry, earthworks, levelling and shaping and re-vegetation of all disturbed areas

ID	LAT	LONG	Description and nature of the problems	Rehabilitation objectives	Expected Outcome	Type of Intervention likely to be required
14	-25.819	29.942	Large dam wall and its spillway appear to be too high and limiting base flows. No obvious erosion.	Lower spillway level and redesign the spillway	Promote hydrological connectivity of upstream and downstream areas	Concrete and earthworks for the new redesign spillway
15	-25.819	29.979	Very eroded dam spillway.	Redesign and lowering of the spillway	Promote hydrological connectivity of upstream and downstream areas	Concrete and earthworks for the new redesign spillway
17	-25.817	29.978	Encroachment of agricultural activities within the wetland area and its catchment area	Increase buffer and/or corridor around the wetland on site	Promote natural vegetation establishment and re-colonisation and improve species richness.	Ripping and re-vegetation of the buffer areas
18	-25.817	29.965	Trench	Deactivate trench	Promote water distribution, increase wetness signature. Increase diffuse flow across the wetland and decrease rate of passage of water through the wetland	Plug trench using series of plugs and backfill with soil. Levelling and re-vegetation of filled areas
20	-25.816	29.976	Cattle track could form headcut soon.	Control stock grazing	Promote species richness, prevent headcut erosion formation	Compilation and implementation of grazing management plan
21	-25.815	29.967	Old broken dam wall and impedance of flow to downstream areas	Removal of the impeding structure i.e. dam wall	Promote water distribution, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland and decrease rate of passage of water through the wetland.	Earthworks removal of the dam wall, disc ploughing and re-vegetation of all disturbed areas

ID	LAT	LONG	Description and nature of the problems	Rehabilitation objectives	Expected Outcome	Type of Intervention likely to be required
24	-25.814	29.998	Breached dam wall and formation of preferential flow paths	Removal of the breached dam wall in the system	Promote hydrological connectivity of upstream and downstream areas. Promote water distribution and sedimentation, raise water level, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland particular below the crossing and decrease rate of passage of water through the wetland.	Earthworks removal of the dams, disc ploughing and replacing shaping and levelling and re-vegetation of all disturbed areas. Plug any incised channel with multiple plugs to promote sediment deposition and re-growth of vegetation on site.
26	-25.813	29.972	Single culvert causing preferential flow path erosion downstream of the wetland area	Removal of impeding structure i.e. culvert	Promote hydrological connectivity, water distribution, increase wetness signature and promote natural vegetation establishment and re-colonisation and improve species richness.	Earthworks removing of the single culvert and replacing it with multiple culverts, shaping, levelling and re-vegetation of disturbed areas.
27	-25.812	30.004	Trench off road and formation of preferential flow path into the wetland area	Deactivate trench	Promote water distribution, increase wetness signature. Increase diffuse flow across the wetland and decrease rate of passage of water through the wetland	Plug trench using series of plugs and backfill with soil. Levelling and re-vegetation of filled areas
28	-25.809	29.941	Water piped out of seepage area and causes erosion and headcutting into downstream areas.	Stabilisation of incision and headcutting	Promote water distribution and sedimentation, raise water level, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland particular below pipe discharge area and decrease rate of passage of water through the wetland.	Earthworks removal of the pipe, construction of series erosion stabilisation structures, shaping, levelling and re-vegetation of all disturbed areas.

ID	LAT	LONG	Description and nature of the problems	Rehabilitation objectives	Expected Outcome	Type of Intervention likely to be required
29	-25.807	29.968	Bank collapse	Stabilisation of bank collapsing	Promote water distribution and sedimentation, raise water level, increase wetness signature and promote vegetation establishment and re-colonisation and improve species richness. Increase diffuse flow across the wetland particular below the crossing and decrease rate of passage of water through the wetland.	Plug incised channel with multiple plugs to promote sediment deposition and re-growth of vegetation on site.
30	-25.804	29.965	Dam wall with slight erosion. Slight channel formation downslope.	Redesign and lowering of the spillway	Promote hydrological connectivity of upstream and downstream areas	Concrete and earthworks for the new redesign spillway, shaping and levelling and re-vegetation of all disturbed areas
31	-25.794	29.998	Wetland road crossing and impeding of flow	Removal of impeding structures i.e. culverts and any other obstructions	Promote hydrological connectivity, water distribution, increase wetness signature and promote natural vegetation establishment and re-colonisation and improve species richness.	Earthworks removing of the culverts and replacing it with multiple culverts and all other impeding structures, shaping, levelling and re-vegetation of disturbed areas.

Table 3: Table indicating projected gains on the wetland systems to be rehabilitated onsite as per proposed rehabilitation measures as outlined in the proposed wetland rehabilitation strategy for the site.

Site Name	PES SCORE	PES Category	AREA (Ha)	PES Integrity	HA/EQ	Expected Component Improvement	Projected PES	PES Category	PES Integrity	HA/EQ
Pan 08	2.95	C	11.04	7.05	7.78	Hydrology & Vegetation	2.00	C	8.00	8.83
Pan 09	0.95	B	4.10	9.05	3.71	Geomorphology & Vegetation	0.95	B	9.05	3.71
Pan 14	4.95	D	13.36	5.05	6.75	Hydrology, Geomorphology & Vegetation	2.00	C	8.00	10.69
LS08	2.95	C	18.52	7.05	13.06	Hydrology & Vegetation	2.00	C	8.00	14.82
LS12	2.95	C	12.48	7.05	8.80	Hydrology	2.00	C	8.00	9.98
LS16	4.95	D	17.60	5.05	8.89	Hydrology	2.95	C	7.05	12.41
KS16	2.95	C	189.08	7.05	133.30	Vegetation	2.00	C	8.00	151.27
KS19	2.95	C	6.29	7.05	4.44	Hydrology, Geomorphology & Vegetation	2.00	C	8.00	5.03
KS18	2.95	C	14.02	7.05	9.88	Hydrology & Geomorphology	2.00	C	8.00	11.21
KS15	2.95	C	8.77	7.05	6.18	Hydrology & Geomorphology	2.00	C	8.00	7.01
KS13	2.95	C	10.80	7.05	7.61	Hydrology & Vegetation	2.00	C	8.00	8.64
KS12	2.95	C	23.37	7.05	16.47	Hydrology, Geomorphology & Vegetation	2.00	C	8.00	18.69
KS11	5.95	D/E	18.74	4.05	7.59	Hydrology & Geomorphology	2.95	C	7.05	13.21
KS21	2.95	C	5.65	7.05	3.98	Hydrology & Geomorphology	2.00	C	8.00	4.52
DS12	2.95	C	8.33	7.05	5.87	Hydrology & Geomorphology	2.00	C	8.00	6.66
SD_HS1	5.27	D	0.27	4.73	0.13	Hydrology & Geomorphology	2.95	C	7.05	0.19
KS20	2.95	C	10.97	7.05	7.74	Hydrology & Geomorphology	2.00	C	8.00	8.78
		TOTALS	**373.38**		**252.18**					**295.66**
		PROJECTED GAINS	**43.48**							

7. CONCEPTUAL SOLUTIONS AND RESTORATION STRATEGY

7.1 Deactivating Head-cut Erosion and Eroded Channels

Several of the wetlands are characterised by channel erosion, bank collapse and the formation of new channels at lateral head-cuts through previously unchannelled hillslope seepage wetlands. It is proposed that, once migrating head-cuts have been stabilised, the channels should be stabilised and potentially plugged to promote improved water distribution and raise the water table. Where new channels are forming in hillslope seepage wetlands it may be desirable to infill the channels to further promote diffuse flows across the entire wetland front.

The main cautionary considerations of this approach are:

- The timing of construction. It is critical that any structures and the infilling be completed within the dry season.
- Gabions and/or plugs built across channels and at head-cuts should be properly keyed into the channel walls to ensure no new erosion points are provided;
- If possible, the structures should make contact with the bedrock, or be placed on a suitably compacted base to ensure no erosion beneath the structure takes place;
- The bidum incorporated into the gabion structures should be permeable to water;

7.2 Reinstate Overbank Topping

Large areas of the lower channelled valley bottom wetlands have become desiccated due to the combined impacts of:

- The incision of the channel, which decreases the frequency of overbank topping during peak-flow events (a central driving process); and
- The obstruction to longitudinal flow caused by numerous dams upstream;

The strategy for rectifying this is as follows:

- Potentially introduce gabion structures or concrete weirs at appropriate intervals across the channels to reinstate a base-level that encourages more frequent overbank topping into the adjacent wetland. A key component of this is ensuring that all potential re-entry points are appropriately stabilised to prevent lateral erosion and channel straightening;
- The structures will also raise the water table in the section of the HGM unit, bringing the water table within reach of the herbaceous vegetation rhizosphere and hopefully stimulating a change towards a wetland vegetation community.

7.3 Drains, Roads and Dam Walls

- Drains should be deactivated by either filling in or earthen plugs;
- Road crossings require mitigation measures such as box culverts to ensure hydrological connectivity without introducing confined flow to the system;
- Roads across seeps should be placed on a bed of crushed rock to ensure that water may seep beneath the road;
- Roads across wetland could also have speed bumps placed at intervals to force water out of the road and into the adjacent wetland downslope of the wetland;
- Berms affecting flow should be removed or broken at intervals to allow water movement;
- A number of the dams within the hillslope seepage and valley bottom wetlands should be removed to increase flows to the downslope reaches of the wetlands. However, erosion in the downstream systems will need to first be stabilised to ensure that increases in flows do not further exacerbate erosion; and
- In remaining dams, spillways should be re-enforced using concrete or gabions to prevent incision into the wall. A spreader canal should be employed downstream to facilitate water distribution across the width of the downstream wetland to reinstate diffuse flow.

7.4 Wetland Buffering

Where cultivation extends into the wetland boundaries or lies in close proximity to wetland habitat, it is recommended that a buffer be incorporated around the wetlands, and cultivation be withdrawn from the buffer area to allow natural vegetation to become reinstated. A buffer area will provide a measure of protection to the wetland habitat by reducing sediment input directly to the wetlands, improving wetland habitat integrity along the wetland fringes and allowing space for surface flows to infiltrate without causing erosion of the wetland soils. The size of the buffer would need to be determined by factors such as the nature of the current agriculture, the current condition of the wetlands, and the topography of the wetland catchment. *A minimum buffer of 20 metres should however be considered based on the guidelines provided in the Mpumalanga Biodiversity Conservation Plan (Ferrar & Lötter, 2007).*

7.5 Burning and Grazing

- In areas where erosion is severe or proposed structures such as gabions are installed, the wetland and its buffer should be fenced off to control access by cattle;
- Ideally the wetlands should only be grazed in autumn, although some parts of each system should be left un-grazed to provide refugia for wetland fauna;
- Water points may be established at certain points in the wetland systems that are specifically modified to be able to withstand the disturbance from cattle;
- In wetlands where natural fires are controlled or prevented, the wetlands should be burned periodically (every 4 to 5 years) and such action will require the compilation and implementation of a fire management plan. Care should be taken to burn at times outside the nesting periods for important wetland bird species; and

- A full post-restoration management plan should be established to ensure that the management of the area is compatible with achieving the restoration objectives of the project.

7.6 Alien Vegetation Management

- The large plantations of alien vegetation should ideally be removed;
- An organisation such as Working for Wetlands should be consulted regarding removal to ensure that it is done efficiently and sensitively without causing unnecessary soil disturbance;
- Alien vegetation removal should begin in the upper ends of the catchments to ensure that reseeding of cleared areas does not take place from the upstream seed bank;
- Cleared areas may need to be re-vegetated to stabilise the soil if natural re-vegetation with indigenous species does not take place; and
- An alien vegetation management plan should be compiled to establish the objectives and methodology necessary to successfully prevent the further encroachment of alien and weed vegetation within the wetlands.

8. SITE SELECTION OUTCOME

The outcome of this assessment revealed that opportunities for suitable areas for compensation are available within the mining right area of Exxaro. However, further assessments will need to be undertaken in these areas to determine if these will meet the required offset targets. It should be noted that this can only be possible if the remaining areas are not going to be mined in the future. This requires that they are set aside solely for offsetting purposes to meet required offset targets, and not be reassigned as mining areas at a later stage. Should this not be possible, additional areas as indicated below will need to be considered and also further assessed in terms of their adequacies in meeting offset targets.

The results of the desktop assessment indicated that within the upper reaches of the catchments X11C and X11D of the Inkomati River, a number of wetland systems that fulfil the initial selection criteria as candidates' for offset investigations are supported.

The selection process was based on finding areas that have been minimally affected by mining activities (either current and/or projected mining activities known around the areas), and have similar landscape characteristics to those areas to be impacted upon by the proposed Belfast opencast operations. The similar characteristics in this context are defined in terms of underlying geology, vegetation type, prevailing landuse and the variety of wetland types contained within the landscape. An additional consideration was the likelihood of future mining in the area, since realistic offsetting implies the sterilisation of the underlying coal resource.

The following were identified as having the desired criteria (**Figure 7 and 8**);

1. Wetland within the remaining extent of the Belfast mineral rights area provided coal deposits earmarked for Phase 2 can be sterilised in perpetuity; and
2. Wetland areas located West and Southwest of the Exxaro mineral rights areas within the catchment of the Leeuwbankspruit. This area includes several small pans that are regarded as Critical Biodiversity areas. From a protection based offset it make sense to protect these areas as they represent a like-for-like of several of the pans to be lost and they lie within the affected catchment areas.

Within the Belfast Mineral Rights area there is believed to be a great deal of scope to achieve the no-net-loss target required to offset the loss of wetland functionality resulting from the Phase 1 mine plan, however, this will depend on the extent of the future Phase 2 mine plan and the extent of wetland areas that may be lost to future mining within the Belfast Mineral Rights area.

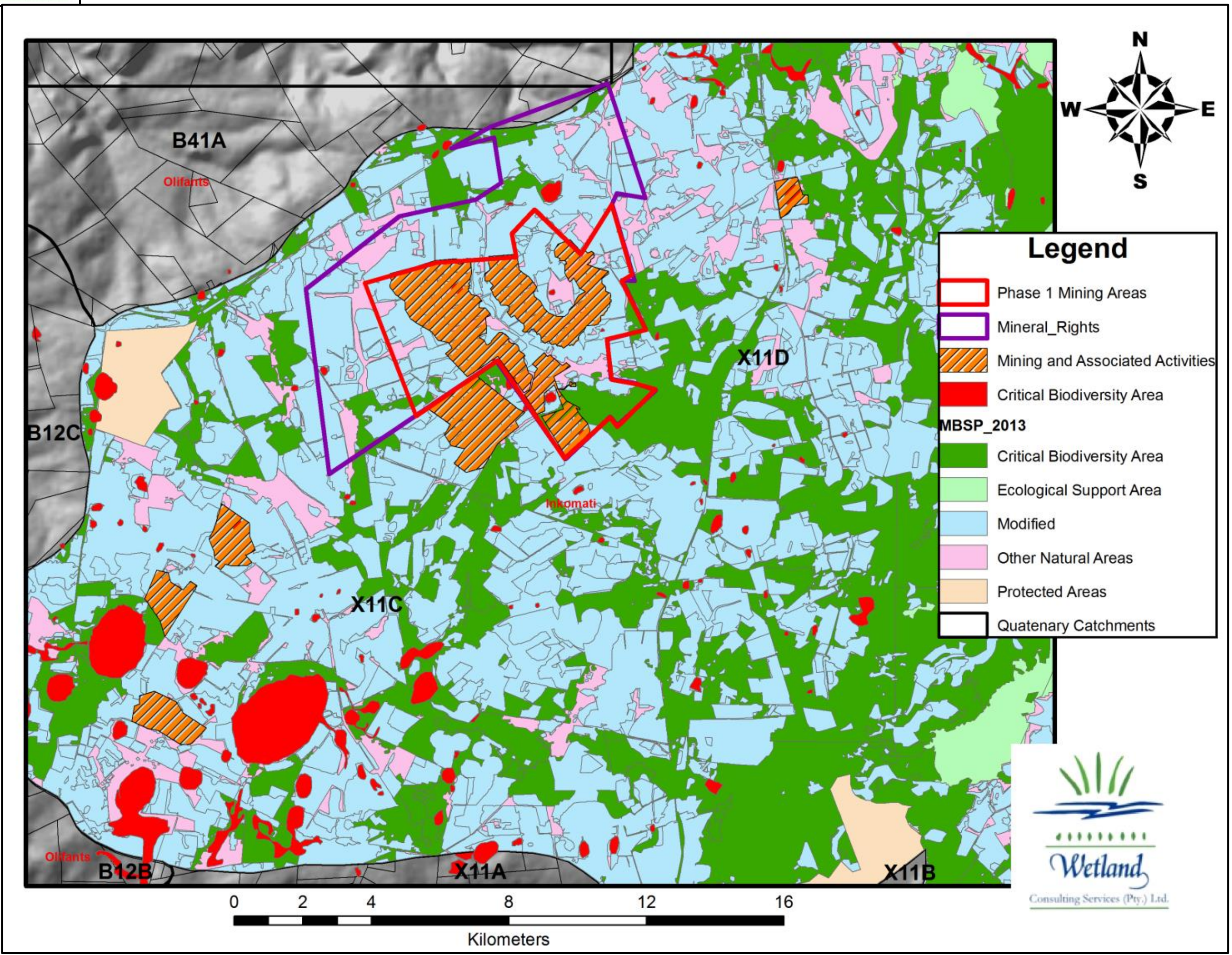

Figure 7: Map indicating critical biodiversity areas (in terms of wetlands) around the Belfast Project area in terms of the MBSP 2013

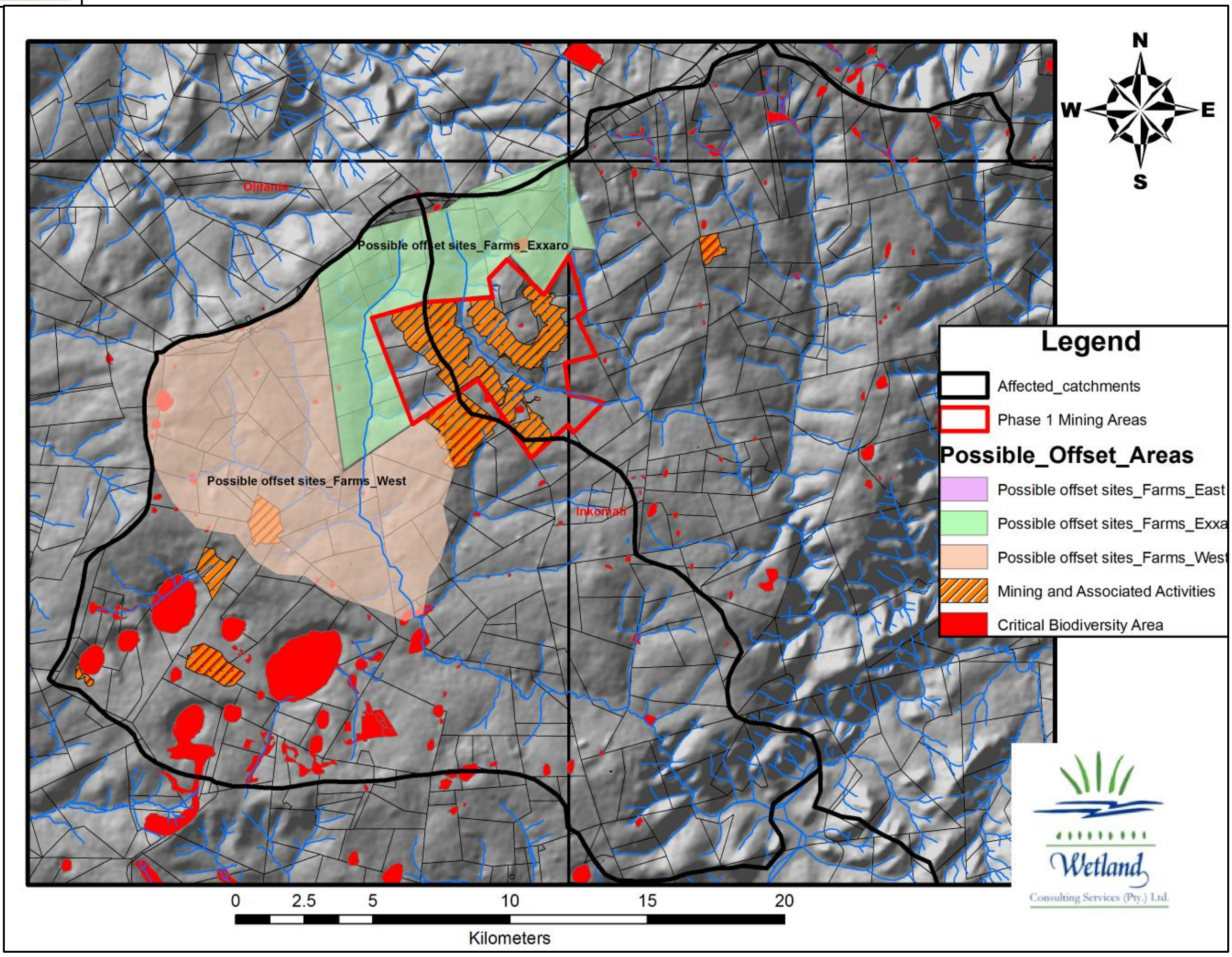

Figure 8: Map indicating possible offset areas for the Belfast Project area based on the MBSP 2013

There is the potential that Pan 7 (See Figure 5), which lies across the boundary of the study area and extends into an area currently being mined by another mining house and which, based on Exxaro' s current mine plan, will be partially lost within the opencast area, may be set aside to contribute to offsetting of lost wetland areas. In order for such an offset to be successful, it would require a revision of the current mine plan **to exclude both the pan and its catchment (see Figure 9)**. In addition, as part of the pan lies outside of the Exxaro Mineral Rights boundary, Exxaro would need to engage with the adjacent landowners and come to an agreement to either purchase the remainder of the pan catchment or to rehabilitate and protect the pan and its catchment in collaboration with the adjacent landowners.

If this option is perused then 12.51ha of wetland will be retained in the landscape which equate to 8.13 ha/eq. and ***this will reduce the required overall functional offset target to 74.22 ha/eq. and ecosystem conservation targets to 668.68 ha/eq. Based on this, the required hectare equivalents to satisfy no-net-loss will change from 38.85 to 30.74ha/eq****. and this will be required within the candidate offsite offset site.*

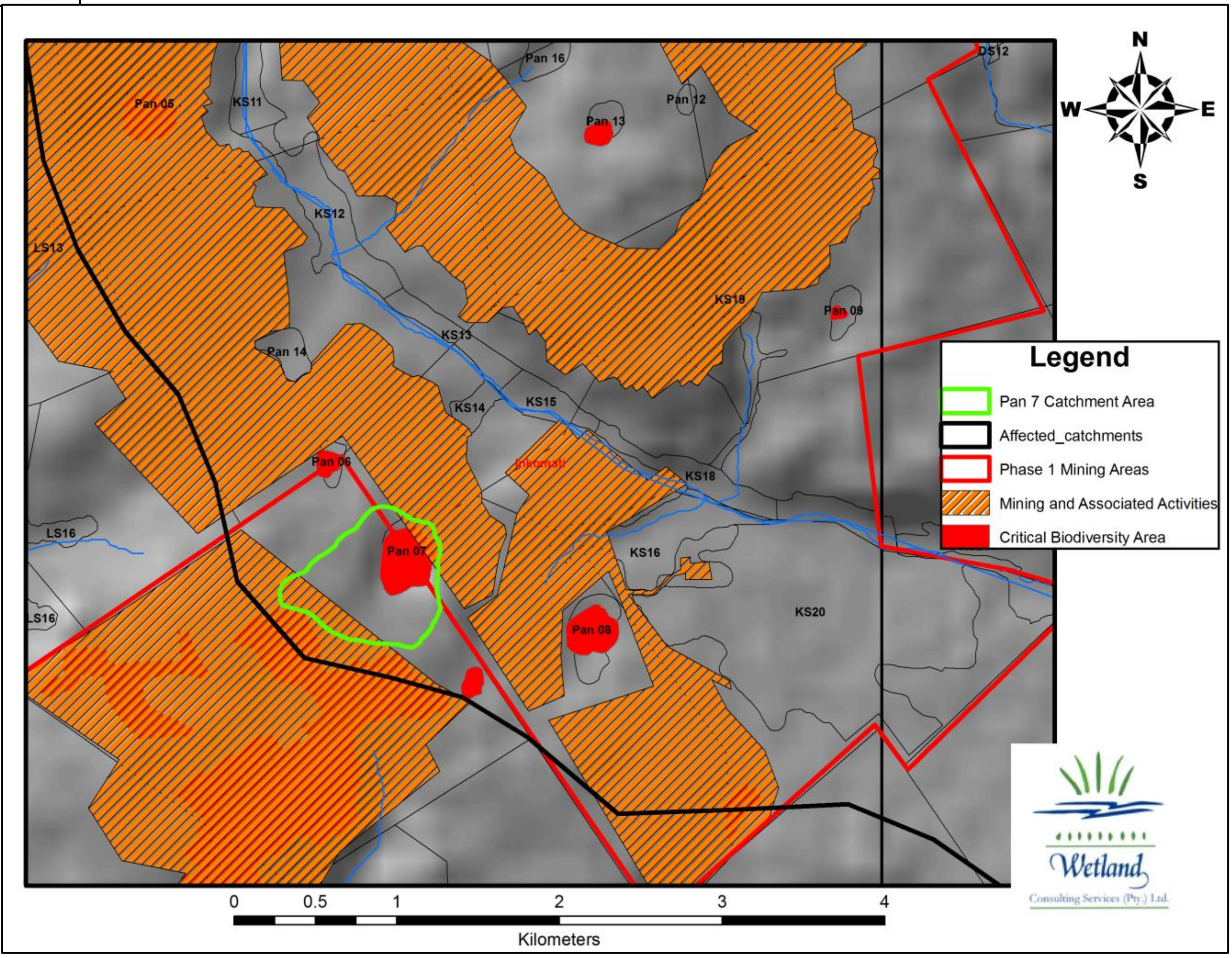

Figure 9: Map indicating Pan 7 and its associated catchment

9. CHALLENGES, RISKS AND OPPORTUNITIES ASSOCIATED WITH THE CANDIDATE SITES

The suitability of the candidate sites as offset sites will depend on Exxaro owning the surface and mineral rights to the land. The challenges, risks and opportunities related to using these areas as offsets are addressed in the section below.

9.1 Challenges Associated with Access and Land Ownership to proposed candidate sites

The land within the Belfast Coal Mine Phase 1 area is owned (or is in the process of being purchased) by Exxaro, in which case access and management of the land and wetlands within this area will not pose a significant risk in terms of achieving the restoration of the wetlands. This is relevant to the remaining wetland areas on site earmarked for rehabilitation that would yield 43 ha-eq towards meeting functional offset targets. The shortfall of 39 ha-eq required to balance the required functional offset targets "no net loss" in order to eliminate such risks associated with access and land ownership should remain in all possible means within the properties that are owned by Exxaro.

It should be noted that if it proves that the requirements cannot be met within the property owned by Exxaro for any reason; depending of type of land tenure it would need to be contractually agreed that the planned land use does not conflict with the rehabilitation and management of the wetlands. It must be emphasised that the areas identified as potential offset sites have not been assessed in detail and the land ownership is uncertain. It is likely that many of the areas/farms earmarked for offset investigations are owned by private farmers. Therefore, surface rights and access to these areas will depend on the interest shown by the farmers as there are no obligations on their side to allow access to their properties. From experience some of the farmers who are productively using the land for agricultural activities normally do not want to entertain the issue of offsets as they believe this will compromise the productivity of their businesses.

9.2 Risks Associated With Conflicting Future Landuses – uncertainty regarding the future landuses in the candidate sites

The candidate sites for offsets at face value appear to be dominated by agricultural activities with limited mining activities. This is one of the main reasons that this catchment was earmarked. Within the study area, it is assumed that Exxaro will purchase the surface rights from the current landowners, which will allow greater control over rehabilitation activities. With all land earmarked for functional offset targets that is owned by Exxaro, the risks associated with future land uses is greatly reduced. By owning the land, Exxaro is able to make all decisions on landuse, even land that is leased out for agricultural purposes, and Exxaro is able to impose conditions and restrictions in contractual agreements with lessees and this is relevant to Phase 1 project area which is yielding 43 ha-eq post rehabilitation activities.

However, Exxaro have no control over the future landuses in areas not owned by Exxaro and this makes the success of any proposed rehabilitation of offset areas vulnerable as there may be conflicting interests with regards to proposed activities between Exxaro and those with surface or other rights within offset areas. This might be a particular case for the additional areas required to yield 39 ha-eq post rehabilitation activities to meet the required functional offset. For example, in any offsite offset sites proposed it is not known exactly who owns mineral rights and what plans are in place for future use for these areas. Uncertainty with regard to future landuse may compromise the offsets proposed by Exxaro in certain areas. The purpose of the offset programme is to ensure that land set aside for offset is protected, rehabilitated and managed to meet targets, over a long period of time or permanently. Therefore, if this cannot be guaranteed due to the parties owning certain exploration rights within these areas, it is likely to nullify the entire purpose of the offset programme for Exxaro. Again by all means the shortfall of 39 ha-eq required to balance the required functional offset targets "no net loss" in order to eliminate such risks associated with conflicting future landuses should remain as far as possible within the properties that are owned by Exxaro.

9.3 Risks Associated With Different Levels of Authorisations That May Be Required

Exxaro would need to secure in some form the areas earmarked in order to implement a meaningful offset programme. The following land tenure options/arrangements could be considered:

1. Outright purchasing of the all identified properties;
2. Subdivision and purchasing of portions of the farms; and only purchasing/keeping the wetland areas (with a suitable buffer zone around them- a biodiversity servitude);
3. Easement agreements, whereby wetland areas are essentially "rented" from existing landowners, and their protection is guaranteed. Such an approach is generally much cheaper than to purchase the land outright on which the wetlands that are to be rehabilitated are located. However wetland protection is uncertain under this type of arrangement. It would then require from Exxaro a commitment to support and fund a long term inspection programme to ensure that the wetlands are protected and managed. As part of the agreement the farmers would have to agree to allow the inspections. Included in the agreement would be a catchment management protocol for the farmers to follow, suitably reimbursed by Exxaro; or
4. Declaration of the area/s as nature reserves.

Whichever arrangement is selected it may require the sterilisation of the mineral resource within the earmarked areas. In any application for authorisation there is no guarantee that authorisation will be granted given South Africa's economic status, dependence on fossil fuels for the majority of its power generation and the value of coal as an export commodity. Therefore there is a risk of not acquiring authorisation to sterilise the resource, promoting conflicting futures landuse which may compromise the effectiveness of the offsets.

In addition, both the onsite and offset site mitigation strategy associated with this project requires authorisation from various government departments i.e. Environmental and Water Affairs. This is required both in terms of NEMA and the National Water Act. Depending on whether the authorities agree with the proposed solutions, there is a risk of the mitigation strategy not being approved.

These can either delay or stop the project from being implemented; although there are likely to be strategic implications should this be the case.

9.4 Opportunity Represented by Offsetting this Area

The upper reaches of the Inkomati catchment forms a meaningful offset area from both a biodiversity and water resources management perspective. This is due to the position of the candidate sites in the upper reaches of the Inkomati water management area and that:

- It has been minimally affected by mining activities;
- It has landuses consisting mainly of open veld and agricultural activities with limited mining activities; and
- It forms part of the head waters of the strategic river system with minimum disturbances and thus provides clean water to downstream areas already heavily impacted by mining activities.

There is therefore a valuable opportunity within this area to create a functionally healthy landscape that can support a good representation of Highveld biodiversity.

10. ONSITE WETLAND MANAGEMENT PLAN AND ASPECTS TO CONSIDER

The wetlands within the proposed Belfast Opencast Coal Mine area, particularly remaining wetlands earmarked for rehabilitation have been considerably impacted by the existing agricultural activities on site, as well as infrastructure developments (e.g. road and rail infrastructure) that traverse the site. As such, considerable opportunity exists for improving remaining wetland condition and functioning through rehabilitation activities. Conceptual solutions and projected improvements have been discussed in details in the above sections.

The aim of the wetland management plan onsite is twofold:

- Ensure the no-net-loss of wetland functional area through implementing rehabilitation measures; and
- To maintain and, if possible, enhance the ecological integrity and functioning of all remaining wetlands adjacent to the mining areas.

In order to realise these aims, a number of management measures indicated below, in addition to the rehabilitation measures already discussed in Section 6 and 7 of the this report, are proposed.

10.1 Management Measures

10.1.1 Construction and Environmental Management Plan Issues

The project team should access and manage the sites i.e. wetlands earmarked for wetland rehabilitation in accordance with the best management practices and any specific requirements from the relevant authorities. The implementation of the propose rehabilitation interventions must take into account all relevant provisions of Best Management Practices and Construction Environmental Management Plan, the recommendations of the Basic Assessments submitted for Environmental Authorisation and the requirements of the Environmental Authorisation Record of Decision for the project. The appointed EAP (Environmental Assessment Practitioner) of the project must compile in conjunction with the design engineer the general construction notes and for the Construction Phase EMP (CEMP) for the project.

10.1.2 Wetland Management Recommendations

While construction-related impacts will be addressed through best management practices and the environmental management plan, there are a range of longer-term aspects that need to be addressed to ensure that anticipated improvements in wetland functionality are achieved and maintained over the long-term. A range of management recommendations are therefore detailed here, which will need to be taken into account when managing the wetland system.

10.1.2.1 Fencing and creating a servitude of remaining wetlands

Access to the wetlands adjacent to the mining areas should be restricted through the installation of fences:

- Fences should be installed along all wetland systems located on Exxaro owned land. Ideally the fenced off area should include a minimum 20m vegetated buffer (if not more). Fences should consist of standard 5 strand cattle fences; such fences will still allow for the free movement of small mammals.
- The required surface infrastructure footprints should be fenced off and no mining related activities should be allowed to take place outside the fenced off area. The fence should be designed according to the safety requirements of the mine.

Access to the wetland areas to people other than authorised individuals should be prevented. Specifically, the dumping of litter, building rubble and garden refuse within the wetland areas should be prevented.

10.1.2.2 Management of rehabilitation interventions on the remaining rehabilitated wetland areas

- Regular monitoring of interventions is critical to ensure that any problems with rehabilitation interventions are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration when inspecting interventions:

- Signs of erosion around the sides of structures (particularly constructed weirs);
- Signs of scouring below the concrete weirs and other structures which could undermine the structures;
- Signs of water not being retained behind weirs which would suggest that water may be finding its way around or under the structures;
- Cracks in concrete structures or damage caused by debris washed down during storms;
- Head-cuts that may develop downstream of structures where water re-enters the main drain;
- Wash / disturbance that has caused failure of earth berms / distribution berms;
- Poor vegetation cover of areas where earthworks have been undertaken; and
- Lack of recovery of wetland vegetation in sections of the wetland.

Where such concerns are noted, input from the Provincial coordinator should be sought to assess the need for maintenance or additional interventions to address issues of concern.

10.1.2.3 Upstream and surrounding mining activities

Upstream and surrounding proposed mining activities will clearly have a direct negative impact on the wetlands. However, recommendations provided as part of the environmental impact assessment studies including water balance and water management plan for the entire operation should be adhered to at all times. DWA should monitor all the conditions of the authorisations to be provided for the proposed operations to ensure minimisation of future and projected impacts to remaining wetlands on site. Should there been any transgressions, appropriate mitigation measures must be enforces as part of on-going monitoring by all the relevant authorities to minimize impacts on the wetland and downstream water resources.

10.1.2.4 Stormwater infrastructure maintenance

All stormwater management infrastructure on site should be inspected at least twice per year, ideally just before the start of the wet season and then again during the middle of the wet season, for any damage or obstructions. Obstructions should be cleared and damage repaired immediately to ensure optimal operation of the infrastructure. All discharge points should also be inspected for signs of erosion and any erosion damage repaired immediately and corrective measures implemented as required.

10.1.2.5 Management of agricultural lands

Should the remaining areas around the mining operations and post mining activities used for agricultural use to keep the land productive, 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 so as to limit impacts associated with sedimentation and pollutant runoff. This should be extended to as much as 50m where steep slopes occur or where intensive cultivation is undertaken.

10.1.2.6 Fire management

With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm per annum, an area of wetland should be burnt every 4 to 5 years. Where possible, burning should be undertaken on a rotational basis. 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. Autumn/early winter breeding species such as the grass 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.

10.1.2.7 Control of alien invasive plants

Alien invasive plants (particularly Poplars, Black wattle, Eucalyptus and Willows) occurring within the wetland pose a threat to wetland functioning and should ideally to be removed as part of rehabilitation activities. This should be considered for future rehabilitation planning cycles.

10.1.2.8 Livestock management

At this stage it is not known what remaining and candidate offset site areas will be utilised for, should the remaining land be utilised for agricultural activities, then 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. 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.

10.1.2.9 Re-vegetation of all disturbed areas within and around remaining wetland areas

Bare soil areas within the wetlands resulting from construction/decommissioning activities should be re-vegetated as soon as possible following the disturbance. A wetland specialist must assist during re-vegetation and must be prescribed the suitable species for re-vegetation of disturbed wetland areas. Typical species that should be considered include a mix of pioneer and climax species such as the following:

- *Digitaria eriantha*
- *Chloris gayana*
- *Eragrostis curvula*
- *Eragrostis tef*
- *Cynodon dactylon*
- *Setaria spp.*
- *Panicum maximum*
- *Melinis repens*

Suitable seed mixes are available from Sakata Seed (Biomosome Grassveld Reclamation Mixture) and Advanced-Seed (Indigi Mix). Soil compaction should be alleviated through ploughing/ripping and scarifying, followed by landscaping to the natural/surrounding landscape profile. Where ploughing/ripping takes place on slopes leading towards wetland areas or water courses, sediment barriers (see below) should be installed along the lower edge of the ploughed area.

Once soil preparation is complete, seed beds should be prepared as per the guidelines supplied by the seed supplier, or as follows: Furrows should be made in the soil by hand using hoes. Furrows must be made horizontally in the soil (parallel to slope) and should be spaced 0.4 meters (maximum) apart and at least 10 cm deep. Work should commence from the top of the slope and be conducted downwards and any loose soil and rocks from the process should be removed to prevent siltation of the wetlands downwards. The beds should follow the contours of the land and not in any way allow water to collect or flow in high volumes, thus creating erosion gullies. Larger clumps of soil and stones should be removed to prevent impeded flow of water. On steep slopes and high erosion risk areas the use of hessian blankets is recommended to increase erosion protection.

Seeding should commence as soon as the hessian is in place and seed bed preparation has been completed. Either hand or hydro-seeding can be considered, depending on the area required to be planted. Both hand and hydro-seeding must be done by professionals only. If any fertilizers are recommended these should be applied to the side slopes only and not within the wetland. If hydro seeding is selected for the seeding process the hydro-seeders used must run for 10 minutes at least before the commencement of the seeding project. This is to ensure adequate mixing of the seed and water. Water extraction for the hydro-seeding from the wetlands and pans is not allowed unless authorization is received from the Department of Water Affairs. A good rehabilitation grass mix can be obtained from Advanced-seed or African grass seeds, but must contain indigenous grass species which are conspicuous in the Highveld grassland. Once the initial rehabilitation has been completed the rehabilitated areas should be checked for erosion at the end of the first summer. If erosion is observed, appropriate action should be taken to limit its extent.

10.1.2.10 Management and monitoring of important biota

- No threatened flora should be collected or harvested;
- No threatened fauna should be hunted;

- Where endangered animal species occur in the wetland, records should ideally be kept of sightings in order to help establish whether or not wetland management practices and rehabilitation efforts are having a positive impact on these species; and
- The local district conservation officer should be contacted to obtain further information on monitoring of important species.

10.1.2.11 Road crossings

Further roads through the wetland should be avoided as far as possible. Should these be necessary, then measures as indicated under conceptual solutions must be implemented to address potential future impacts, such as flow impoundment and concentration. If roads are constructed through wetlands, they should be designed in such a manner that they have minimal impact on natural flow patterns through the wetlands.

10.1.2.12 Removal of redundant infrastructure

Within Exxaro project area, it is recommended that a survey of all roads (farm tracks) and infrastructures located within the remaining wetland areas earmarked for rehabilitation must be undertaken and that, in consultation with the land users, all redundant infrastructures and roads be removed and the footprints rehabilitated. Any such rehabilitation activities should be undertaken under supervision of a wetland specialist.

11. RECOMMENDATIONS AND PROPOSED WORKPLAN GOING FORWARD

It appears that there are potential candidate sites for offset investigations within the upper reaches of the Inkomati Catchment, specifically within the affected quaternary catchments as indicated in Figures 7 and 8. Therefore, an offsite offset investigation will need to be undertaken to search for areas that can be used to achieve the approximately 38.85ha-eq. of wetlands required to reach the objective of no-net-loss of functional wetland area. Areas adjacent to the Belfast Coal Mine Phase 1 area as well as the catchment of the Leeuwbankspruit will form the primary focus of the investigations, although the suitability of these areas as potential offsets will be dependent on factors such as the extent of wetland habitat (and sufficient hectare equivalents) and risks associated with landownership and future landuse.

The selection process is based on finding areas that have been minimally affected by mining activities, and have similar landscape characteristics to those areas to be impacted upon by the proposed Belfast opencast mining. The similar characteristics in this context are defined in terms of underlying geology, vegetation type, prevailing landuse and the variety of wetland types contained within the landscape. Further assessments will need to be conducted in these areas to determine whether the available wetlands will appropriately satisfy any offset requirements by adequately compensating for, or replacing, the ecological value of the foregone wetlands in the proposed mining areas.

Exxaro should commence with the following:

1. Initiate an engagement process directed at the property owners within the candidate areas earmarked for offsets. At initial engagement, Exxaro should clearly indicate that the goals are protection of land resources, which will prevent future mining. The outcome of this process would be the formulation of a discussion forum where they can discuss the approach, including the protection and rehabilitation objectives and any other related issues outlined in the proposed offset strategy for Belfast opencast mining.
2. Search for and collate all mining and surface rights information in order to assess any potential conflicting interests associated with the sites, and where possible, start negotiations with the legal owners. The application to sterilise the mineral resource may be required to secure the identified offset against future conflicting landuses, should this be an option.

At this point, following all engagements the prudent approach would be for Exxaro to approach the authorities with the candidate sites as outlined, to gain an idea of the degree of support likely to be forthcoming, prior to further investment on the part of the company. This will also highlight additional concerns by the authorities that may need to be addressed prior to authorisation being granted.

After approval in principle is given by the relevant authority, Exxaro should initiate Phase 2 of the project i.e. development of detailed onsite and offset mitigation strategy. This will include the detailed design phase of the project particularly for wetland rehabilitation interventions in order to ensure requirements for offsets are met,

As part of Phase 2 Exxaro should ensure that the following are adhered to as part of proceeding plan:

1. Appoint specialist consultants to undertake wetland ecological integrity assessments of the offsite candidate sites to evaluate adequacy of these sites to meet required hectare equivalents for no net loss and protection based offset requirements,
2. If it proves that the identified candidate offset sites do not meet the required hectare equivalents, the specialist should make recommendations and identify further sites for Exxaro to initiate further engagements,
3. Parallel to the process of assessment of environmental integrity, an environmental engineer will need to be appointed by Exxaro to design interventions aimed at improving the status of the wetlands within the candidate sites in order to meet the required no net loss principle and to form part of the mitigation strategy;
4. Environmental engineers will provide designs, plans and costing of the required interventions in discussion with the wetland specialist, based on assessment of the problems of each site;
5. The team, including wetland specialists and environmental engineers in conjunction with Exxaro, will compile an offset site wetland mitigation strategy document which will include integrity assessments for both onsite and offsite offset sites and rehabilitation interventions as designed by the engineer;
6. Wetland specialists will be required to compile a wetland management and monitoring plan as part of the mitigation strategy document;

7. Wetland management plan and monitoring plan will set baseline monitoring data that rehabilitation process will be measured against and also ensure that the associated impacts are monitored and managed in order to meet the desired outcomes as set out in the objectives;
8. The reports will then need to be presented to the relevant authorities for approval;
9. The design of a long term monitoring program should be included within the scope of the specialists studies which will accommodate the land tenure option selected. For example, if the offset option i.e. land tenure option selected includes long term rental of land containing wetlands or purchasing of identified areas servitudes or entire farms then at this stage Exxaro will be required to start designing and implementing a strategy to engage with land owners regarding long term land rental for this purpose, in order to educate the landowners, as well as gauge their receptiveness to such a program.

Upon completion of Phase 2, Phase 3 should be initiated. This is implementation of both onsite and offset site intervention designs and this will commence once all plans have been approved by the relevant authorities. Phase 3 includes appointment of the contractor to implement the plans as per the strategy documents.

A monitoring team to collate and report back to all stakeholders the outcomes of the interventions should be appointed by Exxaro. This should be done towards the end of the intervention and implementation phase. This team should comprise of government, private-public partnerships and specialist consultants for transparency in reporting. In the event that the expected outcomes are not achieved, the team should have the capacity as well as resources to take whatever remedial actions that may be recommended and required, whether that may include modification of the objectives or the identification of alternative strategies in order to meet the objectives. The intervals between reporting would be determined by the stage and strategy of the finally adopted rehabilitation plan.

It should be noted that offsets are long term commitments and are procedural processes in nature and therefore should be treated as such. This requires corroborated efforts amongst all involved role players, that is:

1. The applicant - who must ensure that all management plans and monitoring tools are in place and conditions of the offset are met all the times;
2. Government Authorities – who will be responsible of approving mitigation strategy and will be undertaking continuous monitoring as part of compliance and enforcement mandates and possible sterilisation of mineral recourses;
3. Farmers and Surrounding landuses –
   a) Farmers - who must agree to sell and/or to transfer their surface rights depending on ownership and type of land tenure agreed upon to give a way to the mitigation strategy;
   b) Farmers – who will be continuing utilising the land depending on the type of land tenure agreed upon e.g. if rental is an agreed arrangement then farmers will be utilising the offset areas sustainably and managing offset corridors to meet the requirements of the strategy;
   c) Surrounding land users - who will be ensuring there will be continuous management of cumulative impacts in terms of utilisation the land from upstream and downstream of the areas earmarked for mitigation strategy implementation.

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