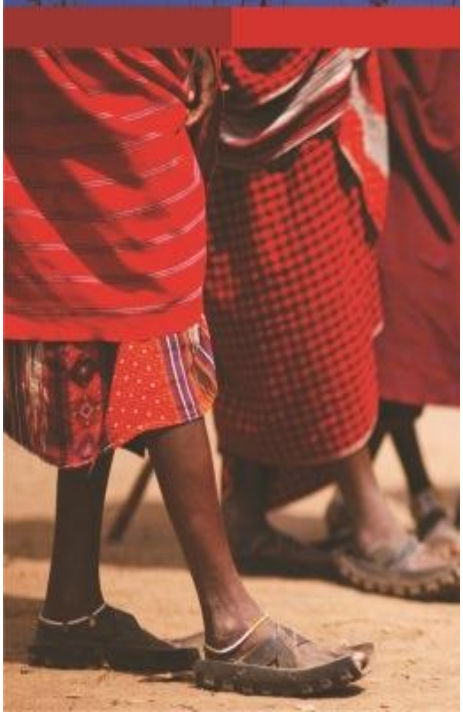

DIGBY WELLS
ENVIRONMENTAL

Freshwater Resource Assessment in the Vicinity of the Proposed Millsite Reclamation

Wetland Sensitivity Mapping and Impact Assessment

Project Number:

SIB4996

Prepared for:

Sibanye-Stillwater

November 2017

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Wetland Sensitivity Mapping and Impact Assessment**
Project Name:	**Freshwater Resource Assessment in the Vicinity of the Proposed Millsite Reclamation**
Project Code:	**SIB4996**

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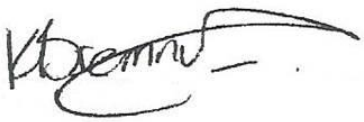
Kieren Bremner	Wetland Specialist, Report Writer and Report Reviewer		26 November 2017
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DECLARATION OF INDEPENDENCE

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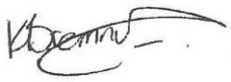
I, Kieren Bremner, as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Sibanye Stillwater, other than fair remuneration for work performed, specifically in connection with the proposed Millsite TSF reclamation and rehabilitation project.



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Qualification(s):	MSc Aquatic Health
Experience (years):	10

EXECUTIVE SUMMARY

Digby Wells Environmental [DWE] (hereinafter Digby Wells) was appointed by Sibanye-Stillwater (Pty) Ltd (hereinafter Sibanye) to conduct a freshwater resource assessment including wetland sensitivity mapping and an impact assessment, as part of the environmental assessment and authorisation process for the reclamation of the Millsite Tailings Storage Facility (TSF) and decommissioning of associated infrastructure, and subsequent rehabilitation. The Millsite TSF forms part of Sibanye's Cooke Mine and is located to the north of the town of Randfontein in the Gauteng Province.

Wetland Sensitivity Mapping

Five HGM units were identified within 500 m of the Millsite TSF, which cover approximately 105.1 ha. These comprised of a Hillslope Seep (HGM Unit 1), which is currently heavily impacted on by a neighbouring sewage works facility, two Channelled Valley Bottom wetlands (HGM Units 2, where only limited impacts were observed, and 4, where serious impacts in terms of altered stream channels, disturbance of soils, altered hydrology and impacts from Alien Invasive Species [AIPs] were observed), an artificial wetland (historical cascade dams) and a Depression (HGM Unit 5, which is seriously impacted on in terms of toxicants and sedimentation).

Present Ecological State (PES)

The wetlands that surround the Millsite TSF exhibit a variety of PES values/conditions, ranging from *Seriously Modified* (Category E), to *Moderately Modified* (Category C). HGM Unit 4 may be considered as *Seriously Modified* (Category E), which is largely due to the alteration of the channel, various gullies, and channelization. The presence of tailings material adjacent to HGM Unit 4 has also impacted the PES score through deposition in the wetland. HGM Units 1 and 5 are both *Largely Modified* (Category D). HGM Unit 1 is impacted on heavily by the presence of a sewage trench that is discharging untreated sewage into the wetland, while HGM Unit 5 has been negatively impacted on by the deposition of tailings, large areas of unvegetated land and the proliferation of AIPs. HGM Unit 2 is *Moderately Modified* (Category C) with some erosion noted at this point. HGM Unit 3 is an artificial wetland and therefore PES scores are not applicable.

Ecological Importance and Sensitivity

The Ecological importance and Sensitivity is *Low* to *Moderate* for all the HGM units, as these wetlands are sensitive to changes but still provide habitat for various species, including species such as the Blue Crane, which have been found to occur in the area. Although the wetlands are modified, they do still provide *Low* to *Moderate* hydrological importance services (ranging between 0.7 and 1.9), such as sediment trapping and assimilation of toxicants, phosphates and nitrates.

Ecological Service Provision

HGM Units 3 and 5, have *Moderately Low* EcoServices scores, while the remainder have an *Intermediate* score. It is important to note that EcoServices provided at HGM Unit 5 are

largely related to toxicant assimilation and sediment control, which may be considered critical impacts affecting this HGM Unit, thus contributing to the score obtained.

Across all the wetlands, carbon storage is *Low* to *Moderately Low*. Cultural value, tourism harvestable resources, cultivated foods and recreation are all *Low* due to the fact that these wetlands are modified systems, within mining boundaries and so are not accessible to potential users. Due to tailings deposition and sewage disposal in these wetlands, the sediment trapping, and assimilation of phosphates, toxicants and nitrates functionality of the systems are *Moderately High* to *High*.

Biodiversity maintenance is varied for the various wetlands, ranging from *Moderately Low* to *Moderately High*. The variation in scores is a result of the difference in habitat modification of the wetlands. Some wetlands are more natural and will provide better habitat for various species while other wetlands are largely modified, providing little habitat and infested with AIPs.

Impact Assessment

The long-term benefits of the proposed reclamation and rehabilitation has the potential to result in improvements of the biodiversity and ecological health and integrity, however, should no management and mitigation measures be implemented a number of impacts are anticipated.

Among the impacts associated with the proposed Millsite TSF reclamation and rehabilitation project are minor potential impacts to soil and water quality as a result of the ingress of hydrocarbons and mechanical spills associated with heavy moving machinery required for the operational, decommissioning and rehabilitation activities.

Larger impacts include compaction of soils, potential loss of natural vegetation and the increased potential for erosion and sedimentation in the Project area and in the vicinity thereof and resulting in impacts further downstream. With unregulated use of existing dirt roads across wetlands and indiscriminate driving and movement of heavy machinery across wetland areas, vegetation establishment will be hindered and erosion will be promoted.

These impacts have the potential to increase sediment loads being deposited on river bends and levees, which in turn may result in the establishment and further spread of invasive hydrophytic plants and loss of stream flow and natural refuge areas in the aquatic systems further downstream. Alterations to the natural hydrology and geohydrology of the area should tailings or contaminated soils not be adequately removed may also result in a loss of the wetland integrity of these systems. Any potential dumping of tailings or contaminated soils in wetland areas has the potential to impact water quality of the wetlands as well as the aquatic resources further downstream of the site.

In addition, any potential temporary stockpiling or dumping of tailings or contaminated soils within wetland areas has the potential to result in loss of stream connectivity, loss of refuge areas, alterations to the terrain profiles of the areas and the creation of preferential flow paths, which may result in sedimentation, alterations to the vegetation structure of the area,

encourage alien vegetation encroachment and result in increased erosion and sedimentation potentials.

Removal of vegetation and disturbance of soils in the vicinity of the project footprint is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive vegetation species, further altering the natural vegetation profiles of the wetlands encountered in the vicinity of the MIllsite TSF.

Transport of tailings and contaminated soils has the potential to result in further contamination and sedimentation of the freshwater resources present through spills. Furthermore, disturbance of historical tailings and contaminated soils has the potential to result in increased oxidation of pollutants such as pyrites, which has the potential to increase impacts to water quality of the freshwater resources in the vicinity of the Millsite TSF.

In addition, disturbance and reclamation of tailings and contaminated soils has the potential to result in increased erosion and sedimentation of the freshwater resources present.

Summary

While the above-mentioned impacts have the potential to result in temporary further degradation of the wetlands present, it is the opinion of the ecologist that the proposed Millsite TSF reclamation and rehabilitation project is likely to have a positive impact on the ecological integrity of the area in general, should the relevant mitigation and management measures outlined in this report be adhered to.

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p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

GLOSSARY OF TERMS

Alien invasive vegetation	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome - usually international in origin.
Basal cover	The cross-sectional area of the plant that extends into the soil.
Base flow	Long-term flow in a river that continues after storm flow has passed.
Biodiversity	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the Ecosystems, ecological processes and landscape of which they are integral parts.
Catchment	The area contributing to runoff at a particular point in a river feature.
Ecoregion	An ecoregion is a "recurring pattern of Ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Groundwater	Subsurface water in the saturated zone below the water table.
Intermittent flow	Flows only for short periods.
Indigenous vegetation	Vegetation occurring naturally within a defined area.
Perennial	Flows all year round.
Wetland	Defined according to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) as: *"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

ACRONYMS

AIP	Alien Invasive Management Plan
BRP	Bioregional Plan
CMA	Catchment Management Agencies
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWAF	Department of Water and Forestry
DWE	Digby Wells Environmental
DWS	Department of Water and Sanitation
EC	Ecological Class
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMF	Environmental Management Framework
EMO	Environmental Management Officer
F	Facultative species
FD	Facultative dry-land species
FW	Facultative Wetland species
GDARD	Gauteng Department of Agriculture and Rural Development
GIS	Geographical Information System
Ha	Hectares
HGM	Hydrogeomorphic
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRA	Mining Right Area
NEM:BA	National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystems Priority Areas
NWA	National Water Act, 1998 (Act No. 36 of 1998)

OW	Obligate Wetland Species
PES	Present Ecological State
REC	Recommended Ecological Category
RQIS	Resource Quality Information Services
SANBI	South African National Biodiversity Institute
SFI	Soil Form Indicator
SWI	Soil Wetness Indictor
TSF	Tailings Storage Facility
TUI	Terrain Unit Indicator
WMA	Water Management Areas
WRC	Water Research Commission
WRDM	West Rand District Municipality
WUL	Water Use Licence

1 Introduction

Digby Wells Environmental [DWE] (hereinafter Digby Wells) was appointed by Sibanye-Stillwater (Pty) Ltd (hereinafter Sibanye) to conduct a freshwater resource assessment including wetland sensitivity mapping and an impact assessment, as part of the environmental assessment and authorisation process for the reclamation of the Millsite Tailings Storage Facility (TSF), henceforth referred to as the "Project area" (Figure 1-1). The field assessment took place on the 6th of November 2017 and the report was compiled in the following weeks.

1.1 Project Background

The Project area has been associated with gold mining for more than a century. Due to this extensive history of gold mining and combined with the impacts of anthropogenic activity in the West Rand area, impacts to the local water resources can be divided into a quantitative aspect as well as a pollution aspect (Coetzee, 2004). Those impacts affecting the availability of water are quantitative impacts, which include the dolomitic aquifers that were dewatered by the mining activities. Pollution impacts are associated with the quality of water that has been seriously compromised due to controlled/uncontrolled and point/non-point source pollution being released into the catchments due to the mining activities.

The Millsite TSF forms part of Sibanye's Cooke Mine and is located to the north of the town of Randfontein in the Gauteng Province (Figure 1-1). The TSF falls within the West Rand Municipality.

The Project area is situated within a region that is characterised by gold mining activities. Harmony's Doornkop and Mintails' Mogale Gold mines are situated in close proximity. This report serves to detail the findings of the Wetland Impact Assessment for the Project area, with a focus on the Millsite TSF and its surrounds.

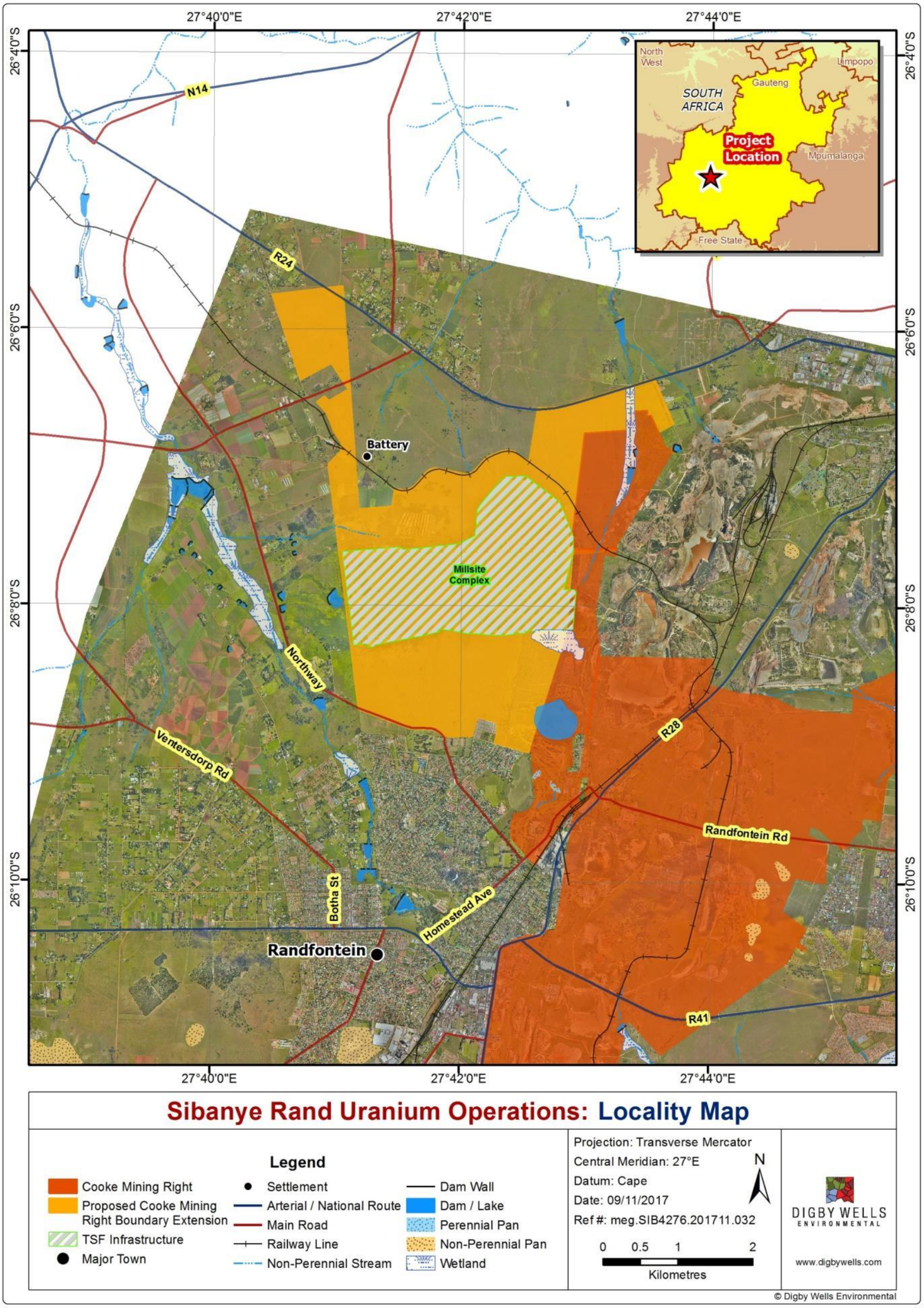


Figure 1-1: Local Setting

2 Terms of Reference

Digby Wells was commissioned by Sibanye to complete a Wetland Impact Assessment for the rehabilitation of Cooke Mine's Millsite TSF for the purposes of submitting the appropriate Water Use Licence (WUL) applications required.

3 Scope of Work

The following actions are required for this Scope of Work:

- The identification and the delineation of wetlands within 500m of the Millsite TSF;
- A description and characterisation of the identified wetland areas;
- Determination of the wetland ecological health, importance and sensitivity;
- Assessment of potential impacts to the wetlands from the activities; and
- Discussion of recommended mitigation measures to be taken into account.

4 Policy and Legal Framework

The wetlands assessment aims to support the following regulations, regulatory procedures and guidelines:

- Section 24 of the Constitution of the Republic of South Africa ,1996 (Act No. 108 of 1996);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA);
- Section 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- Department of Water and Forestry (DWAF) Guidelines for the Delineation of Wetlands (2005);
- Mining and Biodiversity Guideline (DEA *et al*., 2013);
- Gauteng Conservation Plan (GDARD, 2011);
- Regulations on use of water for mining and related activities aimed at the protection of water resources (GN 704 in GG 20119 of 4 June 1999);
- Wetland Management Series (published by Water Research Commission (WRC, 2007);
- National Freshwater Ecosystems Priority Areas (NFEPA, Nel *et al.,* 2011); and
- SANBI, in collaboration with the DWS report on "Wetland offsets: a Best-Practice Guideline for South Africa" (Macfarlane, *et al.,* 2014).

5 Details of the Specialists

Kathryn Roy: Flora and Wetlands Consultant. Kathryn received a Bachelor of Science in Ecology and Environmental Science and an Honours degree in Environmental Management from the University of Cape Town. She also has received her MSc in Restoration Ecology through the University of KwaZulu-Natal. She joined Digby Wells in February 2016 to form part of the Mine Closure and Rehabilitation Department where she was responsible for development of site specific rehabilitation plans, working closely with both the botany and soils specialists in Digby Wells. Her previous experience was gained in the Restoration Ecology Branch at the eThekwini Municipality in Durban.

Kieren Jayne Bremner: Wetlands Manager. Kieren completed an M.Sc (Aquatic Health) from the University of Johannesburg and has 10 years of consulting experience. In her early career she was exposed to various sectors of the Environmental Management field such as water use licensing, BAs, EIAs and public participation. During this time she was given the opportunity to initiate and manage various aquatic biomonitoring programmes within the mining and energy production sectors within South Africa. In 2009, Kieren began to focus largely on wetland and aquatic specialist assessments, gaining invaluable and extensive experience in the biomonitoring and water monitoring field in rivers and wetlands throughout South Africa. International countries of project experience include: Botswana, the Democratic Republic of Congo and Ghana. Kieren is registered by the SA RHP as an accredited aquatic biomonitoring specialist.

6 Aims and Objectives

The aim of the wetland study was to conduct an assessment on the wetland habitats associated with the Project area. This assessment determines the wetland boundaries and the baseline ecological state prior to the proposed reclamation of the Millsite TSF and associated rehabilitation. This information is to inform the Project and relevant authorities on the risks associated with the wetland ecosystems so that mitigation measures can be carried out according to best practice and to set a baseline against which to monitor impacts.

7 Methodology

7.1 Literature Review and Desktop Assessment

Wetlands are sensitive ecosystems that perform many complex functions. These functions include inter alia the maintenance of biodiversity and water quality, toxicant assimilation, carbon storage, streamflow regulation, flood attenuation, and various social benefits. (Wet-EcoServices Manual, 2008). The Ramsar Convention on Wetlands refers to wetlands as one of the most important life support systems on earth owing to the services provided.

For the purposes of this Project, wetland areas were identified and preliminary wetland boundaries were delineated at the desktop level using detailed aerial imagery (Southern

Mapping, 2015) along with 5m contours. Baseline and background information was researched and used to understand the area on a desktop level prior to fieldwork; this included but was not limited to:

- NFEPA (Nel *et al*., 2011);
- Mining and Biodiversity Guidelines;
- Water Management Areas (WMA) and Quaternary Catchments;
- West Rand District Municipality (WRDM) Conservation Tools; and
- Gauteng C-Plan.

7.1.1 National Freshwater Ecosystem Priority Areas

The NFEPA project provides a collated, nationally consistent information source of wetland and river ecosystems for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes (Nel *et al.* 2011). The spatial layers (FEPA's) include the nationally delineated wetland areas that are classified into hydrogeomorphic (HGM) NFEPA project types and ranked in terms of their biodiversity importance. These layers were assessed to evaluate the importance of the wetland areas located within the Project area.

Whilst being an invaluable tool, it is important to note that the NFEPA's were delineated and studied at a desktop and low resolution level. Thus, the wetlands delineated via the ground-truthing work done through this study may differ from the NFEPA data layers. The NFEPA assessment does, however, hold significance from a national perspective. As mentioned above, the NFEPA wetlands have been ranked in terms of importance in the conservation of biodiversity and Table 7-1 below indicates the criteria considered.

Table 7-1: NFEPA Wetland Classification Ranking Criteria

Criteria	Rank
Wetlands that intersect with a RAMSAR site.	1
▪ Wetlands within 500 m of an IUCN threatened frog point locality; ▪ Wetlands within 500 m of a threatened water-bird point locality; ▪ Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes; ▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and ▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.	2

Criteria	Rank
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.	3
Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).	4
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.	5
Any other wetland (excluding dams).	6

7.1.2 Mining and Biodiversity Guideline

The Mining and Biodiversity Guideline was developed collaboratively by the South African Biodiversity Institute (SANBI), the Department of Environmental Affairs (DEA), the Department of Mineral Resources (DMR), the Chamber of Mines and the South African Mining and Biodiversity Forum in 2013. The purpose of the guideline was to provide the mining sector with a manual to integrate biodiversity into the planning process thereby encouraging informed decision-making around mining development and environmental authorisations. The aim of the guideline is to explain the value for mining companies to consider biodiversity management throughout the planning process. The guideline highlights the importance of biodiversity in managing the social, economic and environmental risk of the proposed mining project. The country has been mapped into biodiversity priority areas including the four categories listed in Table 7-2 below, each with associated risks and implications.

Table 7-2: Mining and Biodiversity Guideline Categories (SANBI, 2013)

Category	Risk and Implications for Mining
Legally protected	Mining prohibited; unless authorised by ministers of both the DEA and DMR.
Highest Biodiversity Importance	Highest Risk for Mining: the EIA process must confirm significance of the biodiversity features that may be seen as a fatal flaw to the proposed project. Specialists must provide site-specific recommendations for the application of the mitigation hierarchy that informs the decision making processes of mining licences, water use licences and environmental authorisations. If granted, authorisations should set limits on allowed activities and specify biodiversity related management outcomes.
High Biodiversity Importance	High Risk for Mining: the EIA process must confirm the significance of the biodiversity features for the conservation of biodiversity priority areas. Significance of impacts must be discussed as mining options are possible but must be limited. Authorisations may set limits and specify biodiversity related management outcomes.

Category	Risk and Implications for Mining
Moderate Biodiversity Importance	Moderate Risk for Mining: the EIA process must confirm the significance of the biodiversity features and the potential impacts as mining options must be limited but are possible. Authorisations may set limits and specify biodiversity related management outcomes.

7.2 Gauteng Province Conservation Tools

7.2.1 Gauteng Conservation Plan Background

Gauteng Nature Conservation, a component of the Gauteng Department of Agriculture and Rural Development (GDARD), produced the Gauteng Conservation Plan Version 3 (C-Plan 3) in December 2010. The latest version is C-Plan 3.3 which became available in October 2011 and was revised in December 2013. C-Plan 3.3 is a valuable tool to ensure adequate, timely and fair service delivery to clients of GDARD, and will be critical in ensuring adequate protection of biodiversity and the environment in Gauteng Province.

The main purposes of the C-Plan 3.3 are:

- To serve as the primary decision support tool for the biodiversity component of the Environmental Impact Assessment (EIA) process;
- To inform protected area expansion and biodiversity stewardship programmes in the province; and
- To serve as a basis for development of Bioregional Plans in municipalities within the province.

7.3 West Rand District Municipality (WRDM) Conservation Tools

7.3.1 WRDM Environmental Management Framework and Bioregional Plan

The WRDM, according to the WRDM Environmental Management Framework (EMF) (2013), is experiencing extreme pressure between mining, agriculture and tourism in terms of biodiversity, heritage, air quality, water availability and quality, and geological constraints. According to the NEMA EMF Regulations, an EMF is defined as "*a study of the biophysical and socio-cultural systems of a geographically defined area to reveal where specific land uses may best be practiced and to offer performance standards for maintaining appropriate use of such land."* These frameworks are designed to facilitate ease of access to up-to-date environmental information so as to enable decision making related to environmental management principles. The EMF will serve as a management and decision-support tool that provides authorities with information about the status quo of the environment and the associated planning parameters. It will identify and spatially represent areas of potential conflict between sensitive environments and development proposals. The aim of the EMF is to:

- Promote sustainability;

- Secure environmental protection; and
- Promote cooperative environmental governance.

Bioregional plans (BRP) are one of a range of tools provided for in the National Environmental Management: Biodiversity Act (No. 10 of 2004) (NEM:BA) that can be used to facilitate the management and conservation of biodiversity priority areas outside the protected area network. Similarly to the EMF, the purpose of a bioregional plan is to inform land-use planning, environmental assessment and authorisations, and natural resource management, by a range of sectors whose policies and decisions impact on biodiversity. This is done by providing a map of biodiversity priority areas with accompanying land-use planning and decision-making guidelines. The WRDM BRP was published in November 2011 and revised in March 2014; making it the most recent municipal biodiversity and conservation document. The plan was developed in parallel with, and is deliberately designed to be compatible with, the WRDM EMF.

7.4 Wetland Identification, Delineation and Classification

The wetland delineation procedure considers four attributes to determine the limitations of the wetland, in accordance with DWAF guidelines (now Department of Water and Sanitation (DWS) (2005)). The four attributes are:

- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur;
- Soil Form Indicator – identifies the soil forms, which are associated with prolonged and frequent saturation;
- Soil Wetness Indicator – identifies the morphological “signatures” developed in the soil profile as a result of prolonged and frequent saturation; and
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

7.4.1 Terrain Indicator

Terrain Unit Indicator (TUI) areas include depressions and channels where water would be most likely to accumulate. These areas are determined with the aid of topographical maps, aerial photographs and engineering and town planning diagrams (DWAF, 2005). The Hydro-geomorphic HGM Unit system of classification focuses on the hydro-geomorphic setting of wetlands which incorporates geomorphology; water movement into, through and out of the wetland; and landscape / topographic setting. Once wetlands have been identified, they are categorised into HGM Units as shown in Table 7-3.

Table 7-3: Description of the various HGM Units for Wetland Classification

Hydromorphic wetland type	Diagram	Description
Floodplain		Valley bottom areas with a well-defined stream channel stream channel, gently sloped and characterised by floodplain features such as oxbow depression and natural levees and the alluvial (by water) transport and deposition of sediment , usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom with a channel		Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from the main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from the channel entering the wetland and also from adjacent slopes.
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterised by colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.
Isolated hillslope seepage		Slopes on hillsides that are characterised by colluvial transport (transported by gravity) movement of materials. Water inputs are from sub-surface flow and outflow either very limited or through diffuse sub-surface flow but with no direct link to a surface water channel.
Pan/Depression		A basin-shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. It is inward draining). It may also receive subsurface water. An outlet is usually absent and so this type of wetland is usually isolated from the stream network.

7.4.2 Soil Form Indicator

Hydromorphic soils are taken into account for the Soil Form Indicator (SFI) which will display unique characteristics resulting from prolonged and repeated water saturation (DWAF, 2005). The continued saturation of the soils results in the soils becoming anaerobic and thus resulting in a change of the chemical characteristics of the soil. Iron and manganese are two

soil components which are insoluble under aerobic conditions and become soluble when the soil becomes anaerobic and thus begin to leach out into the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils.

Resulting from the prolonged anaerobic conditions, iron is dissolved out of the soil, and the soil matrix is left a greying, greenish or bluish colour, and is said to be “gleyed”. Common in wetlands which are seasonally or temporarily saturated is a fluctuating water table, these results in alternation between aerobic and anaerobic conditions in the soil (DWAF, 2005). Iron will return to an insoluble state in aerobic conditions which will result in deposits in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated (DWAF, 2005).

7.4.3 Soil Wetness Indicator

In practice, the Soil Wetness Indictor (SWI) is used as the primary indicator (DWAF, 2005). Hydromorphic soils are often identified by the colours of various soil components. The frequency and duration of the soil saturation periods strongly influences the colours of these components. Grey colours become more prominent in the soil matrix the higher the duration and frequency of saturation in a soil profile (DWAF, 2005). A feature of hydromorphic soils are coloured mottles which are usually absent in permanently saturated soils and are most prominent in seasonally saturated soils, and are less abundant in temporarily saturated soils (DWAF, 2005). The hydromorphic soils must display signs of wetness within 50cm of the soil surface, as this is necessary to support hydrophytic vegetation.

7.4.4 Vegetation Indicator

As one moves along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas plant communities undergo distinct changes in species composition. Valuable information for determining the wetland boundary and wetness zone is derived from the change in species composition. A supplementary method for employing vegetation as an indicator is to use the broad classification of the wetland plants according to their occurrence in the wetlands and wetness zones (Kotze and Marneweck, 1999; DWAF, 2005). This is summarised in Table 7-4 below. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2005). Areas where soils are a poor indicator (black clay, vertic soils), vegetation (as well as topographical setting) is relied on to a greater extent and the use of the wetland species classification as per Table 7-4 becomes more important. If vegetation was to be used as a primary indicator, undisturbed conditions and expert knowledge are required (DWAF, 2005). Due to this uncertainty, greater emphasis is often placed on the SWI to delineated wetland areas. In this assessment, where possible, the SWI has been relied upon to delineate wetland areas due to the high level of anthropogenic impacts characterising the wetlands and freshwater resources of the general

area. The identification of indicator vegetation species and the use of plant community structures have been used to validate these boundaries.

Table 7-4: Classification of Plant Species According to Occurrence in Wetlands (DWAF, 2005)

Type	Description
Obligate Wetland species (OW)	Almost always grow in wetlands: >99% of occurrences.
Facultative Wetland species (FW)	Usually grow in wetlands but occasionally are found in non-wetland areas: 67 – 99 % of occurrences.
Facultative species (F)	Are equally likely to grow in wetlands and non-wetland areas: 34 – 66% of occurrences.
Facultative dry-land species (FD)	Usually grow in non-wetland areas but sometimes grow in wetlands: 1 – 34% of occurrences.

7.5 Wetland Service Provision (WET-Ecoservices)

"The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class" (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and

- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 7-5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

7.6 Wetland Ecological Health Assessment (WET-Health)

According to Macfarlane *et al*. (2009) the health of a wetland can be defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. A level 1 WET-Health assessment was done on the wetlands in accordance with the method described by Kotze *et al.* (2007) to determine the integrity (health) of the characterised HGM units for the Project area. Level 1 was selected due to the large size of the Project area as well as due to the restricted site access, and in turn, limited in-field verification. A Present Ecological State (PES) analysis was conducted to establish baseline integrity (health) for the associated wetlands. The health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions.

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described above.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores, and Present State categories are provided in Table 7-6.

Table 7-6: Impact Scores and Present Ecological State Categories used by WET-Health

Impact Category	Description	Combined Impact Score	PES Category
None	Unmodified, natural.	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (

Table 7-7).

Table 7-7: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland

7.7 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term. The methodology outlined by DWAF (1999) and updated in Rountree and Kotze, (2012), in Rountree *et al.* (2012) was used for this study

In this method there are three suites of importance criteria; namely:

- **Ecological Importance and Sensitivity:** incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- **Hydro-functional Importance:** which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- **Importance in terms of Basic Human Benefits:** this suite of criteria considers the subsistence uses and cultural benefits of the wetland system.

These determinants are assessed for the wetlands on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. It is recommended that the highest of these three suites of scores be used to determine the overall Importance and Sensitivity category of the wetland system, as defined in Table 7-8.

Table 7-8: Interpretation of Overall EIS Scores for Biotic and Habitat Determinants

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological ; Management Class
Very high Systems that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Systems that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Systems that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Systems that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

7.8 Impact Assessment Methodology

The aim of the Impact Assessment is to strive to avoid damage or loss of ecosystems and services that they provide, and where they cannot be avoided, to reduce and mitigate these impacts (DEA, 2013). Offsets that compensate for loss of habitat are regarded as a last resort, after all efforts have been made to avoid, reduce and mitigate. The mitigation hierarchy is described in Table 7-9.

Table 7-9: Mitigation Hierarchy

	**Avoid or Prevent**	Refers to considering options in project location, setting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services and people. This is the best option, but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, project activities should not take place. In such cases, it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation.
	Minimise	Refers to considering alternatives in the project location, sitting, scale, layout, technology and phasing that would minimise impacts on biodiversity and associated ecosystem services. In cases where there are environmental constraints, every effort should be made to minimise impacts.
	Rehabilitate	Refers to rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to near natural state or an agreed land use after mine closure. Rehabilitation may, however, fall short of replicating the diversity and complexity of natural systems.
	Offset	Refers to measures over and above rehabilitation to compensate for the residual negative impacts on biodiversity after every effort has been made to avoid, or minimise and then rehabilitate the impacts. Biodiversity offsets can provide a mechanism to compensate for significant residual impacts on biodiversity.

The impact rating process is designed to provide a numerical rating of the various environmental impacts identified by use of the Input-Output model. As discussed above, it has to be stressed that the purpose of the EIA process is not to provide an incontrovertible rating of the significance of various aspects, but rather to provide a structured, traceable and defendable methodology of rating the relative significance of impacts in a specific context. This will give a greater understanding of the impacts of the proposed project and the issues that need to be addressed by mitigation. It will also provide the regulators information on which to base their decisions. The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

Table 7-10: Impact Assessment Parameter Ratings

Rating	Intensity/Replacability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and/or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain/Highly probable: It is most likely that the impact will occur. <80% probability.

Rating	Intensity/Replacability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures/items of cultural significance.	Average to intense natural and/or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/Replacability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the immediate development site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare/improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/Replacability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and/or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely/None: Expected never to happen. <1% probability.

Table 7-11: Probability/Consequence Matrix

		Significance																																					
Probability	7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
	6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
	5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
	4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
	3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
	2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
	1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Consequence																																					

Table 7-12: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change.	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment.	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and/or social environment.	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and/or social environment.	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and/or social environment.	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and/or social environment.	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

7.9 Assumptions and Limitations

The following limitations were encountered during this study:

- The composition of the freshwater resources in the Project area prior to major disturbance is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available; and
- HGM Unit 5 is considered severely modified from its natural state. Due to the level of toxicity observed at this site, auger points were limited and the wetland boundary presented is based on limited in-field verification and detailed aerial imagery.

8 Baseline Environment

8.1 Drainage and Quaternary Catchment

The water resources of South Africa are divided into quaternary catchments, which are regarded as the principal water management units in the country (DWAF 2011). A quaternary catchment is a fourth order catchment in a hierarchical classification system in which the primary catchments are the major units. The primary drainages are further grouped into or fall under Water Management Areas (WMA) and Catchment Management Agencies (CMA). The Department of Water and Sanitation (DWS) has established nine WMAs and nine CMAs as contained in the National Water Resource Strategy 2 (2013) in terms of Section 5 subsection 5(1) of the National Water Act, 1998 (Act No. 36 of 1998). The establishment of these WMAs and CMAs is to improve water governance in different regions of the country, to ensure a fair and equal distribution of the Nations water resources, while making sure that the resource quality is sustained.

Figure 8-1 indicates the water resource management classification associated with the Project area. The Millsite TSF is associated with primary drainage A and falls within the quaternary catchment A21D.

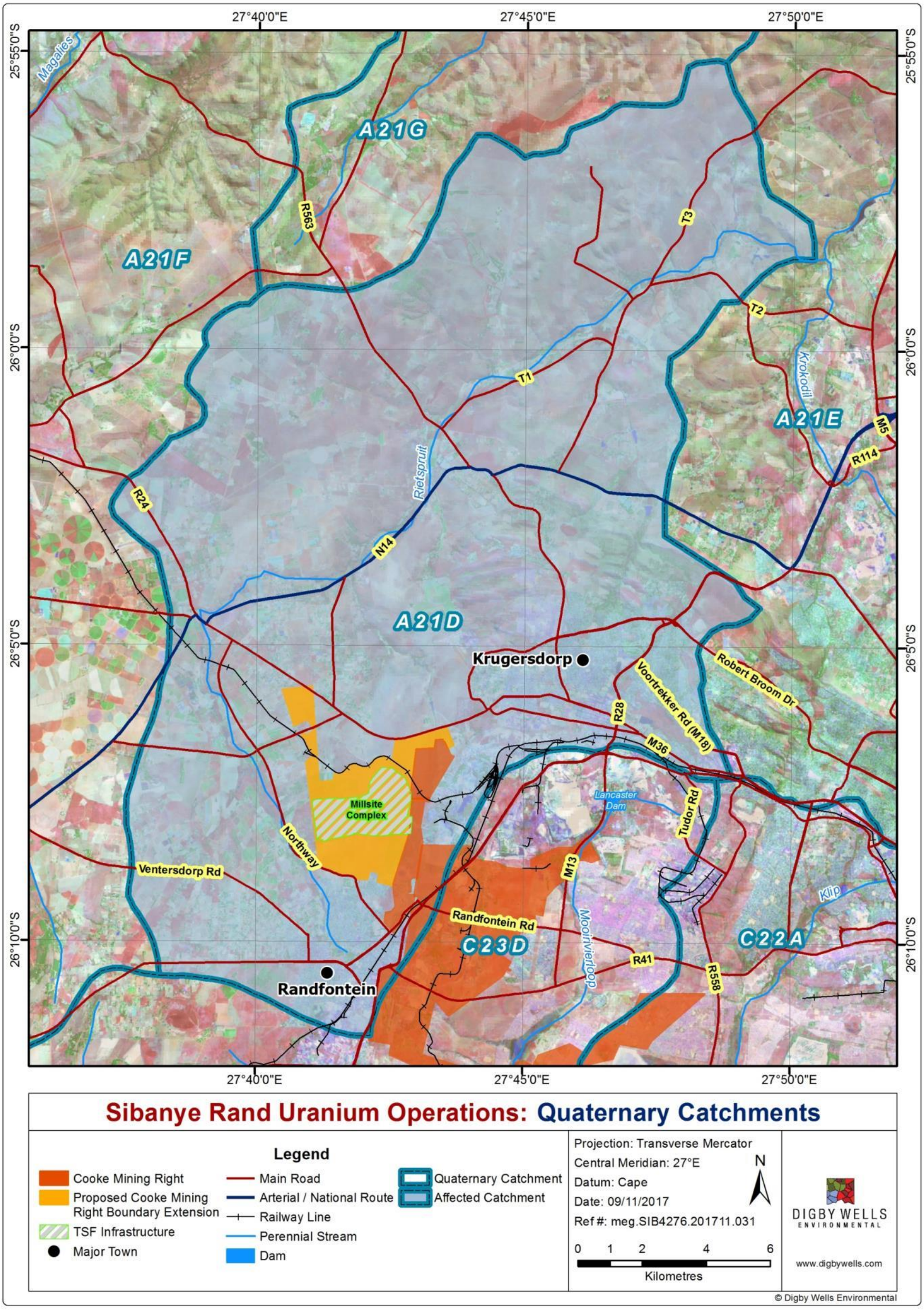


Figure 8-1: Quaternary Catchments

8.2 National Freshwater Ecosystem Priority Areas (NFEPA)

The NFEPA project provides information of wetland and river ecosystems for integrating into freshwater ecosystem and biodiversity planning and decision-making processes. The assessor considered the strategic spatial priorities for conserving the country's freshwater ecosystems and supporting sustainable use of water resources contained therein to evaluate the importance of the wetland areas located within the Cooke Mining Right (Nel *et al.* 2011). Figure 8-2 demonstrates the distribution of NFEPA wetlands within the Project area. The wetland types that dominate the landscape are flats and seeps although some of these have been incorrectly categorised as NFEPA wetlands, whilst in reality they are artificial.

The NFEPA wetlands have been ranked in terms of importance in the conservation of biodiversity. The Project wetlands are rank 4 and 6.

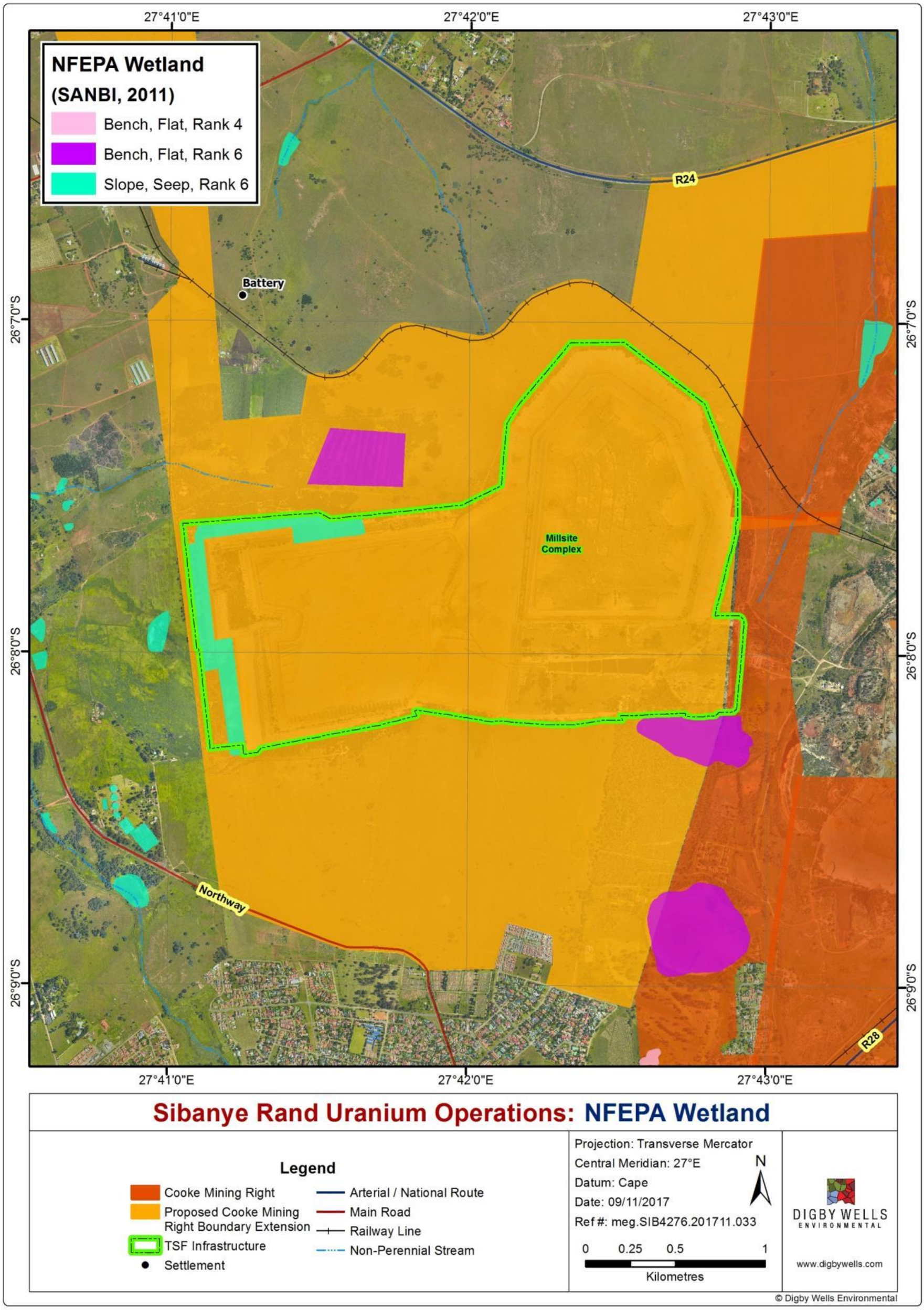


Figure 8-2: NFEPA Wetlands

8.3 Mining and Biodiversity Guidelines

The Mining and Biodiversity Guideline (2013) can be seen as a cumulative finding of all available biodiversity and ecological related information with a final mapped area. The assessment looks at NFEPA and regional biodiversity plans such as the MBSP. This is shown in Figure 8-3 below.

The majority of the Millsite TSF falls under ‘High Risk for Mining’, whilst some areas to the north, west and south of the TSF are designated as ‘Highest Risk for Mining’.

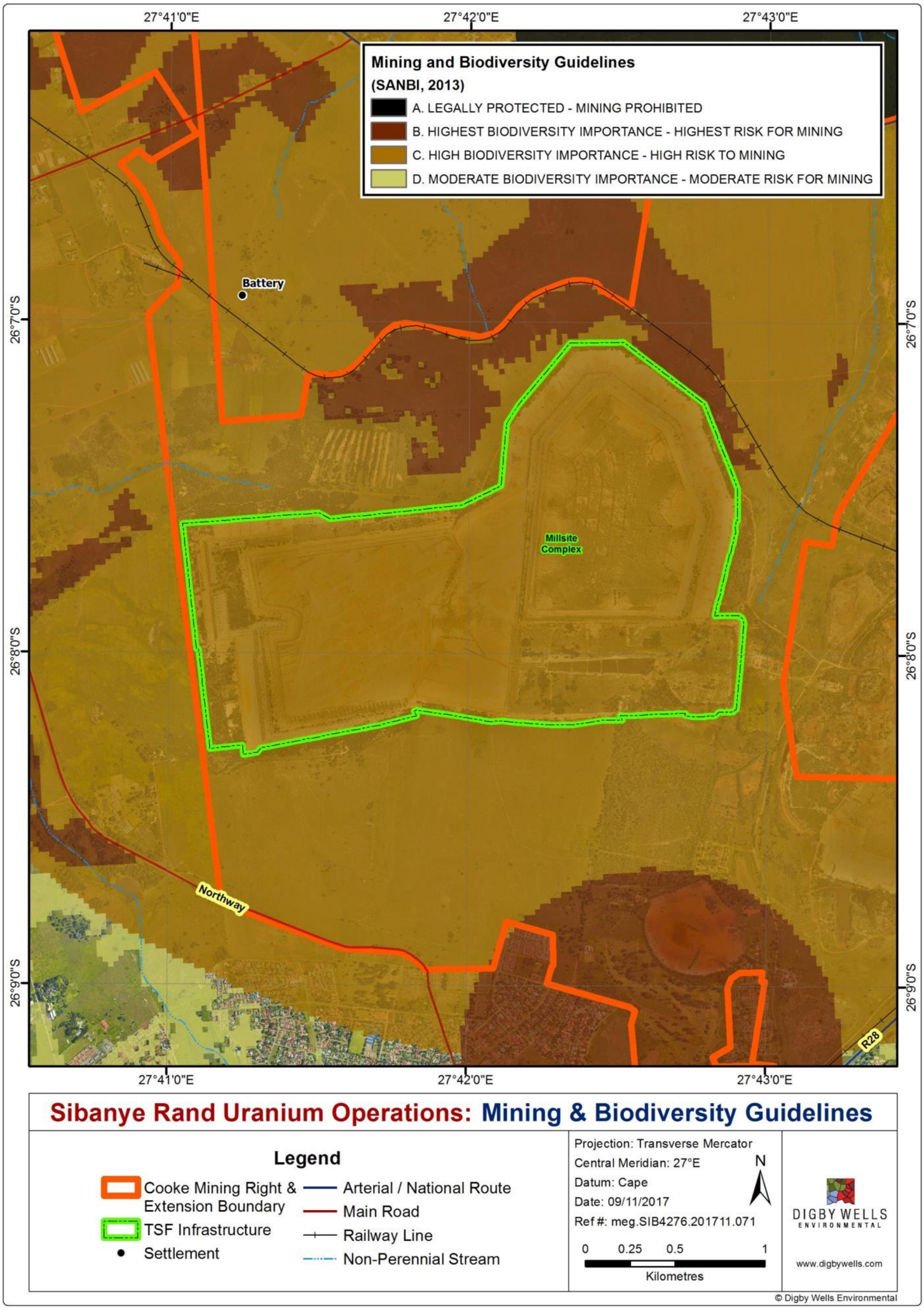


Figure 8-3: Mining and Biodiversity Guideline

8.4 Gauteng C-Plan

According to the C-Plan (Figure 8-4), the Millsite TSF is in very close proximity to a Protected Area (Krugersdorp Nature Reserve) and is surrounded by Ecological Support Areas. The TSF also has *Important Areas* to the North and *Irreplaceable Areas* to the West.

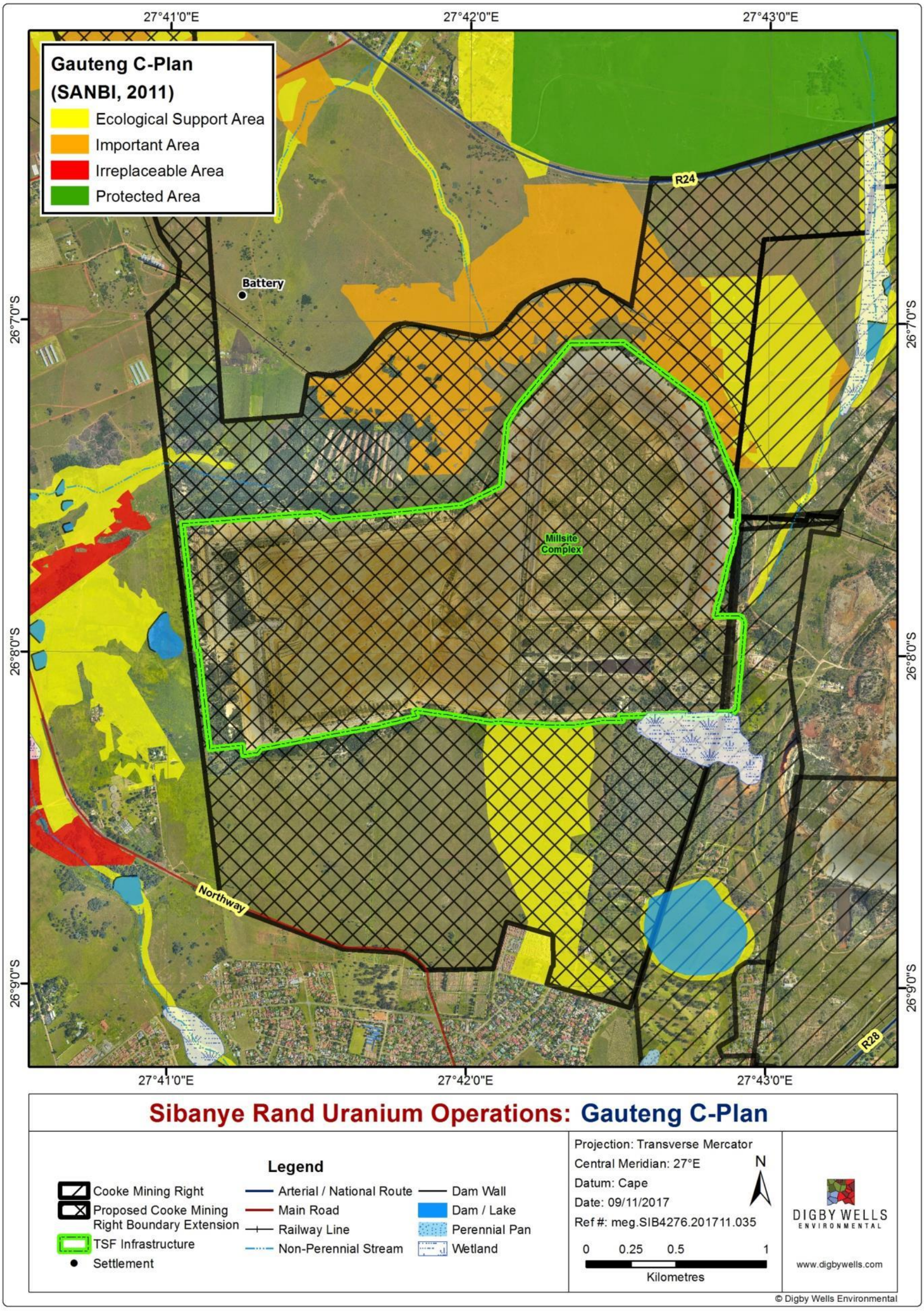


Figure 8-4: Gauteng C-Plan

8.4.1 WRDM EMF and BRP Wetlands

The WRDM contains a high diversity of river and wetland ecosystems (WRDM BRP, 2014); incorporating a total of 1 032.35 ha of Eastern Temperate Freshwater Wetlands, of which none are conserved. However, there are 3 960ha of important wetlands in the WRDM according to the Gauteng C Plan of which only 2.7% are under formal conservation.

Wetlands, watercourses, and pan wetlands are delineated in the WRDM, as shown in Figure 8-5. The pan wetland systems are highlighted as circular cluster areas; the waterbodies are associated with dams and other non-natural wetland conditions; and the wetlands are associated with valley bottom systems.

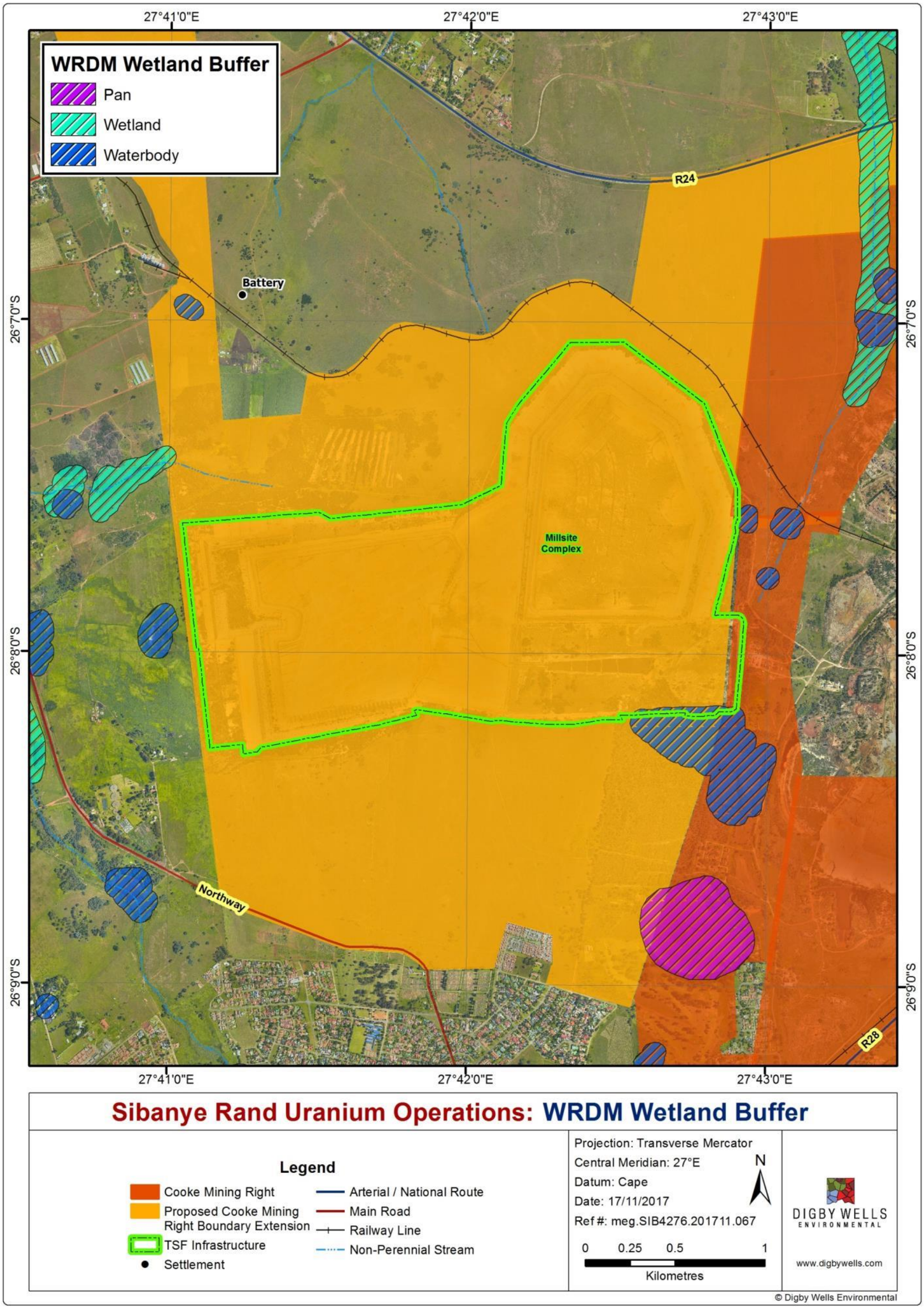


Figure 8-5: WRDM and BRP Wetlands

8.5 Regional Vegetation

The Millsite TSF falls within Soweto Highveld Grassland with patches of Carletonville Dolomite Grassland to the Northand the Eastern Temperate Freshwater Wetlands to the South, as described by Mucina and Rutherford (2006) (refer to Figure 8-6). Common and characteristic plant species of the Soweto Highveld Grassland, Carletonville Dolomite Grassland and Eastern Temperate Freshwater Wetlands are listed in Table 8-1, Table 8-2 and Table 8-3 respectively.

The regional vegetation for the area gives an indication of which species occur naturally in the area and inform the selection of species suitable for rehabilitation.

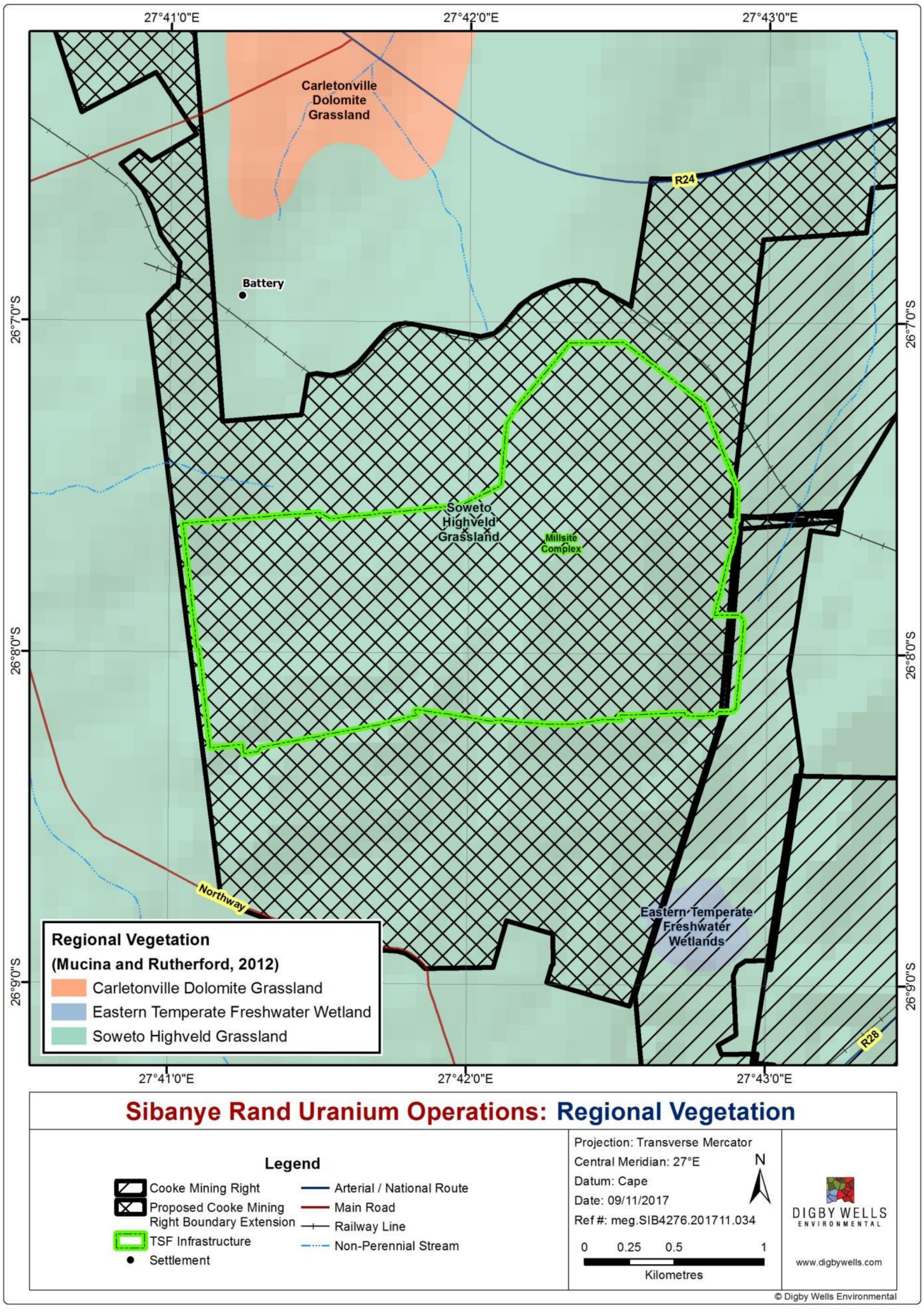


Figure 8-6: Regional Vegetation

Table 8-1: Common and Characteristic Plant Species of the Soweto Highveld Grassland

Plant form	Species
Graminoids (grasses and sedges)	*Andropogon appendiculatus, Andropogon schirensis, Aristida adscensionis, Aristida bipartita, Aristida congesta, Aristida junciformis subsp. Galpinii, Brachiaria serrata, Cymbopogon caesius, Cymbopogon pospischilii, Cynodon dactylon, Digitaria diagonalis, Diheteropogon amplectens, Elionurus muticus, Eragrostis capensis, Eragrostis chloromelas, Eragrostis curvula, Eragrostis micrantha, Eragrostis plana, Eragrostis planiculmis, Eragrostis racemosa, Eragrostis superba, Harpochloa falx, Heteropogon contortus, Hyparrhenia hirta, Microchloa caffra, Paspalum dilatatum, Setaria nigrirostris, Setaria sphacelata, Themeda triandra, Tristachya leucothrix*
Herbs	*Acalypha angustata, Berkheya setifera, Dicoma anomala, Euryops gilfillanii, Geigeria aspera var. aspera, Haplocarpha scaposa, Helichrysum miconiifolium, Helichrysum nudifolium var. nudifolium, Helichrysum rugulosum, Schistostephium crataegifolium, Senecio coronatus, Vernonia oligocephala Wahlenbergia undulata, Rhynchosia totta, Rhynchosia effuse, Hermannia depressa, Hibiscus pusillus, Graderia subintegra*
Geophytic herbs	*Haemanthus humilis subsp. hirsutus, Haemanthus montanus*

Table 8-2: Plant species characteristic of the Carletonville Dolomite Grassland

Plant form	Species
Graminoids	*Aristida congesta, Brachiaria serrata, Cynodon dactylon, Digitaria tricholaenoides, Diheteropogon amplectens, Eragrostis chloromelas, E. racemosa, Heteropogon contortus, Loudetia simplex, Schizachyrium sanguineum, Setaria sphacelata, Themeda triandra, Alloteropsis semialata subsp. eckloniana, Andropogon schirensis, Aristida canescens, A. diffusa, Bewsia biflora, Bulbostylis burchellii, Cymbopogon caesius, C. pospischilii, Elionurus muticus, Eragrostis curvula, E. gummiflua, E. plana, Eustachys paspaloides, Hyparrhenia hirta, Melinis nerviglumis, M. repens subsp. repens, Monocymbium ceresiiforme, Panicum coloratum, Pogonarthria squarrosa, Trichoneura grandiglumis, Triraphis andropogonoides,Tristachya leucothrix, T. rehmanii*

Herbs	*Acalypha angustata, Barleria macrostegia, Chamaecrista mimosoides, Chamaesyce inaequilatera, Crabbea angustifolia, Dianthus mooiensis, Dicoma anomala, Helichrysum caespititium, H. miconiifolium, H. nudifolium var. nudifolium, Ipomoea ommaneyi, Justicia anagalloides, Kohautia amatymbica, Kyphocarpa angustifolia, Kohautia amatynbica, Ophrestia oblongifolia, Pollichia campestris, Senecio coronatus, Hilliardiella oligocephala*
Geophytic Herbs	*Boophone disticha, Habenaria mossii*
Low Shrubs	*Anthospermum rigidum subsp. pumilum, Indigofera comosa, Pygmaeothamnus zeyheri var. rogersii, Searsia magalismontana, Tylosema esculentum, Ziziphus zeyheriana*
Geoxylic Suffrutex	*Elephantorrhiza elephantina, Parinari capensis subsp. Capensis*

Table 8-3: Plant species characteristic of the Eastern Temperate Freshwater Wetlands

Type	Plant form	Species
Marshes	Megagraminoid	*Cyperus congestus* (d)
	Graminoids	*Agrostis lachnantha* (d), *Carex acutiformis* (d), *Eleocharis palustris* (d), *Eragrostis plana* (d), *E. planiculmis* (d), *Fuirena pubescens* (d), *Helictotrichon turgidulum* (d), *Hemarthria altissima* (d), *Imperata cylindrica* (d), *Leersia hexandra* (d), *Paspalum dilatatum* (d), *P. urvillei* (d), *Pennisetum thunbergii* (d), *Schoenoplectus decipiens* (d), *Scleria dieterlenii* (d), *Setaria sphacelata* (d), *Andropogon appendiculatus*, *A. eucomus*, *Aristida aequiglumis*, *Ascolepis capensis, Carex austro-africana*, *C. schlechteri*, *Cyperus cyperoides*, *C. distans*, *C. longus*, *C. marginatus*, *Echinochloa holubii*, *Eragrostis micrantha*, *Ficinia acuminata*, *Fimbristylis complanata*, *F. ferruginea*, *Hyparrhenia dregeana*, *H. quarrei, Ischaemum fasciculatum*, *Kyllinga erecta*, *Panicum schinzii*, *Pennisetum sphacelatum*, *Pycreus macranthus*, *P. nitidus*, *Setaria pallide-fusca*, *Xyris gerrardii*.

	Herbs	*Centella asiatica* (d), *Ranunculus multifidus* (d), *Berkheya radula*, *B. speciosa*, *Berula erecta* subsp. *thunbergii*, *Centella coriacea*, *Chironia palustris*, *Equisetum ramosissimum*, *Falckia oblonga, Haplocarpha lyrata, Helichrysum difficile*, *H. dregeanum*, *H. mundtii*, *Hydrocotyle sibthorpioides, H. verticillata*, *Lindernia conferta*, *Lobelia angolensis, L. flaccida*, *Mentha aquatica*, *Monopsis decipiens*, *Pulicaria scabra*, *Pycnostachys reticulata*, *Rorippa fluviatilis* var. *fluviatilis*, *Rumex lanceolatus*, *Senecio inornatus*, *S. microglossus*, *Sium repandum*, *Thelypteris confluens*, *Wahlenbergia banksiana*.
	Geophytic Herbs	*Cordylogyne globosa*, *Crinum bulbispermum*, *Gladiolus papilio*, *Kniphofia ensifolia*, *K. fluviatilis*, *K. linearifolia*, *Neobolusia tysonii, Satyrium hallackii* subsp. *hallackii*.
Reed & sedge beds	Megagraminoids	*Phragmites australis* (d), *Schoenoplectus corymbosus* (d), *Typha capensis* (d), *Cyperus immensus*.
	Graminoid	*Carex cernua*.
Water bodies	Aquatic Herbs	*Aponogeton junceus*, *Ceratophyllum demersum*, *Lagarosiphon major*, *L. muscoides*, *Marsilea capensis*, *Myriophyllum spicatum, Nymphaea lotus*, *N. nouchali* var. *caerulea*, *Nymphoides thunbergiana*, *Potamogeton thunbergii*.
	Carnivorous Herb	*Utricularia inflexa*.
	Herb	*Marsilea farinosa subsp. farinosa.*

9 Wetland Assessment Findings

9.1 Wetland delineation and classification

Five HGM units were identified within 500 m of the Millsite TSF, which cover approximately 105.1 ha. The breakdown of the wetland types per area is detailed in Table 9-1 with localities shown in Figure 9-2. Figure 9-1 illustrates the various wetlands identified.

A Zone of Regulation of 100 m around each wetland has been assigned according to GN 704 for activities requiring the separation of clean and dirty water systems.

Table 9-1: Wetland HGM Units

HGM Unit	HGM Unit Type	Area (ha)
1	Hillslope Seep	36.2
2	Channelled Valley Bottom	14.8
3	Artificial Wetland	16.8
4	Channelled Valley Bottom	21.1
5	Depression	16.2

Figure 9-1: Millsite Wetlands (A:HGM Unit 1; B: HGM Unit 1 illustrating sewage discharge; C: Sewage sludge; D: HGM Unit 2; E: HGM Unit 3; F:HGM Unit 4; G: HGM Unit 5)

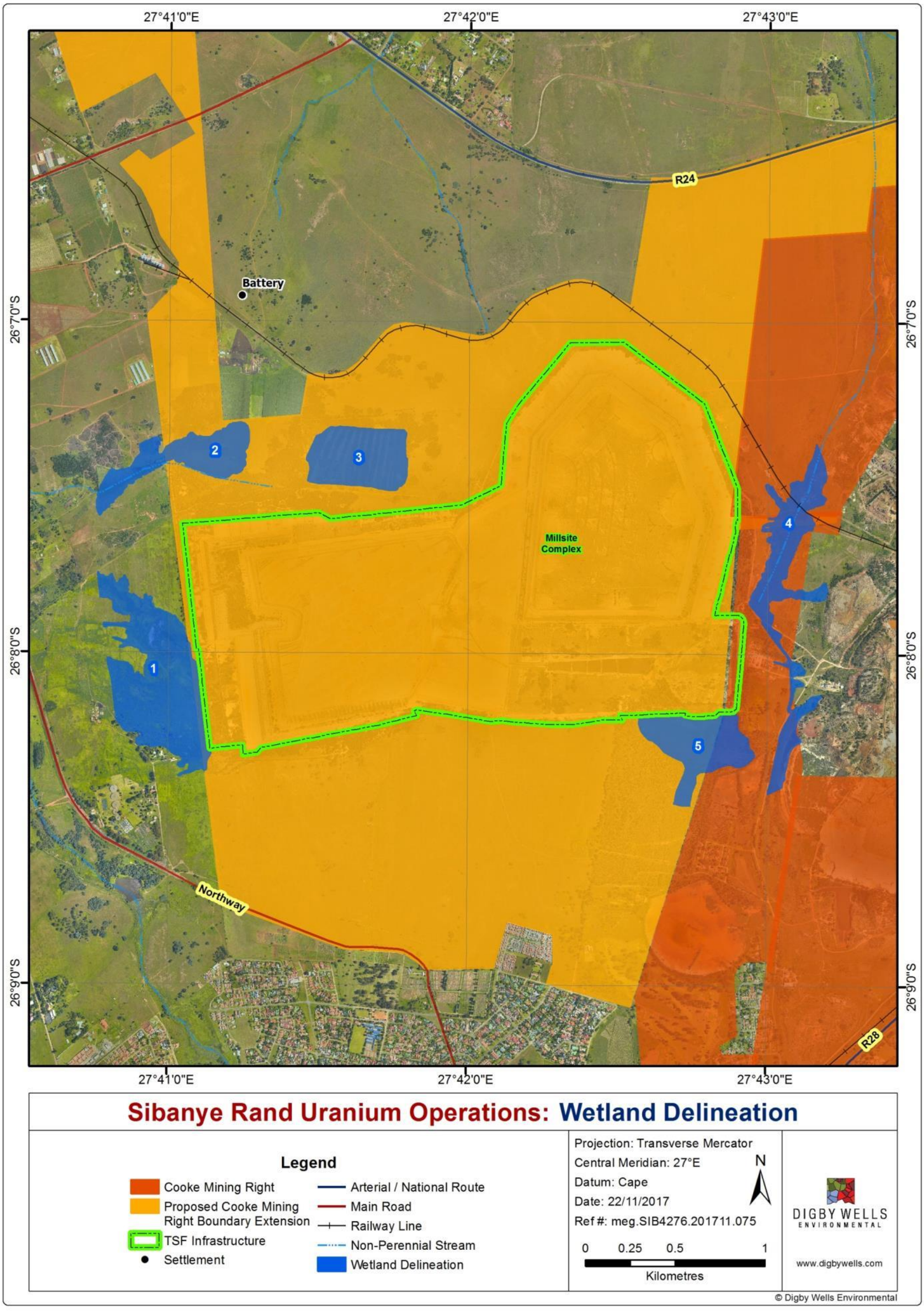


Figure 9-2: Wetland Delineation

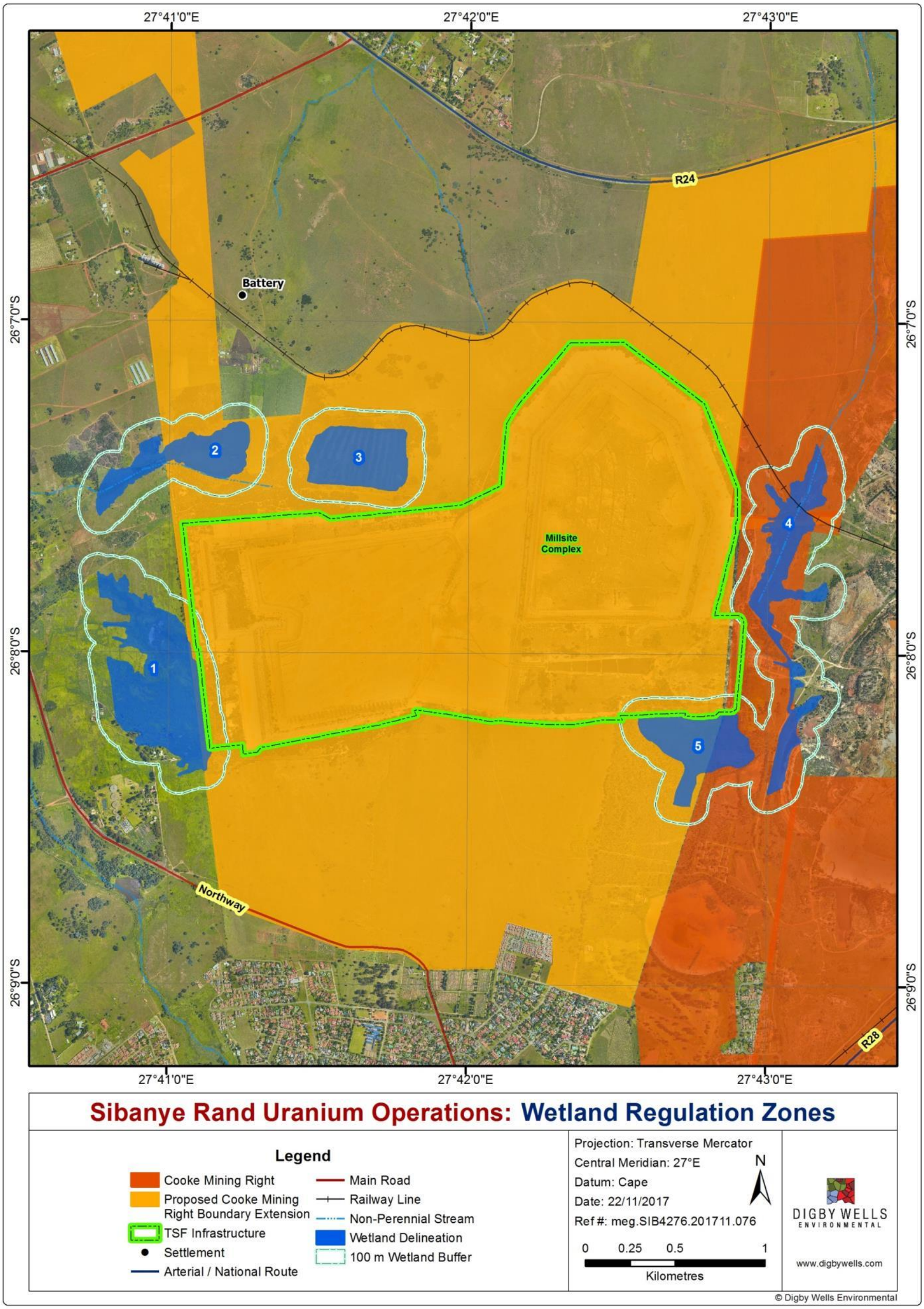


Figure 9-3: Wetland Regulation Zones

9.1.1 Wetland Ecological Assessment

9.1.1.1 Present Ecological State

The wetlands that surround the Millsite TSF exhibit a variety of PES values, ranging from *Seriously Modified* (Category E), to *Moderately Modified* (Category C) (Table 9-2).

One *Seriously Modified* (Category E) wetland is present in the Project Area. HGM Unit 4, has the worst PES (6.74) which is largely due to the alteration of the channel, various gullies, and channelization. The presence of tailings material adjacent to HGM Unit 4 has also impacted the PES score through deposition in the wetland.

HGM Units 1 and 5 are both *Largely Modified* (Category D). HGM Unit 1 (5.94) is impacted on heavily by the presence of a sewage trench that is discharging untreated sewage into the wetland (see Figure 9-1 C and D). HGM Unit 5 (4.13) has been negatively impacted on by the deposition of tailings, large areas of unvegetated land and the proliferation of Alien Invasive Species (AIPs).

HGM Unit 2 is *Moderately Modified* (Category C) with the highest PES score (3.49). There has only been a moderate change in ecosystem processes but the natural habitat remains predominantly intact. Erosion and deposition of tailings are the main contributing factors to the *Moderately Modified* status of that wetland.

HGM Unit 3 is an artificial wetland and therefore PES scores are not applicable.

Table 9-2: Present Ecological Health Scores

HGM Unit	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score	PES Score
1	6.5	3.2	7.8	5.94	D
2	2	1.0	8.3	3.49	C
3	**N/A for artificial wetlands**				
4	9	2.7	7.4	6.74	E
5	3.5	1.4	7.8	4.13	D

9.1.1.2 Ecological Importance and Sensitivity

The wetlands surrounding the Millsite TSF exhibit *Moderate* to *Low* EIS values.

The Ecological importance and Sensitivity is *Low* to *Moderate* (0.7 to 1.7) for all the HGM units, as these wetlands are sensitive to changes but still provide habitat for various species, including species such as the Blue Crane, which have been found to occur in the area.

Although the wetlands are modified, they do still provide *Moderate* to *Low* hydrological importance services (ranging between 0.7 and 1.9), such as sediment trapping and assimilation of toxicants, phosphates and nitrates.

In general, the values are very *Low* for 'Direct Human Benefits' (ranging between 0.1 and 0.3) as there is limited human use of water, natural resources and cropping and no cultural/tourism/research benefits of these wetlands.

Table 9-3: EIS Scores

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score	Final EIS Category
1	1.3	1.6	0.2	1.6	C
2	1.7	1.9	0.3	1.9	C
3	0.7	0.7	0.1	0.7	D
4	1.7	1.4	0.1	1.7	C
5	0.7	0.9	0.1	0.9	D

9.1.1.3 EcoServices

Table 9-4 indicates the EcoService scores for the various HGM Units.

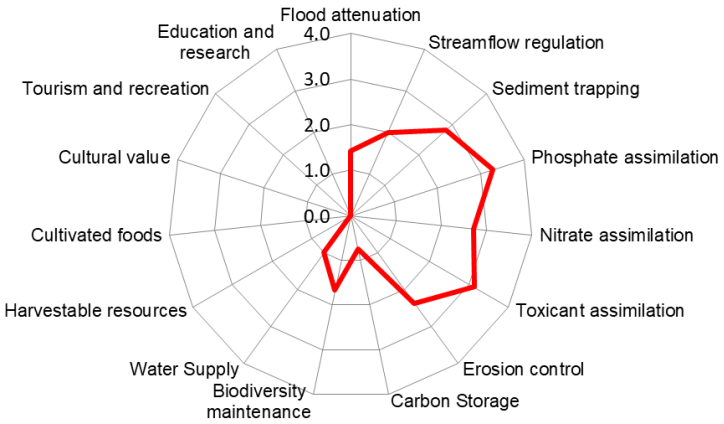
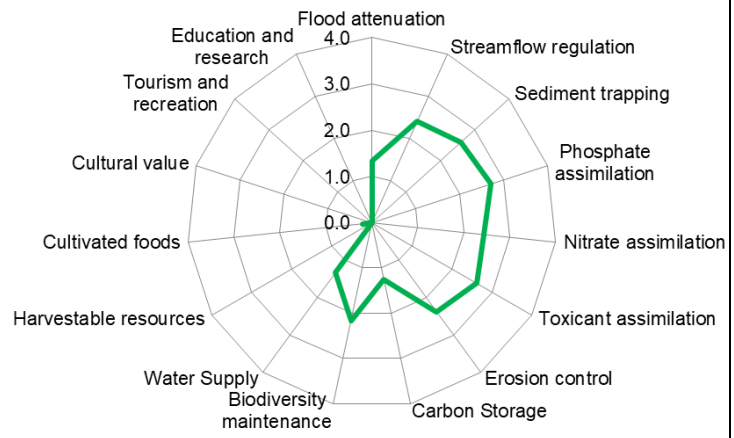
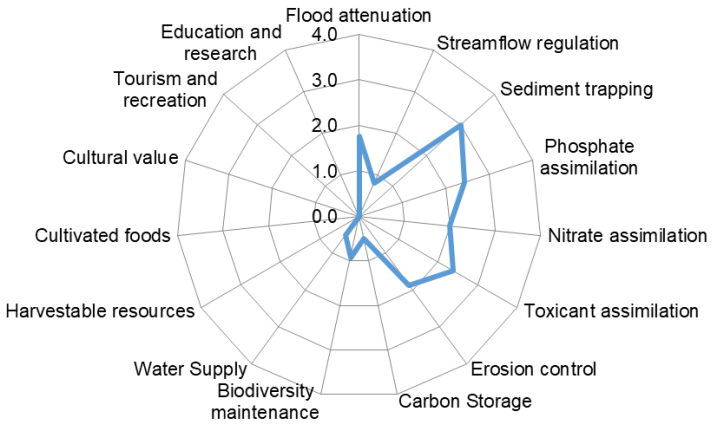
HGM Units 3 and 5, have *Moderately Low* EcoServices scores, while the remainder have an *Intermediate* score. It is important to note that EcoServices provided at HGM Unit 5 are largely related to toxicant assimilation and sediment control, which may be considered critical impacts affecting this HGM Unit, thus contributing to the score obtained.

Across all the wetlands, carbon storage is *Low* to *Moderately Low*. Cultural value, tourism harvestable resources, cultivated foods and recreation are all *Low* due to the fact that these wetlands are modified systems, within mining boundaries and so are not accessible to potential users.

Due to tailings deposition and sewage disposal in these wetlands, the sediment trapping, and assimilation of phosphates, toxicants and nitrates functionality of the systems are *Moderately High* to *High*.

Biodiversity maintenance is varied for the different wetlands, ranging from *Moderately Low* to *Moderately High*. The variation in scores is a result of the difference in habitat modification of the wetlands. Some wetlands are more natural and will provide better habitat for various species while other wetlands are largely modified, providing little habitat and infested with AIPs.

Table 9-4: EcoServices Scores

HGM Unit	EcoService Score	EcoServices Radial Plot
1	1.4 Intermediate	
2	1.4 Intermediate	
3	1.1 Moderately Low	

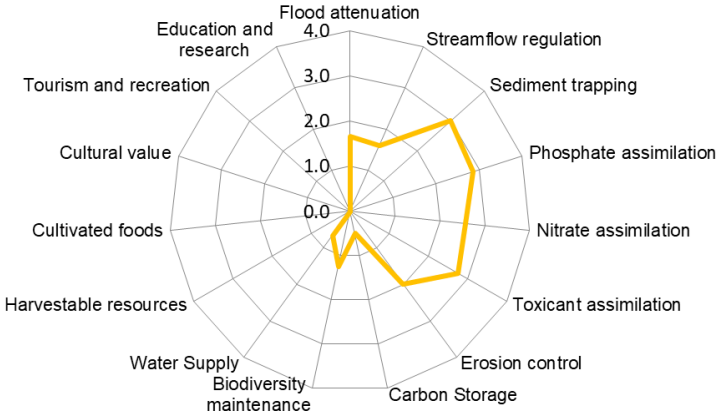
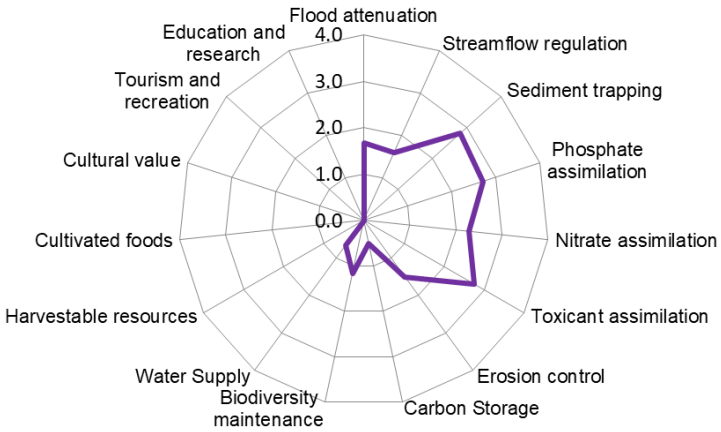
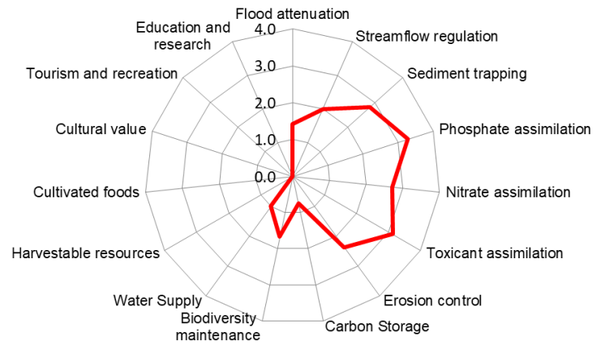
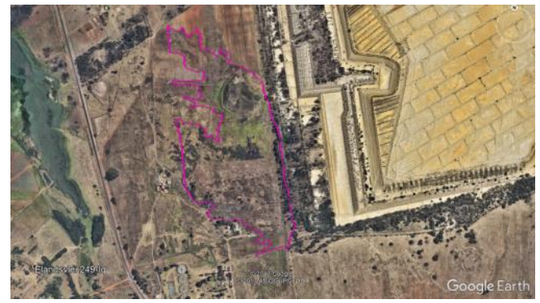
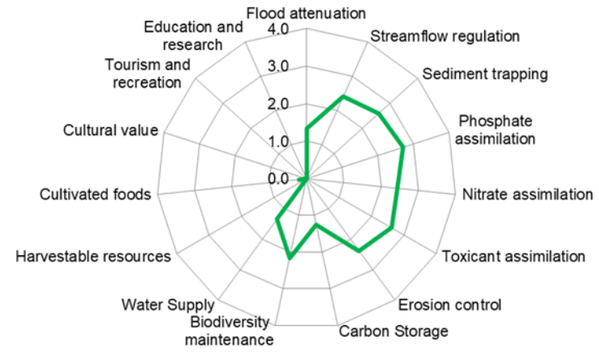
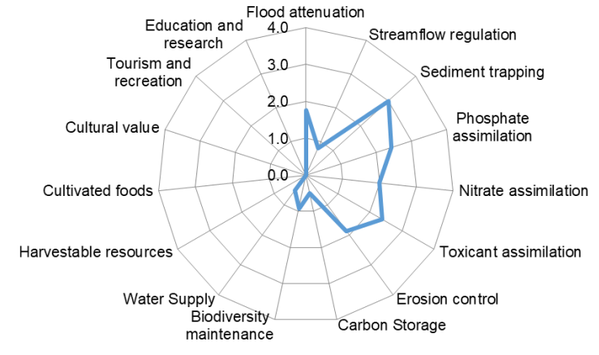
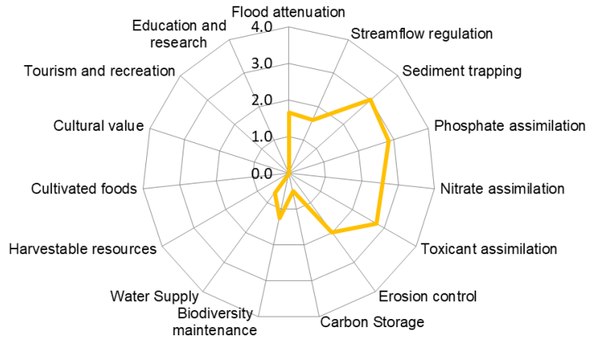
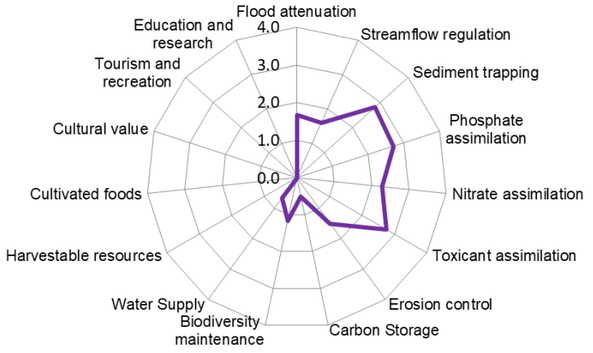
4	1.3 Intermediate	
5	1.2 Moderately Low	

Table 9-5: Wetland Summary

HGM unit	HGM unit Type	Size (ha)	PES	EIS	Ecoservices	Ecoservices Radial Plot	Image
1	Hillslope Seep	36.2	D	C	1.4		
2	Channelled Valley Bottom	14.8	C	C	1.4		
3	Artificial Wetland	16.8	**N/A for artificial wetlands**	D	1.1		

HGM unit	HGM unit Type	Size (ha)	PES	EIS	Ecoservices	Ecoservices Radial Plot	Image
4	Channelled Valley Bottom	21.1	E	C	1.3		
5	Depression	16.2	D	D	1.2		

10 Impacts Assessment

10.1 Discussion of Potential Impacts

The activities assessed for the wetlands impact assessment are listed in Table 10-1. This section includes an impact assessment for activities associated with the proposed Millsite Tailings Storage Facility (TSF) reclamation and rehabilitation project. The Millsite TSF is situated in the vicinity of multiple wetland features of varying degrees of ecological integrity. Figure 9-1 provides an indication of the locality of the various wetland features in relation to the Millsite TSF.

It is the opinion of the ecologist that the proposed Millsite TSF reclamation and rehabilitation project is likely to have a positive impact on the ecological integrity of the area in general, should the relevant mitigation and management measures outlined in this report be adhered to.

Table 10-1: Project Activities

Activity	Phase of Project
Reclamation of the Millsite tailings material	Operational
Decommissioning and clean-up of remaining tailings, contaminated wetland soils and related infrastructure	Decommissioning
Rehabilitation of TSF footprint and surrounding areas	Rehabilitation/Closure
Monitoring and maintenance of decommissioned areas	Post-closure

10.1.1 Operational Phase

10.1.1.1 Project Activities Assessed

Project activities and associated impacts for the proposed Millsite TSF reclamation and rehabilitation project are listed in Table 10-2.

Table 10-2: Interactions for the Decommissioning Phase

Interaction	Impact

Interaction		Impact
1	Site access roads crossing wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for onset of erosion
2	Heavy moving machinery and vehicles required for tailings reclamation	Potential contamination of soils as a result of the ingress of hydrocarbons; Compaction of soils; Loss of natural vegetation; Increased sedimentation; and Increased potential for onset of erosion
3	Removal of tailings and contaminated soils	Physical disturbance of contaminated soil and tailings resulting in erosion and sedimentation; Ingress of pollutants to watercourses and wetland areas as a result of tailings and contaminated soil spills during transport and reclamation activities; Potential for further contamination of the freshwater resources present as a result of increased oxidation as a result of disturbance of the tailings during reclamation activities

10.1.1.2 Impact Description

Among the impacts associated with the proposed Millsite TSF reclamation and rehabilitation project are minor potential impacts to soil and water quality as a result of the ingress of hydrocarbons and mechanical spills associated with heavy moving machinery required for the operational activities.

Larger impacts include compaction of soils, potential loss of natural vegetation and the increased potential for erosion and sedimentation in the operational areas and resulting in impacts further downstream. With unregulated use of existing dirt roads across wetlands and indiscriminate driving and movement of heavy machinery across wetland areas, vegetation establishment will be hindered and erosion will be promoted. These impacts have the potential to increase sediment loads being deposited on river bends and levees, which in turn may result in the establishment and further spread of invasive hydrophytic plants and

loss of stream flow and natural refuge areas in the aquatic systems further downstream. Alterations to the natural hydrology and geohydrology of the area should tailings or contaminated soils not be adequately removed may also result in a loss of the wetland integrity of these systems. Any potential dumping of tailings or contaminated soils in wetland areas has the potential to impact water quality of the wetlands as well as the aquatic resources further downstream of the site.

In addition, any temporary stockpiling or dumping of tailings or contaminated soils within wetland areas has the potential to result in loss of stream connectivity, loss of refuge areas, alterations to the terrain profiles of the areas and the creation of preferential flow paths, which may result in sedimentation, alterations to the vegetation structure of the area, encourage alien vegetation encroachment and result in increased erosion and sedimentation potentials.

Removal of vegetation and disturbance of soils in the vicinity of the operational footprint is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive vegetation species, further altering the natural vegetation profiles of the wetlands encountered in the vicinity of the MIllsite TSF.

Transport of tailings and contaminated soils has the potential to result in further contamination and sedimentation of the freshwater resources present through spills. Furthermore, disturbance of historical tailings and contaminated soils has the potential to result in increased oxidation of pollutants such as pyrites, which has the potential to increase impacts to water quality of the freshwater resources in the vicinity of the Millsite TSF.

In addition, disturbance and reclamation of tailings and contaminated soils has the potential to result in increased erosion and sedimentation of the freshwater resources present.

10.1.1.3 Management Objectives

The objectives for management measures for the operational phase are to preserve wetland functionality and integrity for the duration of the operational phase and into the decommissioning, rehabilitation and closure phases of the proposed Millsite TSF reclamation project and for activities not to expand from the general footprint area and cause severe degradation of wetlands that are already impacted upon.

10.1.1.4 Management Actions and Targets

The following mitigation and management measures have been prescribed for the decommissioning phase:

- Ensure that sound environmental management is in place during the proposed operational phase;
- Ensure that as far as possible all operational activities take place outside of wetland/riparian areas and their associated 100 m zone of regulation;

- Limit the footprint area of the operational activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils;
- If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated;
- Ensure that no incision and canalisation of the wetland features present takes place as a result of the proposed operational activities;
- All erosion noted within and in the vicinity of the area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan;
- All soils compacted as a result of operational activities should be ripped and profiled;
- A suitable alien-vegetation control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones;
- Permit only essential personnel within the 100 m zones of regulation for all wetland features identified;
- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel;
- No crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;
- No material may be dumped or stockpiled within any wetland areas in the vicinity of the proposed decommissioning footprint.
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zone of regulation. All vehicles must remain on demarcated roads and within the Project area footprint;
- All vehicles must be regularly inspected for leaks;
- Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- All spills should be immediately cleaned up and treated accordingly;
- Water quality with special mention of pH, dissolved salts and specific problem substances like pyrites need to be managed, and monitored in order to ensure that reasonable water quality occurs downstream of the mined areas to allow for the on-going survival of wetland and aquatic communities of some diversity and reasonable sensitivity;
- Appropriate sanitary facilities must be provided for the duration of the operational activities and all waste must be removed to an appropriate waste facility;
- Monitor all systems for erosion and incision;

- During the operational phase, erosion berms should be installed on roadways and in the vicinity of disturbed soils and cleared vegetation soils as well as in areas where tailings or contaminated soils are reclaimed or removed to prevent gully formation and siltation of the wetland areas. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed;
  - Where the track slopes between 2% and 10%, berms every 25m should be installed;
  - Where the track slopes between 10%-15%, berms every 20m should be installed;
  - Where the track has slope greater than 15%, berms every 10m should be installed.

10.1.1.5 Impact Ratings

The wetlands present in the vicinity of the Millsite TSF have already been impacted as a result of various activities and further impacts related to sedimentation and habitat degradation may result in a further drop in ecological state of the wetland features present. Table 10-3 represents the impact ratings for the operational phase.

Table 10-3: Potential Impacts of the Operational Phase

Dimension	Rating	Motivation	Significance
Activity and Interactions: Reclamation of the Millsite tailings material			
Prior to Mitigation/Management			
Duration	Project life (5)	The impact will cease after the operational, decommissioning, rehabilitation and closure phases of the project has been completed.	Minor (negative) – 56
Extent	Greater municipal area (4)	General scouring from sedimentation, as well as degraded habitat due to water quality deterioration will affect entire watercourse and river reaches.	
Intensity x type of impact	Serious long term environmental effects (5)	Due to the sensitivity of wetland systems in general and the already degraded nature of the systems present, should no management or mitigation measures be employed, activities could result in serious long term impacts.	

Dimension	Rating	Motivation	Significance
Probability	Probable (4)	Should no precautionary measures be implemented, further impacts to the wetlands present are considered probable.	
Nature	Negative		
Post-Mitigation			
Duration	Project life (5)	The impact will cease after the operational, decommissioning, rehabilitation and closure phases of the project has been completed.	Minor (negative) - 27
Extent	Limited (2)	Impacts will be limited only to the project footprint area and will affect only small portions of historically impacted wetlands within the TSF footprint	
Intensity x type of impact	Minor effects on the biological or physical environment (2)	Due to the impacted nature of the systems present, should the project proceed, and the appropriate precautions and management or mitigation measures be employed, it is unlikely that further significant degradation of the wetlands present occur.	
Probability	Unlikely (3)	Should the proposed decommissioning and rehabilitation project proceed improvements to the ecological integrity of the systems present are considered likely.	
Nature	Negative		

10.1.2 Decommissioning Phase

10.1.2.1 Project Activities Assessed

Project activities and associated impacts for the proposed decommissioning are listed in Table 10-4.

Table 10-4: Interactions for the Decommissioning Phase

Interaction	Impact

Interaction		Impact
4	Site access roads crossing wetlands	Increased vehicular movement along wetland crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for onset of erosion
5	Removal of any remaining tailings, contaminated soils and tailings infrastructure	Potential dumping of decommissioned infrastructure in wetland/riparian areas; Potential incomplete removal of infrastructure; Disturbance of natural vegetation structures; Further contamination of wetland soils; Sedimentation of wetlands and their downstream resources

10.1.2.2 Impact Description

Among the impacts associated with the proposed decommissioning phase are minor potential impacts to soil and water quality as a result of the ingress of hydrocarbons and mechanical spills associated with moving machinery required for the decommissioning activities.

Larger impacts include compaction of soils, potential loss of natural vegetation and the increased potential for erosion and sedimentation in the decommissioned areas and resulting in impacts further downstream. With unregulated use of existing dirt roads across wetlands and indiscriminate driving and movement of heavy machinery across wetland areas, vegetation establishment will be hindered and erosion will be promoted. These impacts have the potential to increase sediment loads being deposited on river bends and levees, which in turn may result in the establishment and further spread of invasive hydrophytic plants and loss of stream flow and natural refuge areas in the aquatic systems further downstream.

Any temporary storage or dumping of decommissioned infrastructure within wetland areas, as well as any materials associated with the removal of remaining tailings or contaminated soils has the potential to result in loss of stream connectivity, loss of refuge areas, alterations to the terrain profiles of the areas and the creation of preferential flow paths, which may result in sedimentation, alterations to the vegetation structure of the area, encourage alien vegetation encroachment and result in increased erosion and sedimentation potentials.

Removal of vegetation and disturbance of soils in the vicinity of the decommissioning footprint is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive vegetation species, further altering the natural vegetation profiles of the wetlands encountered in the vicinity of the decommissioning footprint.

10.1.2.3 Management Objectives

The objectives for management measures for the decommissioning phase are to preserve wetland functionality and integrity for the duration and into the rehabilitation and closure phases of the proposed Millsite reclamation project and that activities do not expand in the general footprint area and cause severe degradation of wetlands that are already impacted upon.

10.1.2.4 Management Actions and Targets

The following mitigation and management measures have been prescribed for the decommissioning phase:

- Ensure that sound environmental management is in place during the proposed decommissioning phase;
- Ensure that as far as possible all decommissioned infrastructures, tailings and contaminated soils are placed outside of wetland/riparian areas and their associated 100 m zone of regulation;
- Limit the footprint area of the decommissioning activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils;
- If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated;
- Ensure that no incision and canalisation of the wetland features present takes place as a result of the proposed decommissioning activities;
- All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan;
- All soils compacted as a result of decommissioning activities should be ripped and profiled;
- A suitable alien-vegetation control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones;
- Permit only essential personnel within the 100 m zone of regulation for all wetland features identified;

- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel;
- No crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;
- Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the wetlands and the aquatic resources further downstream;
- No material may be dumped or stockpiled within any rivers, tributaries or drainage lines in the vicinity of the proposed decommissioning footprint.
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the decommissioning area footprint;
- All vehicles must be regularly inspected for leaks;
- Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- All spills should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the duration of the decommissioning activities and all waste must be removed to an appropriate waste facility;
- Monitor all systems for erosion and incision;
- Ongoing wetland rehabilitation is necessary both within and in the vicinity of the proposed decommissioning footprint and appropriate wetland monitoring techniques must take place on an annual basis during the summer/wet season in order to identify any emerging issues, trends or improvements in the receiving environment.

10.1.2.5 Impact Ratings

The majority of wetlands that are at risk of negative impacts during the decommissioning phase have been identified as largely modified to seriously modified and further impacts related to sedimentation and habitat degradation may result in a further drop in ecological state of the wetland features present.**Table 10-5 Table 10-5** represents the impact ratings for the decommissioning phase.

Table 10-5: Potential Impacts of the Decommissioning Phase

Dimension	Rating	Motivation	Significance
Activity and Interactions: Decommissioning of Millsite TSF Infrastructure			
Prior to Mitigation/Management			

Dimension	Rating	Motivation	Significance
Duration	Medium term 1 – 5 years (3)	The impact will cease after the decommissioning, rehabilitation and closure phases of the project has been completed.	Minor (negative) – 44
Extent	Greater municipal area (4)	General scouring from sedimentation, as well as degraded habitat due to water quality deterioration will affect entire watercourse and river reaches.	
Intensity x type of impact	Serious medium term environmental effects (4)	Due to the sensitivity of wetland systems in general and the already degraded nature of the systems present, should no management or mitigation measures be employed, activities could result in serious medium term impacts.	
Probability	Probable (4)	Should no precautionary measures be implemented, further impacts to the wetlands present are considered probable.	
Nature	Negative		
Post-Mitigation			
Duration	Medium term 1 – 5 years (3)	The impact will cease after the decommissioning, rehabilitation and closure phases of the project has been completed.	Minor (positive) + 36
Extent	Limited (2)	Impacts will be limited only to the project footprint area and will be rehabilitated accordingly on completion of the decommissioning phase.	
Intensity x type of impact	Positive impact will be moderate with a visible improvement to the natural resources present (4)	Due to the impacted nature of the systems present, should the decommissioning and rehabilitation project proceed, and the appropriate precautions and management or mitigation measures be employed, the project could result in a significant ecological improvement of the wetland systems present	

Dimension	Rating	Motivation	Significance
Probability	Probable (4)	Should the proposed decommissioning and rehabilitation project proceed improvements to the ecological integrity of the systems present are considered likely.	
Nature	Positive		

10.1.3 Rehabilitation, Closure and Post-Closure Phases

10.1.3.1 Project Activities Assessed

Project activities and associated impacts for the Rehabilitation, Closure and Post-closure Phases are listed in Table 10-6.

Table 10-6: Interactions for the Rehabilitation, Closure and Post-Closure Phases

Interaction		Impact
6	Site access roads crossing wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for onset of erosion

Interaction		Impact
7	Rehabilitation, closure and post-closure activities within and around any wetland/riparian habitat, such as demolition and removal of all infrastructure, and subsequent rehabilitation and closure of the wetland areas present in the vicinity of the decommissioning footprint including: ▪ Rehabilitation of historical impacts to the wetlands in the vicinity of the proposed decommissioning footprint ▪ Removal of alien invasive vegetation and implementation of an alien vegetation management plan ▪ Clean-up of any waste or hazardous materials in the vicinity of the proposed decommissioning footprint, both in and in the vicinity of wetland areas ▪ Ripping and re-profiling of slopes and natural terrain profiles in the vicinity of the decommissioned Millsite TSF and associated historically eroded areas ▪ Re-seeding of disturbed or cleared areas. Re-seeding of re-profiled areas.	Similarly to the decommissioning phase, the activities occurring within an ecologically sensitive catchment pose significant potential negative impacts to functioning wetlands and catchment. Furthermore, the rehabilitated area could cause major negative impacts due to spread of alien invasive vegetation, increased soil compaction erosion and subsequent sedimentation into the wetland ecosystems.

10.1.3.2 Impact Description

The rehabilitation, closure and post-closure activities occurring within an ecologically sensitive catchment pose significant potential negative impacts to functioning wetlands and catchment including spread of alien invasive vegetation, increased soil compaction, erosion and subsequent sedimentation into the wetland ecosystems should the appropriate activities and management and mitigation measures not be adequately implemented.

10.1.3.3 Management Objectives

The objective of the mitigation and management measures for the rehabilitation, closure and post-closure phases of the proposed project is to ensure that there are no long-term impacts to wetlands post-closure.

10.1.3.4 Management Actions and Targets

The following mitigation and management measures have been prescribed for the rehabilitation, closure and post-closure phase:

- Wetland monitoring must be carried out during both the decommissioning and rehabilitation phases to ensure no unnecessary impact to wetlands takes place. Monitoring should take place on an annual basis during the summer/wet season and carried out by an independent consultant for the duration of the decommissioning phase. Monitoring should continue to take place every two years until the systems are considered stable;
- Wetlands and their associated 100 m zone of regulation, to be clearly demarcated and avoided;
- An alien vegetation management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases of the proposed decommissioning and rehabilitation project;
- As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils and vegetation, clearance should be kept to a minimum as the biomass in the area is not very high and so therefore plants will not grow quickly;
- Monitor all systems for erosion and incision;
- All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses;
- Preventative measures such as hessian sheeting should be used in steep re-seeded areas where high erosion potentials exist;
- The use of indigenous phyto-remediation specific grass, forb and tree species is encouraged;
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint;
- Compacted soils should be ripped, re-profiled and re-seeded;
- All vehicles must be regularly inspected for leaks;

- Re-fueling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- All existing litter, debris should be removed from the wetland areas and littering should be prohibited on an ongoing basis;
- All spills should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility;
- Ongoing wetland rehabilitation is necessary both within and in the vicinity of the proposed decommissioning footprint and appropriate wetland monitoring techniques must take place on an annual basis during the summer/wet season in order to identify any emerging issues, trends or improvements in the receiving environment.

10.1.3.5 Impact Ratings

During the rehabilitation, closure and post-closure phases, minor impacts are expected. Table 10-7 represents the impact rating for the rehabilitation, closure and post-closure phases.

Table 10-7: Potential Impacts of the Rehabilitation, Closure and Post-Closure Phase

Dimension	Rating	Motivation	Significance
Activity and Interactions: Rehabilitation of habitat and wetlands within and in the vicinity of the proposed Millsite TSF and associated infrastructure reclamation project			
Prior to Mitigation/Management			
Duration	Medium term 1 – 5 years (3)	The impact will cease after the decommissioning, rehabilitation and closure phases of the project has been completed.	Minor (negative) – 44
Extent	Greater municipal area (4)	General scouring from sedimentation, as well as degraded habitat due to water quality deterioration will affect entire watercourse and river reaches.	
Intensity x type of impact	Serious medium term environmental effects (4)	Due to the sensitivity of wetland systems in general and the already degraded nature of the systems present, should no management or mitigation measures be employed, activities could result in serious medium term impacts.	

Dimension	Rating	Motivation	Significance
Probability	Probable (4)	Should no precautionary measures be implemented, further impacts to the wetlands present are considered probable.	
Nature	Negative		
Post-Mitigation			
Duration	Long term (4)	Benefits of the rehabilitation with be permanent, should the appropriate management and mitigation measures be adequately implemented	Minor (Positive) + 44
Extent	Local (3)	Improvements are likely to be observed both on a site specific and a local level in terms of improvements to stream flow and connectivity, reduced impacts related to sedimentation and improved water quality.	
Intensity x type of impact	Positive impact will be moderate with a visible improvement to the natural resources present (4)	Due to the impacted nature of the systems present, should the rehabilitation project proceed, and the appropriate precautions and management or mitigation measures be employed, the project could result in a significant ecological improvement of the wetland systems present	
Probability	Probable (4)	Should the proposed decommissioning and rehabilitation project proceed improvements to the ecological integrity of the systems present are considered likely.	
Nature	Positive		

10.1.4 Cumulative Impacts

The freshwater resources in this area are currently heavily impacted as a result of various cumulative impacts as a result of extensive mining activities in the area (both historical and artisanal). In addition, other impacts to the freshwater resources present in the vicinity of the proposed project include agricultural cultivation and grazing activities and impacts from increasing urbanisation and other anthropogenic activities.

Furthermore, the deposition of re-mined tailings will need to be investigated and a suitable location approved.

It is the opinion of the ecologist that should this project be allowed to proceed and the recommended management and mitigation measures supplied in this report are adhered to, the ecological integrity and functioning of the wetland ecosystems present are likely to improve, with special mention of HGM Unit 4 and HGM Unit 5.

10.2 Monitoring Plan

Due to the extensive nature of the rehabilitation required in some areas, with special mention again of HGM Unit 4 and HGM Unit 5, the Wet-health and Wet-Ecoservices tools are to be used to re-evaluate PES and eco-services on an annual basis by a suitably qualified wetland specialist for at least 5 years after the decommissioning and closure of the proposed project during the summer/wet monitoring season. Thereafter, monitoring is recommended every two years until the system is deemed appropriately rehabilitated. If monitoring results necessitate corrective action in terms of alien vegetation removal and erosion control, these corrective measures should be implemented immediately.

The Environmental Management Officer (EMO) must be present on site during decommissioning and rehabilitation phases and must ensure that the wetland areas and their associated zones of regulation are clearly demarcated and that no unnecessary clearing of vegetation takes place.

11 Conclusion and Recommendations

Digby Wells Environmental [DWE] (hereinafter Digby Wells) was appointed by Sibanye-Stillwater (Pty) Ltd (hereinafter Sibanye) to conduct a freshwater resource assessment including wetland sensitivity mapping and an impact assessment, as part of the environmental assessment and authorisation process for the reclamation of the Millsite Tailings Storage Facility (TSF) and subsequent rehabilitation. The Millsite TSF forms part of Sibanye's Cooke Mine and is located to the north of the town of Randfontein in the Gauteng Province.

Wetland Sensitivity Mapping

Five HGM units were identified within 500 m of the Millsite TSF, which cover approximately 105.1 ha. These comprised of a Hillslope Seep (HGM Unit 1), which is currently heavily impacted on by a neighbouring sewage works facility, two Channelled Valley Bottom wetlands (HGM Units 2, where only limited impacts were observed, and 4, where serious impacts in terms of altered stream channels, disturbance of soils, altered hydrology and impacts from Alien Invasive Species [AIPs] were observed), an artificial wetland (historical cascade dams) and a Depression (HGM Unit 5, which is seriously impacted on in terms of toxicants and sedimentation).

Present Ecological State (PES)

The wetlands that surround the Millsite TSF exhibit a variety of PES values, ranging from *Seriously Modified* (Category E), to *Moderately Modified* (Category C). HGM Unit 4 may be considered as *Seriously Modified* (Category E), which is largely due to the alteration of the channel, various gullies, and channelization. The presence of tailings material adjacent to HGM Unit 4 has also impacted the PES score through deposition in the wetland. HGM Units 1 and 5 are both *Largely Modified* (Category D). HGM Unit 1 is impacted on heavily by the presence of a sewage trench that is discharging untreated sewage into the wetland, while HGM Unit 5 has been negatively impacted on by the deposition of tailings, large areas of unvegetated land and the proliferation of AIPs. HGM Unit 2 is *Moderately Modified* (Category C) with some erosion noted at this point. HGM Unit 3 is an artificial wetland and therefore PES scores are not applicable.

Ecological Importance and Sensitivity

The Ecological importance and Sensitivity is *Low* to *Moderate* for all the HGM units, as these wetlands are sensitive to changes but still provide habitat for various species, including species such as the Blue Crane, which have been found to occur in the area. Although the wetlands are modified, they do still provide *Low* to *Moderate* hydrological importance services (ranging between 0.7 and 1.9), such as sediment trapping and assimilation of toxicants, phosphates and nitrates.

Ecological Service Provision

HGM Units 3 and 5, have *Moderately Low* EcoServices scores, while the remainder have an *Intermediate* score. It is important to note that EcoServices provided at HGM Unit 5 are largely related to toxicant assimilation and sediment control, which may be considered critical impacts affecting this HGM Unit, thus contributing to the score obtained.

Across all the wetlands, carbon storage is *Low* to *Moderately Low*. Cultural value, tourism harvestable resources, cultivated foods and recreation are all *Low* due to the fact that these wetlands are modified systems, within mining boundaries and so are not accessible to potential users. Due to tailings deposition and sewage disposal in these wetlands, the sediment trapping, and assimilation of phosphates, toxicants and nitrates functionality of the systems are *Moderately High* to *High*.

Biodiversity maintenance is varied for the various wetlands, ranging from *Moderately Low* to *Moderately High*. The variation in scores is a result of the difference in habitat modification of the wetlands. Some wetlands are more natural and will provide better habitat for various species while other wetlands are largely modified, providing little habitat and infested with AIPs.

Impact Assessment

Among the impacts associated with the proposed Millsite TSF reclamation and rehabilitation project are minor potential impacts to soil and water quality as a result of the ingress of hydrocarbons and mechanical spills associated with heavy moving machinery required for the operational, decommissioning and rehabilitation activities.

Larger impacts include compaction of soils, potential loss of natural vegetation and the increased potential for erosion and sedimentation in the Project area and in the vicinity thereof and resulting in impacts further downstream. With unregulated use of existing dirt roads across wetlands and indiscriminate driving and movement of heavy machinery across wetland areas, vegetation establishment will be hindered and erosion will be promoted.

These impacts have the potential to increase sediment loads being deposited on river bends and levees, which in turn may result in the establishment and further spread of invasive hydrophytic plants and loss of stream flow and natural refuge areas in the aquatic systems further downstream. Alterations to the natural hydrology and geohydrology of the area should tailings or contaminated soils not be adequately removed may also result in a loss of the wetland integrity of these systems. Any potential dumping of tailings or contaminated soils in wetland areas has the potential to impact water quality of the wetlands as well as the aquatic resources further downstream of the site.

In addition, any potential temporary stockpiling or dumping of tailings or contaminated soils within wetland areas has the potential to result in loss of stream connectivity, loss of refuge areas, alterations to the terrain profiles of the areas and the creation of preferential flow paths, which may result in sedimentation, alterations to the vegetation structure of the area, encourage alien vegetation encroachment and result in increased erosion and sedimentation potentials.

Removal of vegetation and disturbance of soils in the vicinity of the project footprint is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive vegetation species, further altering the natural vegetation profiles of the wetlands encountered in the vicinity of the MIllsite TSF.

Transport of tailings and contaminated soils has the potential to result in further contamination and sedimentation of the freshwater resources present through spills. Furthermore, disturbance of historical tailings and contaminated soils has the potential to result in increased oxidation of pollutants such as pyrites, which has the potential to increase impacts to water quality of the freshwater resources in the vicinity of the Millsite TSF.

In addition, disturbance and reclamation of tailings and contaminated soils has the potential to result in increased erosion and sedimentation of the freshwater resources present.

Summary

While the above-mentioned impacts have the potential to result in further degradation of the wetlands present, it is the opinion of the ecologist that the proposed Millsite TSF reclamation and rehabilitation project is likely to have an overall positive impact on the ecological integrity

of the area in general, should the relevant mitigation and management measures outlined in this report be adhered to.

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