Environmental Authorisation Process to Decommission a Conveyor Belt, Road, Pipeline and Quarry at Twistdraai East Colliery, Secunda, Mpumalanga Province

Soil Impact Assessment Report

Project Number:

SAS554

Prepared for:

Sasol Mining (Pty) Ltd

January 2019

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Soil Impact Assessment Report**
Project Name:	**Environmental Authorisation Process to Decommission a Conveyor Belt, Road, Pipeline and Quarry at Twistdraai East Colliery, Secunda, Mpumalanga Province**
Project Code:	**SAS554**

Name	Responsibility	Signature	Date
Siphamandla Madikizela Pr.Sci.Nat	Report writer		January 2019
Mia Smith	Reviewer		February 2019
Claire Wannenburgh	Project manager		February 2019

DECLARATION OF INDEPENDENCE

I, **Siphamandla Madikizela**, in my capacity as a specialist consultant, hereby declare that:

- I act as an independent specialist and I will comply with the Act, regulations and all other applicable legislation;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act 1998 (Act 107 of 1998);
- I undertake to disclose to the client and the competent authority all material information in my possession that reasonably has or may have the potential of influencing – any decision to be taken with respect to the application by the competent authority and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I undertake to have my work peer reviewed on regular basis by a competent specialist in the field of study for which I am registered;
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- Based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best if my professional judgement.

Title/ Position:	Soil Scientist
Qualification(s):	MSc in Soil Science
Experience (years):	5
Registration(s):	SACNASP (*Prof. Nat. Sci.: 400154/17*)
Signature:	

EXECUTIVE SUMMARY

Introduction

Digby Wells Environmental (*hereinafter* Digby Wells) was appointed by Sasol Mining Pty (*hereinafter* Sasol Mining) as the Independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process for Decommission a Conveyor Belt, Road, Pipeline and Quarry at Twistdraai East Colliery.

This report presents the findings of a specialist soil impact assessment in support of the Basic Assessment Process being undertaken in accordance with the National Environmental Management Act (Act No. 107 of 1998) (NEMA). This report presents the following relevant project components:

- Description of the soil forms;
- Determination of the current land use;
- Description of soil chemical and physical properties;
- Identification and assessment of potential impacts on soils resulting from the existing and proposed activities; and
- Mitigation measures to minimise impacts associated with the existing and proposed activities.

Methodology

Soils were investigated by augering to a maximum depth of 1.2 m or to the depth of refusal. Soil survey positions were recorded as waypoints using a handheld Global Positioning System (GPS). At each observation point, the South African Taxonomic Soil Classification System was used to describe and classify the soils. Land use was determined from assessing aerial imagery and was ground-truthed during the site visit.

The soil impact report discusses the approach and findings of a desktop and field survey carried out on 3 December 2018 in the study area. The following legislation was considered during the assessment:

- NEMA; and
- The Conservation of Agricultural Resources Act, 1993 (Act No. 43 of 1993), (CARA).

Findings

The project area is underlain by sediments of the Karoo Sequence in the Highveld Coalfield. The area is characterised by an undulating topography of mixed grassland and cultivated fields, with surface elevations ranging from 1 590 up to 1660 meters above mean sea level (mamsl). The project area falls within the Soweto Highveld Grassland vegetation type of the Grassland biome.

The land type data gathered suggested that the dominant land type on site were Ea17 and Ea20, characterised by vertic, melanic and red structured diagnostic horizons. Soils include swelling structured black and apedal soils. Soils are generally deeper in the valleys and stream crossings. The main land uses in the area are cultivated land and veld for grazing. The area is underlain by a historic underground coal mine.

The soils can be described as clay, sandy clay loam, sandy loam, silt loam and clay loam. The soil pH ranged from 5.5 to 7.5 and these soils are considered to be acidic to neutral. The organic carbon content of the soils at the soil sampling locations ranged from 1% to 7%. The phosphorus concentrations encountered in the samples from the site were all very low when compared to the soil fertility guidelines, with most concentrations being >1 mg/kg and the maximum concentration measured at 5 mg/kg. Calcium, potassium and magnesium concentrations in the soil were generally high when compared to the soil fertility guidelines. These concentrations are adequate for crop production and the nutrients concentrations are not limiting plant production on site or are considered to be toxic.

The analytical data shows that Copper, Manganese and Zinc concentrations did not exceed the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality in the Republic of South Africa (GN R 37603, May 2014) promulgated in terms of National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM: WA) for Soil Screening Values (SSV1 and SSV2). However, S9 exceeded the Norms and Standards for SSV1. Soil remediation is needed to eliminate risk to humans or the environment.

Impact Assessment

The potential impacts associated with the project on soils include:

- Erosion due to exposed soil surfaces;
- Compaction of soils due to movement of heavy machinery and vehicles; and
- Soil contamination through hydrocarbon or oil spillages machinery and vehicles.

It is anticipated that the impact of demolition of the conveyor belts, pipeline and road on loss of soil as a resource through erosion and compaction and contamination will be of minor to moderate negative significance.

Recommendations

The following actions are recommended to minimise adverse effects of the proposed activities on soils:

- Runoff must be controlled and managed by use of proper stormwater management measures;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place. Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place at regular intervals and after high rainfall events;

- Establishment of effective soil cover and adequate protection from wind and water;
- Soil chemical amelioration to enhance the growth capability of the soils;
- Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical;
- Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated;
- Minimise unnecessary removal of the natural vegetation cover;
- All vehicles must be regularly inspected for potential hydrocarbon leaks;
- No re-fuelling is allowing on site; and
- Fuel and oils spills should be remediated using commercially available emergency clean up kits. For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site.

LIST OF ACRONYMS

CARA	The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
DWE	Digby Wells Environmental
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EIS	Ecological Importance and Sensitivity
GPS	Global Positioning System
Ha	Hectares
IFC	International Finance Corporation
IWWMP	Integrated Water and Waste Management Plan
MAE	Mean Annual Evaporation
Mamsl	Metres above mean sea level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MR	Mining Right
NEFPA	National Freshwater Ecosystem Priority Areas
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM: WA	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
Norms and Standards	National Norms and Standards for the Remediation of Contaminated Land and Soil Quality in the Republic of South Africa (GN R 37603, May 2014) promulgated in terms of National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM: WA) for Soil Screening Values (SSV1 and SSV2)
NWA	National Water Act (Act No. 36 of 1998) (NWA)
PES	Present Ecological State
RSIP	Rehabilitation Strategy and Implementation Plan
RoM	Run of Mine
SANAS	South African National Accreditation System

SASA	South African Sugar Association
Sasol Mining	Sasol Mining (Pty) Ltd
SoW	Scope of Work
SSVs	Soil Screening Values
SWQTV	South African Quality Target Values
TEP	Twistdraai Export Plant
WMA	Water Management Area
WUL	Water Use Licence

GLOSSARY OF TERMS

Term	Definition
Acidity	A property expressed by the pH value when this is below 7.0 in a soil/water suspension.
Alkalinity	A property expressed by the pH value when this exceeds 7.0 in a soil/water suspension.
Auger	A tool for drilling into the soil and withdrawing a small sample for field or laboratory observation.
Biome	A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.
Cation	An element with a positive charge.
Clay	A soil consisting of particles <0.002 mm in equivalent diameter.
Contamination	Contamination is the presence of an unwanted constituent, harmful substance or impurity in a material and natural environment.
Exchangeable cation	A positively charged ion held on or near the surface of a solid particle by a negative surface charge of a colloid and which may be replaced by other positively charged ions in the soil solution.
Infiltration	The downward entry of water into the soil through the soil surface.
Leaching	The removal of materials in solution from the soil.
Organic carbon	Gives an estimate of the amount of organic matter in a soil as a percentage by weight.
pH (soil)	A measure of the acidity or alkalinity of a soil. It represents the negative logarithm of the hydrogen ion concentration in a specified soil/water suspension on a scale of 0 to 14.
Pollution	Any change in the environment cause by – i. Substances; ii. Radioactive or other waves; or iii. Noise, odours, dust or heat. Emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future (NEMA, 1998).
Remediation	Means the management of a contaminated site to prevent, minimise, or mitigate harm to human health or the environment.

Sand	A soil particle that in the USDA soil texture system is of size 0.05 to 2.0 mm in diameter.
Silt	A soil particle that in the USDA soil texture system is of size 0.002 to 0.05 mm in diameter.
Sodicity	A property expressed by the amount of exchangeable sodium present relative to the cation capacity of a soil horizon.
Soil classification	The systematic arrangement of soils into groups or categories based on similarities and difference in their characteristics.
Soil Screening Value 1 & 2	Means soil quality values that are protective of both human health and eco-toxicological risk for multi-exposure pathways, inclusive of contaminant migration to the water resource and values are protective of risk to human health in the absence of a water resource.
Soil texture	The relative proportions of the various separates in the soil as described by the classes of soil texture.

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1 Introduction

Sasol Mining (Pty) Ltd (*hereinafter* Sasol Mining), is the holder of a converted new order Mining Right (MR), which was consolidated from several prospecting and mining rights (known as the Secunda Complex MR) with Department of Mineral Resources (DMR) reference number: MP 30/5/1/2/3/2/1/138 MR.

This application relates specifically to the remaining decommissioning activities to be undertaken at Twistdraai East Shaft, which requires both an Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998) (NEMA) and for which a General Authorisation in accordance with the National Water Act (Act No. 36 of 1998) (NWA) will be applicable.

The proposed project is a decommissioning and rehabilitation project with the aim to ensure all mining infrastructure is removed with minimal impact to the surrounding environment and to ensure the area is rehabilitated to a more natural state. The project aims to have an overall positive impact on the surrounding environment.

Digby Wells Environmental (*hereinafter* Digby Wells) was appointed by Sasol Mining as the independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process. This report presents the findings of a specialist soil impact assessment that forms part of the Basic Assessment Process.

1.1 Project Background

The underground mining method at Twistdraai Colliery was bord and pillar with high extraction mining. As part of daily management of the various shaft areas, the Secunda Complex has been subdivided with each of Sasol's shaft areas having its own, separate Environmental Management Programme (EMPr). The Twistdraai Colliery's EMPr with DMR reference number: MP 30/5/1/2/3/2/1(138) EM was amended and submitted to the DMR in 2010. The DMR approved the EMPr amendment on 29 February 2012.

The Twistdraai Colliery is made up of three separate shafts, namely:

- Twistdraai West Shaft;
- Twistdraai East Shaft; and
- Twistdraai Central Shaft.

Of these three shafts, two (the Central and West Shafts) have been decommissioned, rehabilitated or renovated for alternative purposes. The Twistdraai East shaft is the last shaft to be decommissioned with most of the infrastructure already having been decommissioned. The decommissioning of the infrastructure located at each of these shafts was undertaken in accordance with its Amended Environmental Management Programme Report (EMPr), approved in 2012 (Ref No. MP 30/5/1/2/3/2/1(138) EM).

The following activities are to be undertaken which may require environmental authorisation:

- Decommissioning and rehabilitation of an access road and associated culverts which was constructed between Mynpad Road and the Twistdraai East Shaft which permits access to the Shaft;
- Decommissioning and rehabilitation of the conveyer belt servitude including access road, water supply pipeline and culverts which was previously utilised to transport coal from Twistdraai Colliery to Twistdraai Export Plant; and
  - It must be noted that the decommissioning of the water supply pipelines will only be decommissioned where it daylights over various tributaries. The remaining pipelines which are located beneath ground level will not be disturbed or removed during the decommissioning process.
- Decommissioning and rehabilitation of a mine water supply pipeline located within the conveyor belt servitude.

The proposed project is a decommissioning and rehabilitation project with the aim to ensure all mining infrastructure is removed with minimal impact to the surrounding environment and to ensure the area is rehabilitated to a more natural state. The project aims to have an overall positive impact on the surrounding environment.

1.2 Mining Method

The Mine utilised a Bord-and-Pillar underground mining method in all areas and the Nevid high extraction method was utilised in other identified areas. The reserves were accessed via vertical man and materials shafts and an incline shaft.

Run of Mine (RoM) coal was processed at the Twistdraai Export Plant (TEP). The RoM was estimated to be 58.33 million tons (Mt).

2 Project Location

Twistdraai East is located approximately 6.5 km south of the town of Trichardt, Twistdraai West is situated approximately 8.3 km south west of Trichardt and Twistdraai Central is located approximately 11.9 km south east of the Trichardt town. The location of Twistdraai is summarised in Table 2-1 and illustrated in Figure 2-1. The general layout of the site is shown in Figure 2-2.

Table 2-1: Summary of Project Location Details

Province	Mpumalanga Province
District Municipality	Gert Sibande District Municipality
Local Municipality	Govan Mbeki Local Municipality
Nearest Town	Trichardt and Twistdraai (Secunda Region)
Catchment Zone	C12D,
Rainfall Zones	C11 & C12
Water Management Area	Upper Vaal
Property Name and Number	Poverty Acres 585 IS, Frischgewaagd 294 IS and 34 of Goedehoop 290 IS

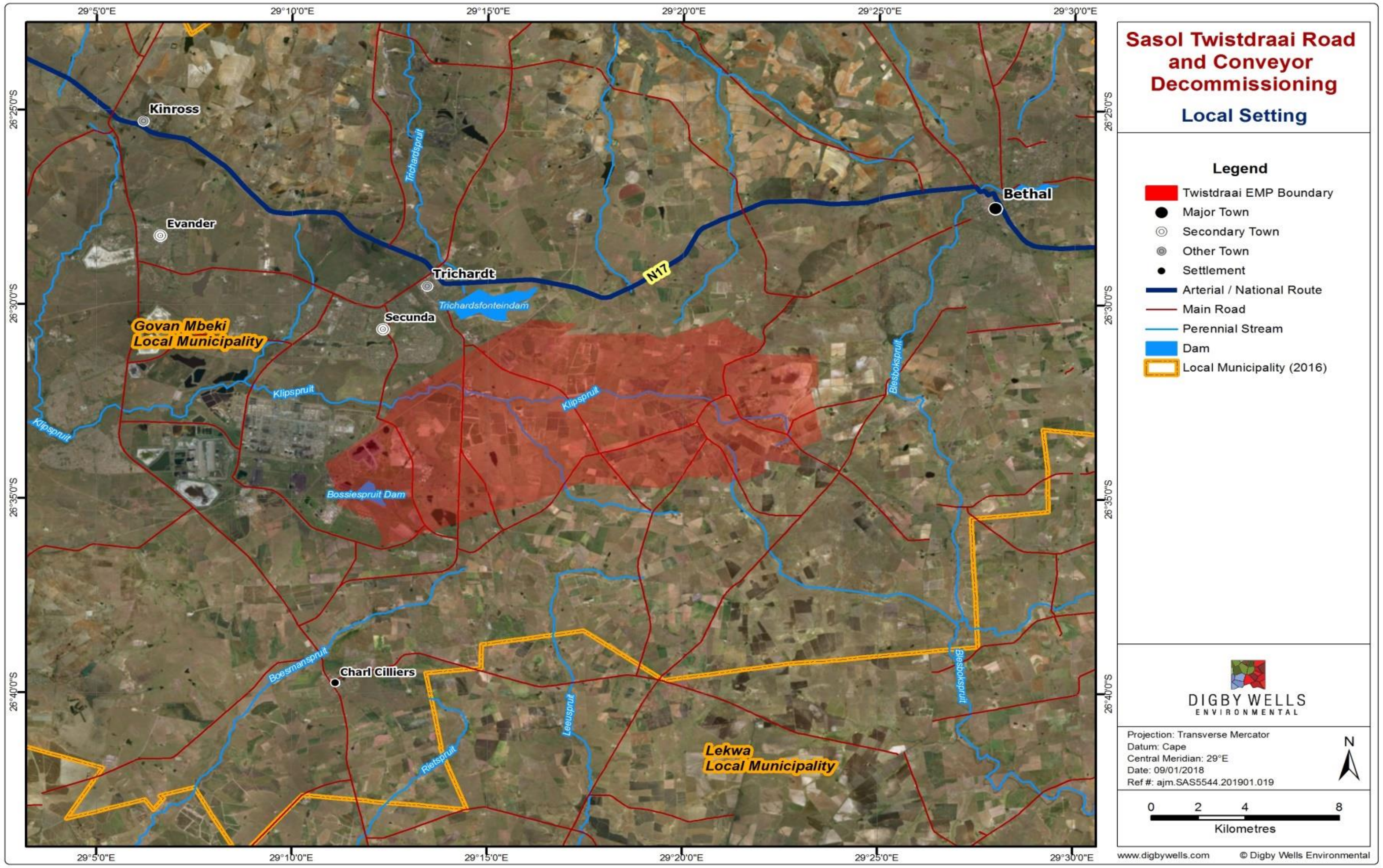

Figure 2-1: Local Setting of the Project Area

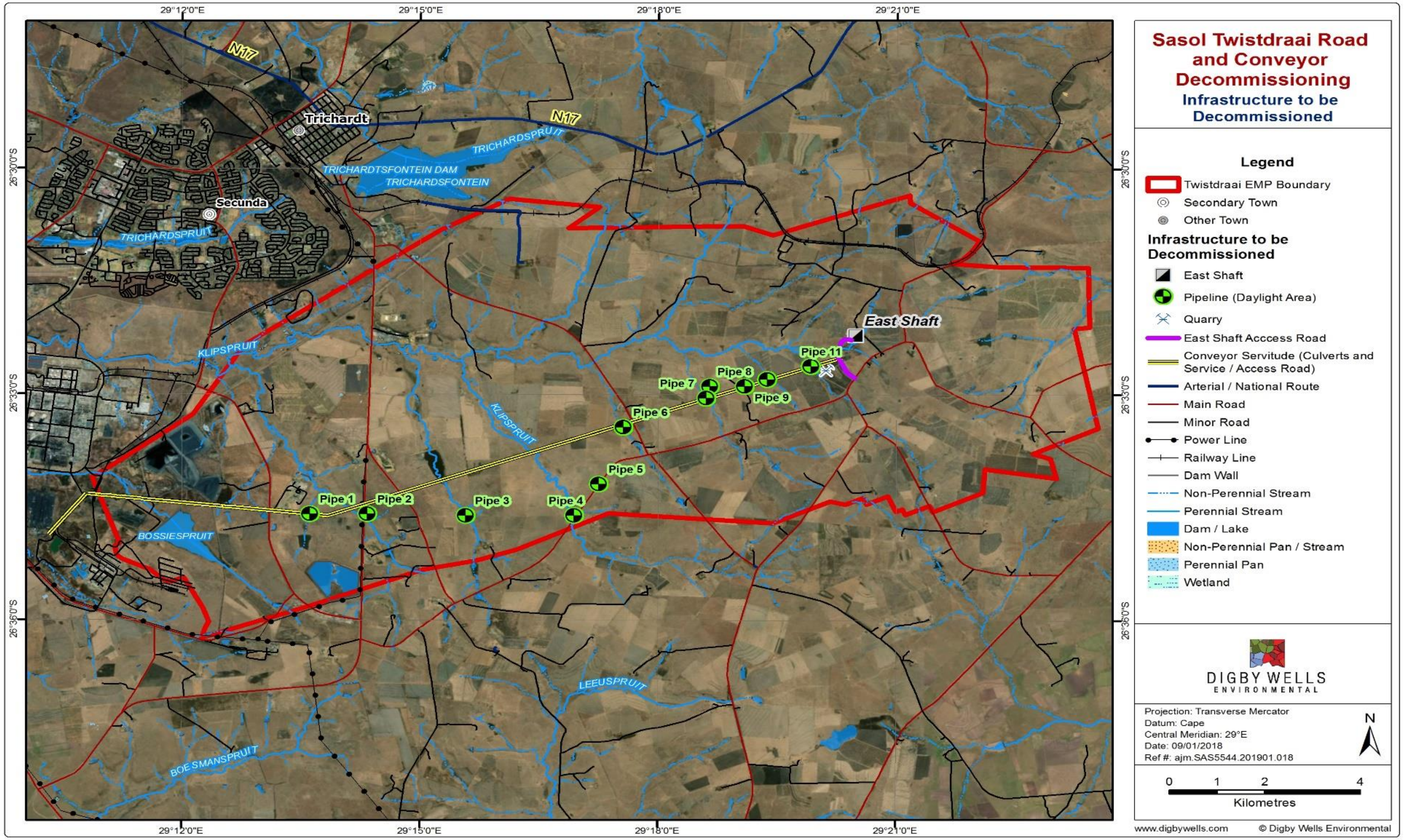

Figure 2-2: Infrastructure Layout

3 Scope of Work

Digby Wells' Scope of Work (SoW) includes:

- Review of all the existing available information;
- Soil survey of the soils occupying the conveyor belt, road, quarry and pipeline. A hand soil auger was used to survey the soil types present and survey positions were recorded as waypoints;
- Description and categorisation of soils using the South African Soil Classification Taxonomic System (Soil Classification Working Group, 2018);
- Description of soils in terms of soil fertility: 10 soil samples were collected at the wetland crossings and shaft areas;
- Identification and assessment of potential impacts on soils resulting from the decommissioning of the infrastructure using the prescribed impact rating methodology; and
- Mitigation measures were recommended to minimise impacts associated with the decommissioning of the infrastructure.

4 Assumptions and Limitations

The following assumptions and limitations have been made:

- The information provided in this report is based on information gathered from the site visit undertaken on 3 December 2018 and information reviewed from previous studies;
- A total of 10 soil samples were collected at the crossings and infrastructure and analysed at an accredited Intertek Laboratory; and
- The area surveyed is based on the layout presented by Sasol Mining.

5 Details of Specialists

The following is a list of Digby Wells' staff who was involved in the compilation and review of the Soil Impact Assessment Report for Twistdraai Colliery:

Siphamandla Madikizela is a Soil Scientist, completed his MSc in Soil Science at University of KwaZulu-Natal and is a Professional Natural Scientist (Registration no. 400154/17) in the Republic of South Africa. He is the part of the Closure, Rehabilitation and Soils Division at Digby Wells Environmental. His role involves conducting soil surveys; soil, land capability and land use environmental impact assessments; soil and agricultural potential studies; soil contamination assessments; interpreting results of soil samples; soil management plans and writing detailed scientific reports in accordance to local legislation and International Finance Corporation (IFC) Standards and World Bank Guidelines. Siphamandla has worked in projects in South Africa, Democratic Republic of the Congo, Senegal, Malawi and Mali.

Mia Smith has a Masters in Environmental Management and Energy Studies. She has experience within the environmental services field including but not limited to mining, industrial, and energy and agricultural. She has more than 10 years consulting experience and joined Digby Wells Environmental as a Manager: Compliance in 2018. She previously worked for Sappi SA as the Risk Manager.

6 Legislative Framework

The South African Environmental Legislation needs to be considered with reference to the management of soil and land use which includes:

- The NEMA requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and treated; and
- The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA) requires that protection of land against soil erosion, the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained.

7 Methodology

To address the SoW for the assessment, the following tasks were undertaken and are detailed in the sections below:

- Literature review and desktop assessment; and
- Field survey and laboratory analyses.

7.1 Literature Review and Desktop Assessment

Digby Wells conducted a literature review of all the existing baseline data related to the soil assessment. The following sources of information were reviewed and utilised for the compilation of this report:

- Sasol Mining (Pty) Ltd. 2010. Environmental Management Programme for Twistdraai Mine;
- Sasol Mining (Pty) Ltd. 2014. Twistdraai Colliery East Shaft. Block 3 Water Use License Conditions: Assessment on Alien Invasive Species;
- Wet-Earth Eco-Specs cc. 2017. Block 3 Mines: Dry Season Biomonitoring Assessment Report for Sasol Mining (Pty) Ltd;
- Sasol Mining (Pty) Ltd. 2017. Integrated Water and Waste Management Plan (IWWMP) Update for Twistdraai Colliery;
- Wetland Consulting Services (Pty) Ltd. 2018. Baseline Wetland Delineation and Assessment for the Sasol Twistdraai Mine; and

- Sasol Mining (Pty) Ltd. 2018. Rehabilitation Strategy and Implementation Plan (RSIP) Including Decommissioning Activities for Twistdraai Mine.

A review of all available data and information was undertaken to determine the *status quo* of the soil environments on the site and the immediate surrounding areas. The desktop study aimed to determine the baseline conditions from existing studies conducted in the area as well as publicly available information.

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the project site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of relatively uniform terrain, soil pattern and climate (Land Type Survey Staff, 1972 - 2006). The maps and their accompanying reports provide a statistical estimate of the different soils expected in the area.

7.2 Field Survey

The field assessment and sampling was undertaken on 3 December 2018. The sampling procedure and methodology for analyses is summarised below.

7.2.1 Soil Classification

An assessment of the soils present at the wetland crossings, shaft, and pipeline and quarry areas was conducted during a field visit. The site was traversed on foot and a hand-held soil auger was used to determine the soil type and depth. Soils were investigated using a bucket auger to a maximum depth of 1.2 m or to the depth of refusal. Survey positions were recorded as waypoints using a handheld Global Positioning System (GPS). Other features such as existing open trenches were helpful to determine soil types and depth. The soil forms (types of soil) found was described using the South African Soil Classification System (Soil Classification Working Group, 2018).

7.2.2 Soil Sampling and Analyses

Using standard sampling procedures, 10 soil samples were collected at depth of 0 to 0.6 m from different locations as illustrated in Figure 7-1. Soil sampling was done using a bucket hand-held auger; samples were stored in plastic bags in a cooler box and sent to a certified laboratory for analysis. The soil samples were analysed for the following:

- Soil pH;
- Exchangeable cations (Calcium (Ca), Magnesium (Mg), Potassium (K) and Sodium (Na)) (Ammonium acetate extraction);
- Phosphorus (P) (Bray No.1 extractant);
- Aluminium (Al), Copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn);
- Soil Organic carbon (OC); and
- Soil Texture (Clay, Sand and Silt).

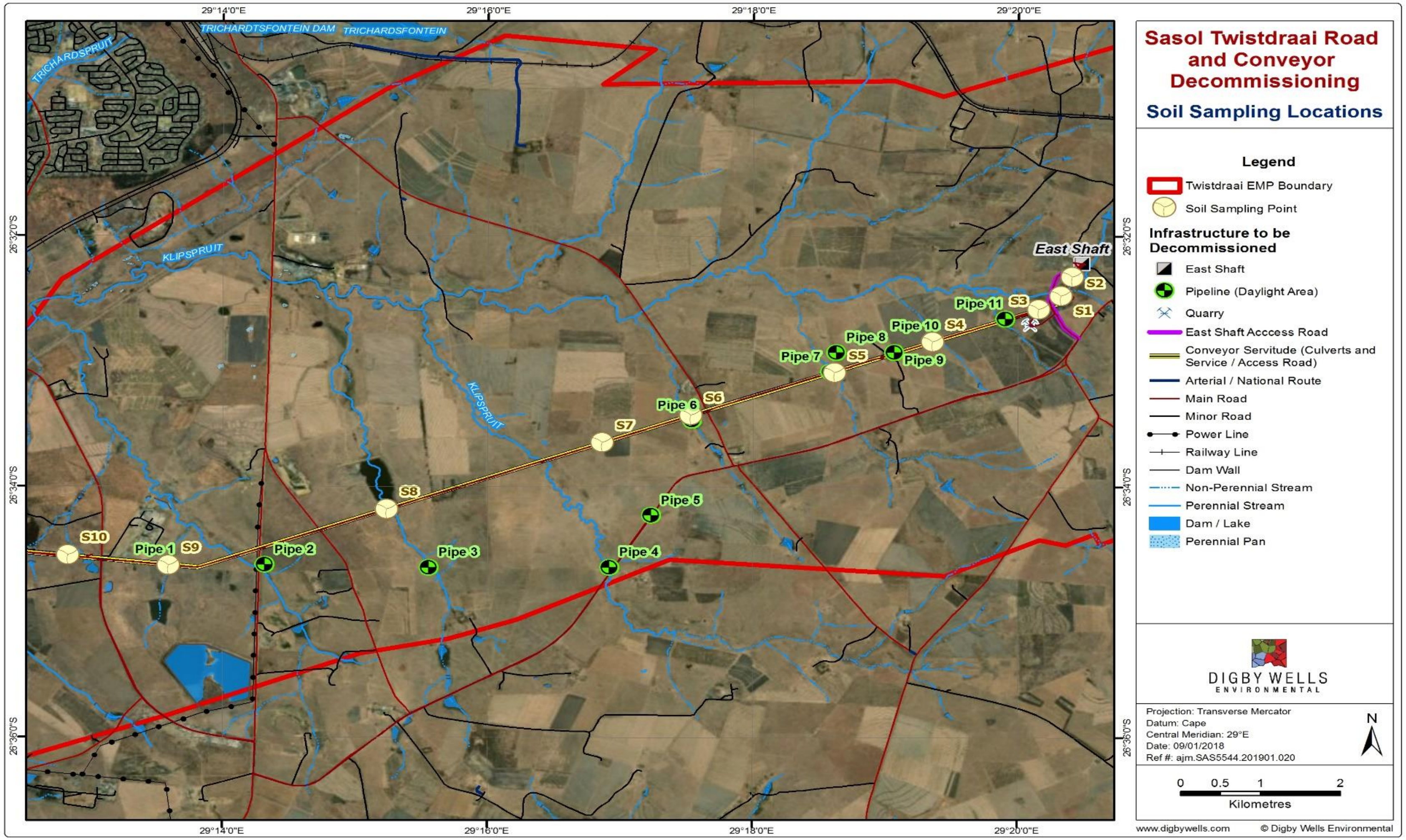

Figure 7-1: Sampling Locations at Twistdraai Colliery

Soil texture is defined as the relative proportion of sand, silt and clay particles found in the soil. The relative proportions of these three fractions (clay, sand and silt) as illustrated by the red arrows in Figure 7-2, determines one of 12 soil texture classes, for example sandy loam, loam, sand and sandy clay loam (Soil Classification Working Group, 1991). The different texture class zones are demarcated by the thick black line in the diagram. The green zone can be used as a guideline for moderate to high agricultural potential but need to be evaluated together with other soil properties.

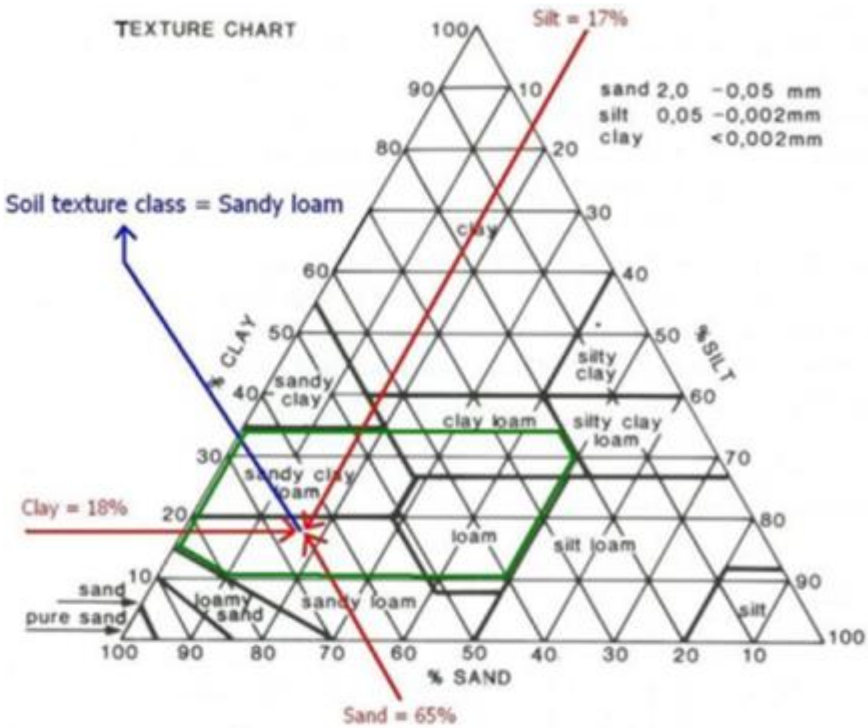

Figure 7-2: The Soil Textural Triangle (South African Sugar Association (SASA), 1999)

7.2.3 Land Use

The current land use was identified using aerial imagery during the desktop assessment and verified through on-site visual inspection. The land use was classified as follows:

- Mines;
- Waterbodies;
- Wetlands;
- Urban built-up; and
- Cultivated areas.

8 Environmental Setting

Baseline information was sourced from the EMPr (Sasol Mining, 2010), RSIP (Sasol Mining, 2018) and IWWMP for the Twistdraai Colliery (Sasol Mining, 2017).

8.1 Climate and Rainfall

The region is characterised by warm to hot summers and cool to cold winters. Showers and thunderstorms occur during the summer months (September – April) and the winter months are normally arid and cold (June – August). The maximum temperatures range from 30°C in summer to 17.1°C in winter. The minimum temperatures range from 25.8°C in summer to just below 5°C in winter.

Rainfall in this region occurs mainly during the summer months and the average Mean Annual Precipitation (MAP) is 667 mm per annum with a peak in January. The potential Mean Annual Evaporation (MAE) for the region is in the order of 1 580 mm which is more than twice as much as the MAP for the area.

8.2 Topography

The Mpumalanga Province is 1 262 meters above mean sea level (mamsl). Twistdraai Colliery lies in a typical Highveld area and drains to the south towards the Vaal River System. The area characterised by undulating topography of grassland and cultivated fields with surface elevations ranging from 1 590 up to 1660 mamsl.

8.3 Geology

The project area is underlain by sediments of the Karoo Sequence in the Highveld Coalfield. Table 8-1 summarises the geology within the area which consists of sandstone, siltstone, tillite, glacial sediments and granite

Table 8-1: Stratigraphy in the Mine Reserve Area

Sequence	Group	Formation	Lithology
Karoo	Ecca	Vryheid	Sandstone & Siltstone
		Pietermaritzburg	Siltstone
		Dwyka	Tillite, glacial sediments
Basement Complex	-		Granite

The stratigraphy of the Twistdraai Colliery Coal reserves comprises of the Number 2 Coal Seam (No. 2), Number 3 Coal Seam (No.3), Number 4 Lower Coal Seam (No. 4L), Number 4 High Coal Seam (No. 4H), Number 5 Lower Coal Seam (No. 5L) and Number 5 High Coal Seam (No. 5H), from the bottom to top. The economically mineable Coal Seam at the

Twistdraai Colliery is No. 4L. The average depth to the Coal Seam is 140 m from the surface and the Seam is 3.5 m thick.

8.4 Surface Water

The Twistdraai Colliery falls within Vaal Major Water Management Area 5 (WMA 5), within quaternary catchment C12D, as illustrated in Figure 8-1. Naturalised Mean Annual Runoff (MAR) for the Twistdraai East Colliery area was calculated to be 70.57 mm and the runoff depth is approximately 11% of the MAP.

According to the approved Water Use Licence (WUL), the following variables in Table 8-2 are included in the surface water monitoring programme.

Table 8-2: Surface Water Quality Monitoring Variables and Frequency

Variables	Frequency
pH	Monthly
Electrical conductivity (mS/m)	Monthly
Total Dissolved Solids (TDS) (mg/ℓ)	Monthly
Alkalinity (mg/ℓ)	Monthly
Ammonia (mg/ℓ)	Monthly
Nitrate (mg/ℓ)	Monthly
Calcium (mg/ℓ)	Monthly
Chloride (mg/ℓ)	Monthly
Aluminium (mg/ℓ)	Monthly
Iron (mg/ℓ)	Monthly
Manganese (mg/ℓ)	Monthly
Zinc (mg/ℓ)	Monthly
Fluoride (mg/ℓ)	Monthly
Magnesium (mg/ℓ)	Monthly
Potassium (mg/ℓ)	Monthly
Sodium (mg/ℓ)	Monthly
Sulphate (mg/ℓ)	Monthly

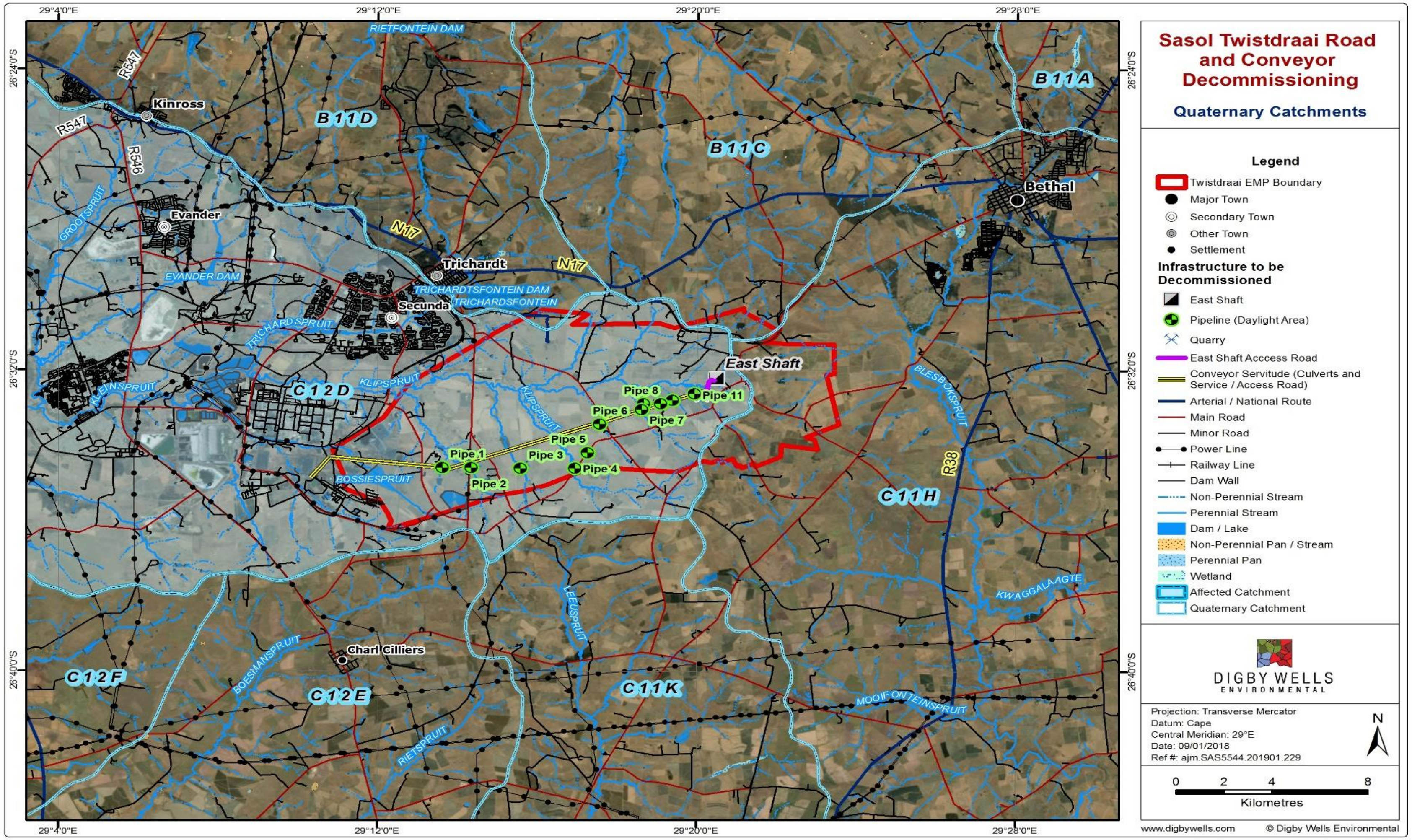

Figure 8-1: Quaternary Catchments

The water quality information is summarised in the Monitoring Report for the Twistdraai East Colliery (Wet-Earth, 2017) and Digby Wells' Surface Water Report (Digby Wells, 2019). Samples were collected from points on the Klipspruit, upstream and downstream of the conveyor belt, as well as at river crossings along the conveyor belt route. Water quality was benchmarked against the South African Water Quality Target Values (SWQTV) (Department of Water Affairs, 1996), South African National Accreditation System (SANAS) 241-1: 2015 drinking water standards (SANAS, 2015) and the Twistdraai WUL (No. 08/C12D/ACEFGIJ/1274).

8.5 Flora

The Highveld grasslands have flat undulating plains with low hills, pan depressions, valleys and outcrops (Mucina & Rutherford, 2006). The area has flat topography which means that the landscape is crossed by rivers with the grassland communities playing a huge role in water purification.

The project area falls within the Soweto Highveld Grassland vegetation type which is located within the Grassland biome, as illustrated in Figure 8-2. According to Mucina & Rutherford (2006), Soweto Highveld Grassland is classified as Endangered due to large scale transformation through mining and cultivation. There are six vegetation units surveyed on the study area:

- Plateau Grassland – *Themeda triandra*;
- Plains Grassland – *Themeda triandra*;
- Rocky Plains Grassland – *Themeda triandra* and *Loudetia simplex*;
- Rocky Shrubland – *Diospyros lycioides* subsp. *guerkei*, *Hyparrhenia hirta* and *Heteropogon contortus*;
- Wetland – Wet valley grassland; and
- Disturbed Grassland.

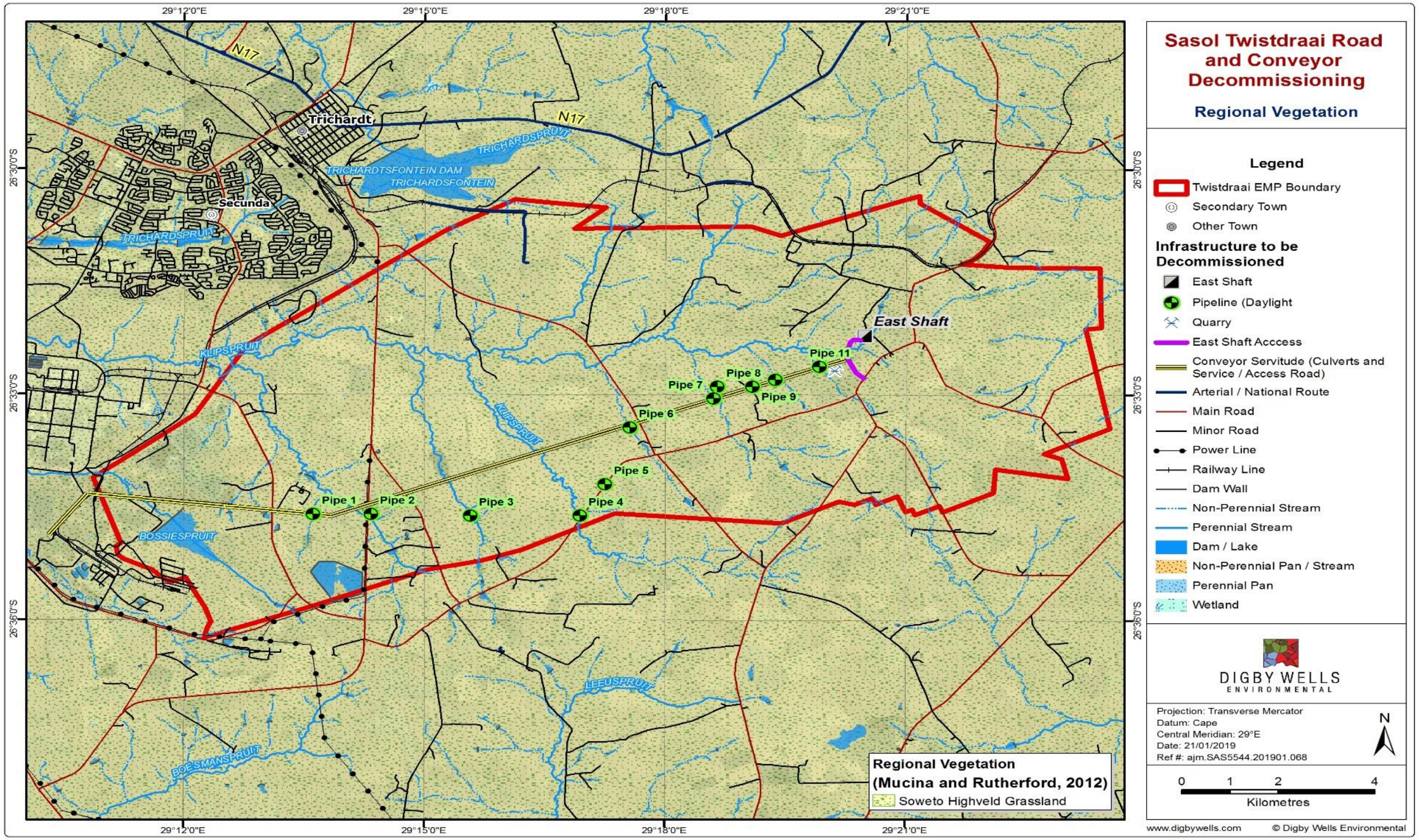

Figure 8-2: Regional Vegetation

8.6 Wetlands

Wetlands on the project area are the refuge sites for water birds and aquatic species. They provide:

- Foraging areas for wader and waterfowl species;
- Hydrological control which helps prevent soil erosion;
- Recharge mechanism for groundwater resources; and
- Water purification by trapping pollutants, including sediment and heavy metals.

Wetlands identified on site were channelled valley bottoms, floodplains or hillslope seepage wetlands. Wetlands on the project area were described using the National Freshwater Ecosystem Priority Areas (NEFPA's) description of a wetland condition and the Present Ecological State (PES) provides a description of the condition category. The identified wetlands fall within the following categories:

- A/B category (Natural or good); and
- C category (Moderately modified), with some loss of natural habitat.

Wetlands were rated high Ecological Importance and Sensitivity (EIS) with biodiversity that is sensitive to flow and habitat modification.

9 Visual Observation

A site visit was conducted on the 3rd of December 2018 to physically assess the conditions of the conveyor belt route, road, pipeline and the quarry to be decommissioned. Plan 9-1 to Plan 9-5 provides a general overview of the assessed areas that will be decommissioned and rehabilitated. The following rehabilitation measures are recommended:

- Remove remaining waste in contractors area after moveable structures and equipment have been removed by contractors;
- Rip the road, as well as any other area that has been compacted, and reseed
- Rip footprint areas to alleviate compaction;
- Reseed with palatable grasses and improve species diversity by planting species;
- Monitor and maintain vegetation establishment;
- Remove alien invasive vegetation;
- Re-profiling the site to be free draining and to emulate the surrounding wetland area which will aim to ensure that water is not impeded, and the flow resumes a natural pattern;
- Remove coal contamination and any other residues and dispose of it at the appropriate facility;

- Alteration of natural hydrology can be prevented by installing energy dissipaters at the discharge point to avoid erosion;
- All erosion noted within the decommissioning footprints should be remedied immediately and included as part of an ongoing rehabilitation; and
- Remove all rubble, culverts and materials from site.

Plan 9-1: Shaft Area to be rehabilitated

Plan 9-2: Conveyor belt removed

Plan 9-3: Water pipeline to be decommissioned

Plan 9-4: Conveyor belt lying on the ground at the crossing

Plan 9-5: Altered channel and silted river at a crossing

10 Findings

Information related to the soils associated with the project area is discussed in this section. The laboratory analyses and results are also presented. The land type data gathered suggested that the dominant land type on site were Ea17 and Ea20 characterised by vertic, melanic and red structured diagnostic horizons, as illustrated in Figure 10-1. Further information related to the soils within the project area is discussed in Section 10.1.

10.1 Land Type and Soil Forms

Table 10-1 shows dominant land types and soil forms found along the road, conveyor belt, pipeline and quarry with visual representation depicted in Figure 10-2 and Figure 10-3. Soils include swelling structured black and apedal soils. Soils are generally deeper in the valleys and wetland crossings.

Table 10-1: Dominant Land Type and Soils

Land Type	Soil Forms	Geology	Characteristics
Ea17 & Ea20	Arcadia and Rensburg forms	Alluvium, dolerite, sandstone and shale of the Ecca Group	Consists of soil with significant accumulation of smectitic (swelling) clay (vertic horizon).

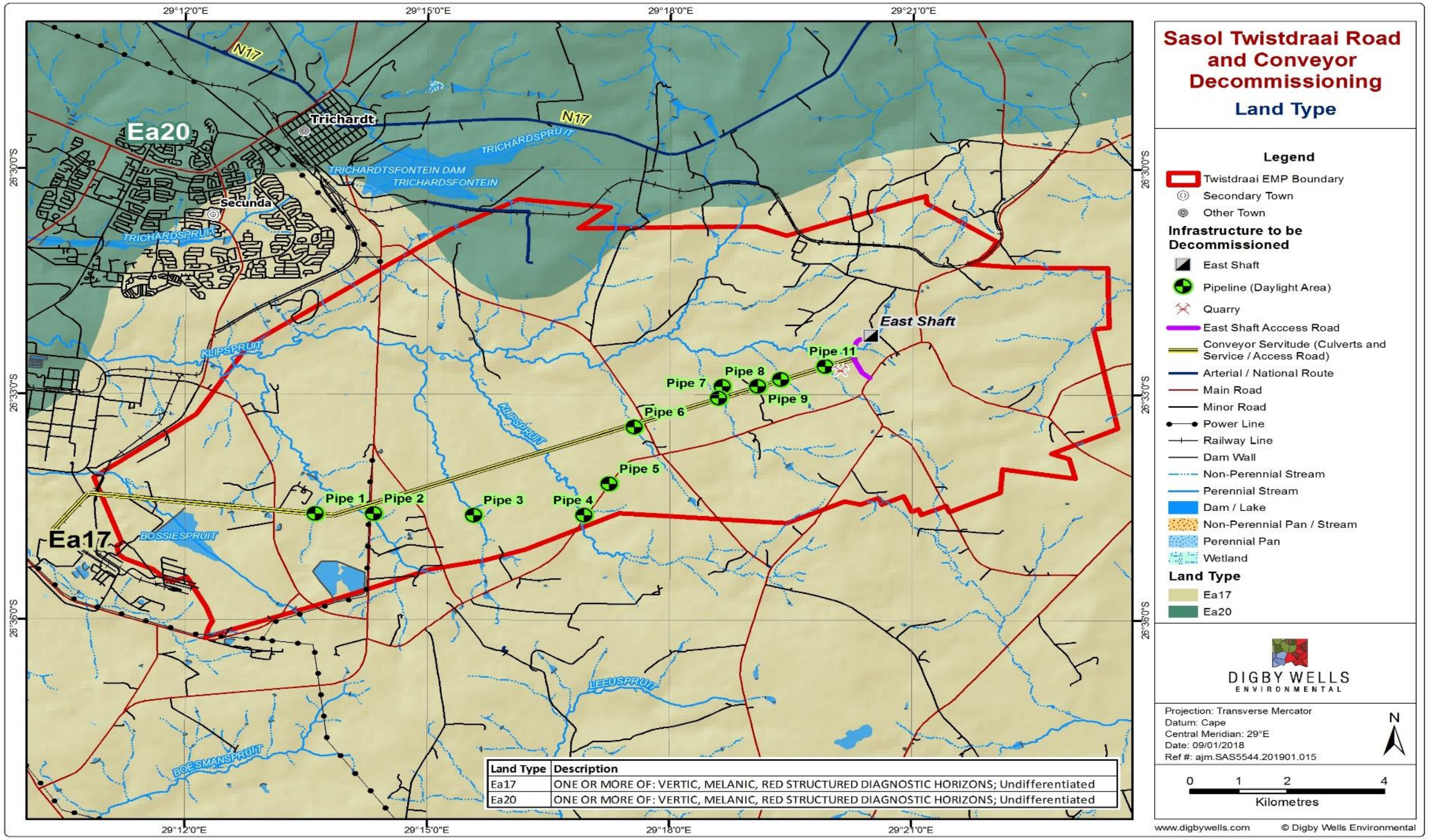

Figure 10-1: Land Type at Twistdraai Colliery

Figure 10-2: Examples of Swelling Structured Black Soils

Figure 10-3: Examples of Apedal Soils

10.2 Present Land Use

The present land use was identified using satellite images and visual observations during the site visit. The main land uses in the area are cultivated land and veld for grazing, as illustrated in Figure 10-4 and Figure 10-5. A large amount of agricultural activities are taking place within the project area and surroundings. The area is underlain by underground mining.

Figure 10-4: Land Use at Twistdraai Colliery and Surrounding

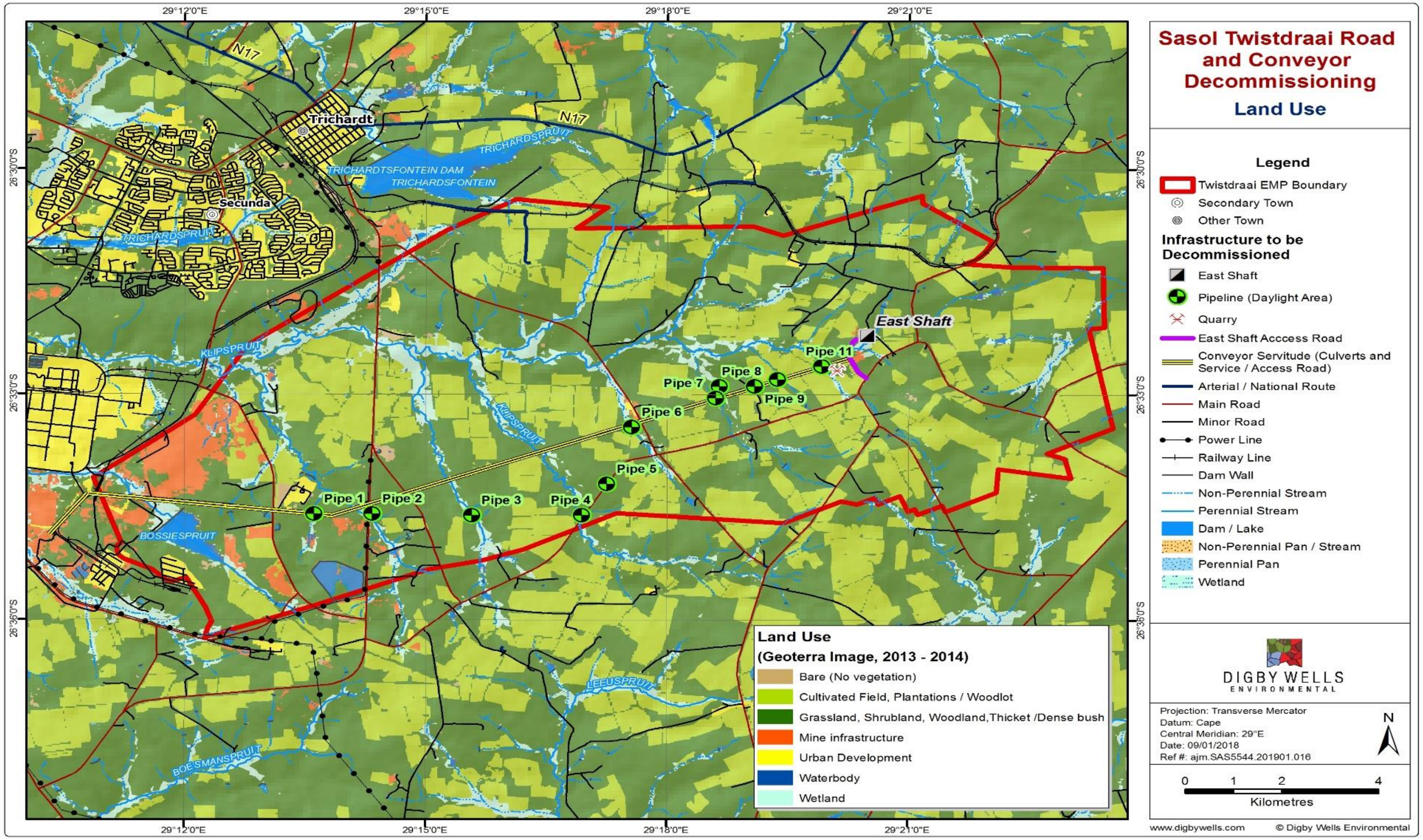

Figure 10-5: Land Use at Twistdraai Colliery and Surrounding

10.3 Soil Chemical and Physical Properties

A total of 10 soil samples were analysed for the chemical and physical properties. The objective of this section of the study is to characterise the soil's physico-chemical properties. The results of soil analysis are presented in Table 10-2 and as a basis for interpreting these results, some local fertility guidelines are presented in Table 10-4.

10.3.1 Soil pH

The soil pH is determined in the supernatant liquid of an aqueous suspension of soil after having allowed the sand fraction to settle out of suspension. Soil pH influences plant growth in the following ways:

- Through the direct effect of the hydrogen ion concentration on nutrient uptake;
- The mobilisation of toxic ions such as aluminium which restrict plant growth; and
- Indirect impacts that include the effect on trace nutrient availability.

The soil pH ranged from 5.5 to 7.5, these soils are acidic to neutral according to the soil fertility guidelines indicated in Table 10-4. The soil pH below 7 may be due to the acidic nature of the parent material from which the soils were derived and leaching of nutrients from parent material. Lime is required to counteract acidity and to increase plant growth performance, should agricultural activities take place.

10.3.2 Soil Organic Carbon

Soil organic carbon provides an indication of organic matter content in soil. Concentrations above 2% to 3% organic carbon are considered moderate to high according to Du Preez *et al*. (2010). The organic carbon content of the soils at the soil sampling locations ranged from 1% to 7% and concentrations below 2% would have required an external nutrient input source, should the soils have been used for agricultural purposes.

10.3.3 Phosphorus

The Bray 1 extraction and analysis procedure for P is preferred for soils with pH concentrations below 7. The P concentrations encountered in the samples from the site were all very low according to the guidelines in Table 10-4, with most values being > 1 mg/kg and the maximum 5 mg/kg. Phosphorus will be a limiting factor in terms ecosystem function if the soil was going to be used for agricultural purposes and concentrations of at least 15 mg/kg would be required. Phosphorus fertilisation would be required to establish good crop stand and growth, should agricultural activities take place. The low available P concentrations of the clayey soils reflect a probable history of no cropping taking place over a period of time.

10.3.4 Exchangeable Cations

The concentrations of the basic cations Ca, Mg, K and Na are determined in soil samples for agronomic purposes through extraction with an ammonium acetate solution. For most soils, cations follow the typical trend Ca>Mg>K>Na.

Ca, K and Mg concentrations in the soil were generally high in Table 10-2 when compared to the soil fertility guidelines in Table 10-4. These concentrations are adequate for crop production and these nutrients are not limiting any production on the site or considered to be toxic. Thus, there is no need to add calcium, potassium and magnesium in a fertiliser form as they might suppress concentrations of potassium during nutrient uptake by plants, should agricultural activities take place. The sodium concentrations ranged from 70 to 800 mg/kg and soils with sodium concentrations below 200 mg/kg are considered not to be sodic.

S2, S3, S7 and S10; had sodium concentrations exceeding 200 mg/kg when compared to the guidelines in Table 10-4 and considered to be sodic due to high sodium concentrations. Soil dispersion is likely to occur and cause dense structure and drainage problems (de Villiers *et al*., 2003).

The clayey (black) soils are considerably better endowed with base cations, organic carbon, clay, and cation exchange capacity. The low available P concentrations of the clayey soils reflect a probable history of no cropping. Because of the high nutrient status and well buffered pH, soils with a vertic horizon are potentially very suitable for rehabilitation work. Although the black clay is potentially difficult to work with because of unfavourable consistence, it has the advantage of a self-mulching habit meaning that clods will weather to a fine crumb structure due to shrinking and swelling with changes in water content. Also, the shrink-swell behaviour could potentially have a favourable effect in counteracting mechanical compaction caused by heavy machinery employed for rehabilitation. Vertic soils can be used successfully for crop and pasture production if managed judiciously (Fey *et al*, 2010).

Table 10-2: Soil Chemical and Physical Properties

Sample ID	pH	P	Na	K	Ca	Mg	OC	Clay	Sand	Silt	Texture
		Concentrations (mg/kg)					Consistency (%)				
S1	6.3	1	123	164	3 912	2 609	1.4	42	38	20	Clay
S2	6.9	5	471	263	5 165	3 029	1.1	26	50	24	Sandy clay loam
S3	5.7	1	265	84	4 880	3 816	1.6	42	32	26	Clay
S4	5.7	1	115	178	4 158	4 074	1.3	42	35	23	Clay
S5	6.4	3	72	171	3 163	1 237	7.4	18	63	19	Sandy loam
S6	5.8	3	101	265	4 165	2 007	1.9	34	35	31	Clay loam
S7	6.7	2	815	151	3 741	2 525	1.3	34	34	32	Clay loam
S8	7.1	2	161	107	5 657	1 709	1.4	18	68	14	Sandy loam
S9	7.2	3	101	173	7 012	2 832	4.2	26	24	50	Silt loam
S10	6.0	2	350	115	4 243	1 568	3.5	30	43	27	Clay loam

Table 10-3: Metals

Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	SSV1	SSV2
Concentrations (mg/kg)												
Aluminium	19912	20407	18255	18938	11218	13495	14041	13022	9393	13271	NA	NA
Copper	4.6	5.3	5.9	7.4	2.0	6.0	7.7	3.2	9.1	6.7	16	19 000
Iron	50.2	70.2	64.7	61.2	23.3	62.5	81.0	33.1	87.4	88.4	NA	NA
Manganese	13.7	14.2	31.5	36.7	15.2	12.8	14.1	5.9	11.1	15.6	740	12 000
Zinc	0.5	0.9	1.1	0.0	43.0	5.3	10.1	4.4	250.4	195.4	240	150 000

Table 10-4: Soil Fertility Guidelines (Fertiliser Association of South Africa, 2003)

<table>
<tr><th colspan="6">Guideline concentrations (mg/kg)</th></tr>
<tr><th colspan="3">Macro Nutrient</th><th>Low</th><th colspan="2">High</th></tr>
<tr><td colspan="3">Phosphorus (P)</td><td><5</td><td colspan="2">>35</td></tr>
<tr><td colspan="3">Potassium (K)</td><td><40</td><td colspan="2">>250</td></tr>
<tr><td colspan="3">Sodium (Na)</td><td><50</td><td colspan="2">>200</td></tr>
<tr><td colspan="3">Calcium (Ca)</td><td><200</td><td colspan="2">>3000</td></tr>
<tr><td colspan="3">Magnesium (Mg)</td><td><50</td><td colspan="2">>300</td></tr>
<tr><th colspan="6">pH (KCl)</th></tr>
<tr><th>Very Acid</th><th>Acid</th><th>Slightly Acid</th><th>Neutral</th><th>Slightly Alkaline</th><th>Alkaline</th></tr>
<tr><td><4</td><td>4.1-5.9</td><td>6-6.7</td><td>6.8-7.2</td><td>7.3-8</td><td>>8</td></tr>
</table>

10.3.5 Heavy Metals

Metals and their compounds present in the soil fractions vary in their degree of mobility. The bioavailability of metals is controlled by biological, chemical and physical processes and their interactions. The bioavailability depends on several soil properties which include:

- Soil pH;
- Organic matter content;
- Form and occurrence of cations;
- Adsorption capacity;
- Oxidation-reduction potential; and
- Activity of micro-organisms.

Error! Reference source not found. summarises the concentrations of heavy metals in each sampling point. These concentrations were screened against the soil screening values (SSV1 and SSV2) of the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality, (GN R 37603, May 2014). Soil screening values are used to assess whether constituents present in the soils are at concentrations high enough to pose a potential risk to the receiving environment and require more detailed risk assessment and investigation regarding the source of the contamination.

Concentrations of parameters in soils below threshold of SSVs would suggest that it is unlikely that the significant contamination has occurred, whereas, concentrations above the threshold of SSVs are considered to indicate possibility of significant degree of contamination. These values provide a good reference against which to compare the present concentrations of parameters in soils.

The SSV1 (all land-uses protective of the water resource) values are appropriate to assess potential soil contamination when there is potential risk to the groundwater resource. There are groundwater users with 1 km of the site and there are surface watercourses that could be impacted by off-site migration of contaminants (GN R 37603, May 2014). If there is no risk to the to the water resources that can be identified at the site then soil results are compared to SSV2 values which has three sub-categories (i.e. informal residential, standard residential and commercial/industrial), based on the risk to receptors defined by activity and exposure related to land use.

The analytical data in Table 10-3 shows that Copper, Manganese and Zinc concentrations did not exceed the SSV1 and SSV2. However, S9 exceeded SSV1.

10.3.6 Soil Texture

The particle size distribution of the soil sampled in the areas was classed into the percentages of sand, silt and clay present. The textural classes were obtained from plotting the three fractions on a textural triangle (Figure 7-2). The soils can be described as clay, sandy clay loam, sandy loam, silt loam and clay loam. Clayey soils have a slow infiltration rate, but a good water retention capacity and these soils are more fertile than sandy soils due to high plant nutrient retention. Soils with high clay content have a low to marginal agricultural potential.

11 Unplanned Events and Low Risks

There is a risk of accidental spillages of hazardous substances which can result in soil contamination, for example hydrocarbons or oils from vehicles or other machinery during decommissioning phases.

11.1 Emergency Procedures

Hydrocarbon spills or leaks can occur; therefore, emergency procedures need to be put in place for remediation (Table 11-1). These procedures can include the following:

- Contractors must ensure that all employees are aware of the procedure for dealing with spills and leaks and properly trained to deal with such incidents;
- Ensure that emergency spill equipment is available to site personnel;
- No re-fuelling is allowed on site; and
- Fuel and oil spills should be remediated using commercially available emergency clean up kits. For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site.

Table 11-1: Unplanned Events and their Management Measures

Unplanned event	Potential impact	Mitigation/Management/Monitoring
Hydrocarbon leaks from vehicles and machinery or hazardous materials	Soil Contamination	▪ Place drip trays where the leak is occurring if vehicles are leaking; ▪ All vehicles should be serviced at the workshop location specifically designed for servicing of machinery; ▪ Machinery must be parked within hard park areas and the machinery must be inspected daily for fluid leaks; ▪ If a spill occurs it should be cleaned up (Drizit spill kit/ Enertech type spill kit, Oil or Chemical spill kit) immediately and if applicable reported to the appropriate authorities; and ▪ Emergency response plans should be in place.
Hazardous substance spillage from waste storage	Soil Contamination	▪ Prevent any spills from occurring; ▪ If a spill occurs it should be cleaned up (Drizit spill kit/ Enertech type spill kit, Oil or Chemical spill kit) immediately and if applicable reported to the appropriate authorities; and ▪ Emergency response plans should be in place.

12 Sensitivity

According to the Department of Water and Sanitation (ex-Department of Water Affairs) (DWAF) (2005), the permanent zone of a wetland area could potentially be categorised by Katspruit, Rensburg, Arcadia, Champagne or Willowbrook soil forms as defined by the South African Classification System (Soil Classification Working Group, 1991). Also, the following soil forms are classified as wetland soils; Longlands, Kroonstad, Avalon, Westleigh, Pinedene and Fernwood (DWAF, 2005). Wetland soils have high sensitivity as they are protected by:

- Section 24 of the Constitution of the Republic of South Africa ,1996 (Act No. 108 of 1996);
- Section 5 of NEMA;
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA); and
- Ramsar Convention on Wetlands of International Importance (1975) (Ramsar Convention).

The sensitive areas are depicted in Figure 12-1

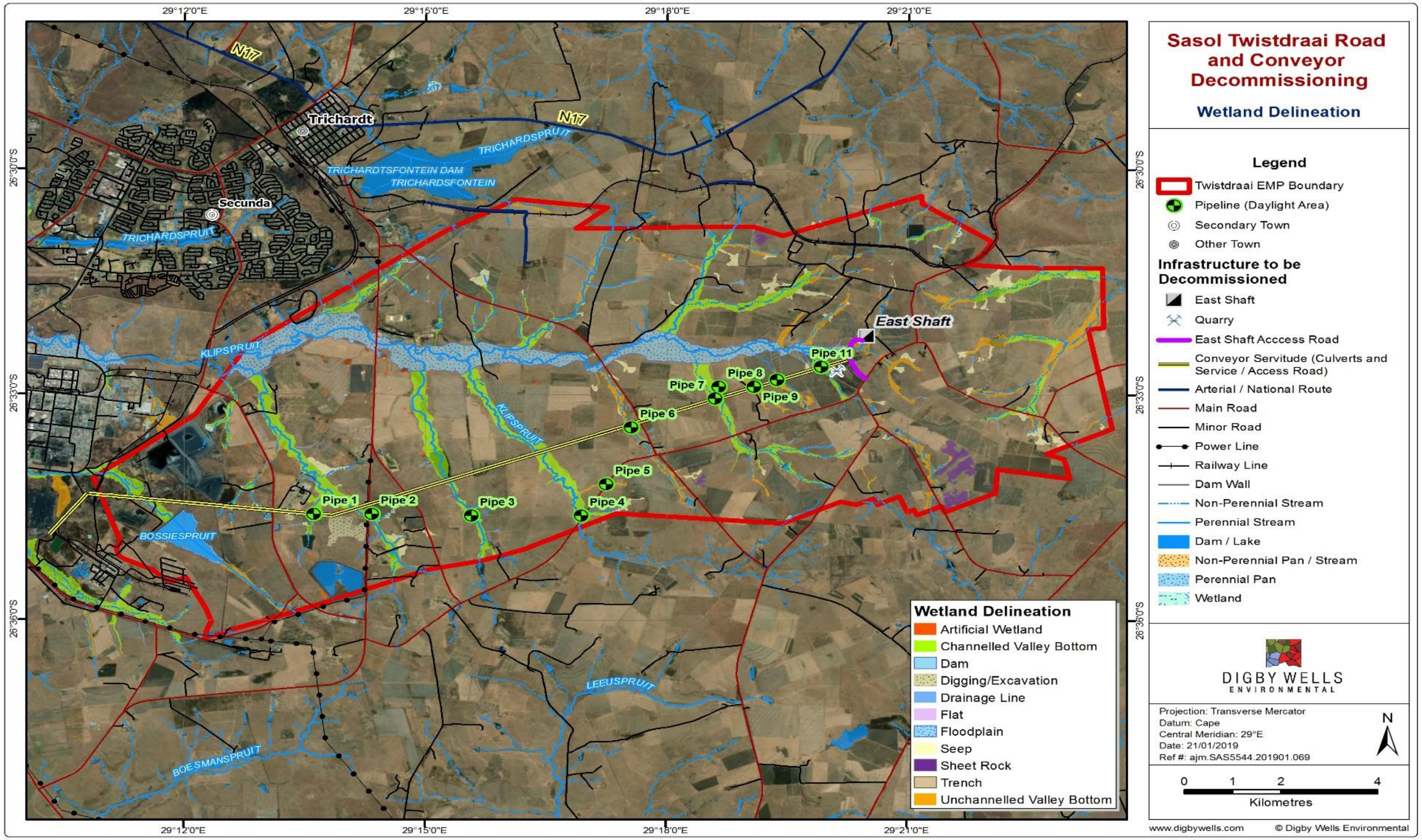

Figure 12-1: Wetlands Delineated on Site, Highlighting Sensitive Areas

13 Impact Assessment

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, concluding in an impact significance rating which identifies the most important impacts that require management. Based on the international guidelines and legislation, the following criteria will be considered when examining potentially significant impacts relating to soils and land use:

- Nature of impacts (direct/indirect and positive/negative);
- Duration (short/medium/long-term, permanent (irreversible)/temporary (reversible) and frequent/seldom);
- Extent (geographical area and size of affected population/species);
- Intensity (minimal, severe and replaceable/irreplaceable);
- Probability (high/medium/low); and
- Measures to mitigate avoid or offset significant adverse impacts.

13.1 Methodology used in Determining and Ranking the Nature, Significance, Consequence, Extent, Duration and Probability of Potential Environmental Impacts and Risks

Impacts and risks have been identified based on a description of the activities to be undertaken. Once impacts have been identified, a numerical environmental significance rating process will be undertaken that utilises the probability of an event occurring and the severity of the impact as factors to determine the significance of an environmental impact.

The severity of an impact is determined by taking the spatial extent, the duration and the severity of the impacts into consideration. The probability of an impact is then determined by the frequency at which the activity takes place or is likely to take place and by how often the type of impact in question has taken place in similar circumstances.

Following the identification and significance ratings of potential impacts, mitigation and management measures will be incorporated into the Basic Assessment Report (BAR). Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below. 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

The matrix calculates the rating out of 147, whereby intensity, extent, duration and probability are each rated out of seven as indicated in Table 13-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation proposed in this report. The significance of an impact is then determined and categorised into one of seven categories, as indicated in Table 13-2, which is extracted from Table 13-1. The description of the significance ratings is discussed in Table 13-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 13-1: Impact Assessment Parameter Ratings

Rating	Intensity/ Replicability		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 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.>65 but <80% probability.

Rating	Intensity/ Replicability		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/ Replicability		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.	<u>Local</u> Local including the site and its immediat surrounding 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.

Rating	Intensity/ Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
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 extending only as far as the development site area.	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 because of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/ Replicability		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 13-2: Probability/Consequence Matrix

Probability	Significance																																					
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
Consequence	-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

Table 13-3: 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) (-)

13.2 Impact Rating

This section aims to rate the significance of the identified potential impacts pre-mitigation and post-mitigation. The potential impacts identified in this section are a result of both the environment in which the proposed project activities takes place, as well as the actual activities. The potential impacts are discussed per aspect and include the following decommissioning activities:

- Demolition of the existing conveyor belt (servitude including road culverts) currently crossing wetlands and streams; and
- Demolition of a road, pipeline and quarry.

Also rehabilitation activities with associated impacts for the Twistdraai Colliery must be undertaken:

- Rehabilitation of areas affected by mining including ripping of soil, vegetation establishment and removal of any carbonaceous material.

13.2.1 Decommissioning Phase

Soils will be impacted on by the movement of heavy machinery and vehicles required to remove conveyor belt (infrastructure located within the servitude), road and pipes. Soils will be compacted by the movement of machinery. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil.

Soil will be prone to erosion where vegetation cannot grow or has been removed. The loss of vegetation cover will exacerbate the impact as runoff potential will be increased, leading to soil erosion. Once the soil is eroded it reduces the overall soil depth and as a result the land capability reduces. Surface water flow may be altered and groundwater infiltration will be minimised in compacted areas.

There is a chance of hydrocarbons or oils spillages from vehicles or other machinery during decommissioning phases which could have an impact on soils.

13.2.1.1 Rating

The decommissioning phase potential impacts are rated in Table 13-4 and Table 13-5.

Table 13-4: Potential Impact – Compaction of Soils and Soil Erosion

Dimension	Rating	Motivation	Significance
Activity and Interaction: Decommissioning of the infrastructure			
Impact Description: The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.			
Prior to Mitigation/Management			

Dimension	Rating	Motivation	Significance
Duration	4	The impact on soil erosion and compaction will occur until the soils have been fully rehabilitated (>10 years).	Minor (negative) - 60
Extent	2	Loss of soil will only occur within project area and its surroundings.	
Intensity	4	Loss of soil resource due to erosion. Once the resource has been lost on the landscape it cannot be recovered.	
Probability	6	By moving equipment on the soil surface, soils will certainly be compacted and erosion will definitely occur.	
Nature	Negative		
Post-Mitigation			
Duration	3	With mitigation measures, impact can be reversible.	Negligible (negative) - 32
Extent	2	Loss of soil is limited only within project area and surroundings.	
Intensity	3	If mitigations are not implemented, resource cannot be recoverable.	
Probability	4	If mitigation measures are not followed it is likely that the impact will occur.	
Nature	Negative		

Table 13-5: Potential Impact – Pollution of Soils by Oil or Hydrocarbon Spillages from Vehicles

Dimension	Rating	Motivation	Significance
Activity and Interaction: Decommissioning of the infrastructure			
Impact Description: Soil chemical pollution as a result of potential oil and fuel spillages from vehicles during decommissioning. The impact will be localised within area.			
Prior to Mitigation/Management			
Duration	6	The impact on soils will take long term.	Moderate (negative) - 78
Extent	1	The impact will be localised within project area.	

Dimension	Rating	Motivation	Significance
Intensity	6	The impact on soils is significant as the wetland soils are sensitive and protected by law.	
Probability	6	Oil or fuel spillages will definitely occur during decommissioning phase.	
Nature	Negative		
Post-Mitigation			
Duration	4	The duration of the impact on soils can be reduced with proper mitigation measures.	Minor (negative) - 36
Extent	1	Impact on soils will occur within the removed infrastructure.	
Intensity	4	With proper mitigation measures the impact can be reduced to low significance.	
Probability	4	The impact on soil resources will likely occur if mitigation measures are not implemented.	
Nature	Negative		

13.2.1.2 Management Actions

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

- Runoff must be controlled and managed by use of proper stormwater management measures;
- Establishment of effective soil cover and adequate protection from wind and water;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place at regular intervals and after high rainfall events;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- All vehicles must be regularly inspected for potential hydrocarbon leaks;
- No re-fuelling is allowed on site;
- Fuel and oils spills should be remediated using commercially available emergency clean up kits. For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site; and

- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.

13.2.2 Rehabilitation Phase

With proper waste management and immediate clean up spill kits, the significance of chemical pollution on soils can be reduced and improve residual soil status. Soil ripping will alleviate compaction in surface soil layers and have little to no effect on deeper soil compaction. Successful re-vegetation of all disturbed area with indigenous vegetation species can reduce the significance of erosion and compaction to low; therefore improving soil status.

13.2.2.1 Rating

The rehabilitation phase potential impacts are rated in Table 13-6.

Table 13-6: Potential Impact – Rehabilitation of the road, pipeline and conveyor routes

Dimension	Rating	Motivation	Significance
Activity and Interaction: Rehabilitation of the disturbed areas			
Impact Description: After decommissioning, there will be less movement of heavy machinery on the soil surface leading to less soil compaction and vegetation's ability to regrow and as a result erosion will be minimised. Other excavations will be re-filled. This will eventually lead to improved soil status			
Prior to Mitigation/Management			
Duration	6	The impact will extend long after the project life span.	Minor (positive) - 72
Extent	2	The effects of reduced loss of top soil will occur within project area.	
Intensity	4	Less movement of heavy machinery on the surface will result in ability for vegetation to regrow and soil development at a moderate rate.	
Probability	6	By implementing site restoration activities, their impacts on the soil and loss of topsoil are certain.	
Nature	Positive		
Post-Mitigation			
Duration	4	These mitigation measures might have a long term effect. Effects will occur long after the project life.	Minor (positive) - 45

Dimension	Rating	Motivation	Significance
Extent	2	Loss of soil will be local and extend across the project area if mitigations are not implemented.	
Intensity	3	Loss of soil will take place if mitigations measures are not implemented.	
Probability	5	Loss of topsoil as a resource will occur if mitigations are not implemented.	
Nature	Positive		

13.2.2.2 Management Actions

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

- Effective soil cover and adequate protection from wind and water;
- Soil chemical and physical amelioration to enhance the growth capability of the soils;
- If erosion has occurred, usable soil should be sourced and replaced and shaped to reduce the recurrence of erosion;
- Only the designated access routes are to be used to reduce any unnecessary compaction;
- Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical; and
- Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.

13.2.3 Post Closure Phase

The post closure phase occurs once all the decommissioning activities have stopped. It is assumed that all activities will have ceased by the post closure phase of the project. No movement of heavy machinery, roads would be fully rehabilitated, soils will have been ripped to alleviate compaction, spillages would have been cleaned-up and re-vegetation would have taken place. Only after care and maintenance will remain post closure. There will be no further impacts on soil during the post closure phase.

14 Monitoring Requirements

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented together with ensuring effectiveness of the management measures in place. The following items should be monitored quarterly for the 1st year and bi-annually for the 2nd year to final closure:

- Soils:
  - Erosion status;
  - Compaction;
  - Runoff; and
  - Contamination.
- Vegetation:
  - Vegetation cover; and
  - Species diversity.

Table 14-1 summarises the soil monitoring requirements for Twistdraai Colliery.

Table 14-1: Soil Monitoring Requirements

Aspect	Activities	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions	Type of Requirement (Monitoring, Auditing and/or Reporting)
Flora	Soil disturbance	Establishment of alien invasive plant species	Alien invasive plant monitoring	Qualified botanist	Quarterly monitoring for two years	Monitoring
Soils	Decommissioning and Post-closure	Erosion, loss of soil fertility, compaction	The rehabilitated area must be assessed for compaction, fertility, and erosion and must meet the Chamber of Mines Guidelines	The soils must be assessed by a soil specialist yearly (during the dry season so that recommendations can be implemented before the start of the wet season) so as to correct any nutrient deficiencies.	The rehabilitated area must be assessed once a year for compaction, fertility, and erosion during the dry season	Monitoring

Aspect	Activities	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions	Type of Requirement (Monitoring, Auditing and/or Reporting)
Wetlands	All activities	All impacts and threats to wetlands, predicted or not.	Monitoring of activities through all phases to ensure all impacts are remediated as soon as possible; thus preventing and long term residual impacts to the system that compromises wetland functionality.	The closure officer of the mine should monitor the wetlands at all times as part of managing the site and the surrounding area. Independent wetland specialist should carry out monitoring on a regular basis during all phases of the mining project and provide recommended remedial actions where required.	**ECO:** Internal monitoring should be done as often as possible according to the management practices of the mine. **Independent wetland specialist:** regularly and when needed, i.e. after an incident.	Monitoring

Aspect	Activities	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions	Type of Requirement (Monitoring, Auditing and/or Reporting)
	Mine closure and post-mining environmental status	Possible post-mining water decant and potential decant	Monitor for all risks and remediate. If a greater extent of wetlands are destroyed due to decant, passive treatment of water will need to be considered along with rehabilitation and a wetland offset strategy.		**Independent wetland specialist:** Monitoring should be done annually and when needed, i.e. after an incident.	Monitoring

15 Conclusions and Recommendations

The land type data gathered suggested that the dominant land type on site were Ea17 and Ea20, characterised by vertic, melanic and red structured diagnostic horizons. Soils include swelling structured black and apedal soils. Soils are generally deeper in the valleys and crossings. The main land uses in the area are underground mining, cultivated land and veld for grazing.

The soils can be described as clay, sandy clay loam, sandy loam, silt loam and clay loam. The soil pH ranged from 5.5 to 7.5, these soils are considered to be acidic to neutral. The organic carbon content of the soils at the soil sampling locations ranged from 1% to 7%. The phosphorus concentrations encountered in the samples from the site were all very low when compared to the soil fertility guidelines, with most concentrations being >1 mg/kg and the maximum concentration being 5 mg/kg. Calcium, potassium and magnesium concentrations in the soil were generally high when compared to the soil fertility guidelines. These concentrations are adequate for crop production and these nutrients are not limiting any production on the site or considered to be toxic.

The analytical data shows that Copper, Manganese and Zinc concentrations did not exceed the National Norms and Standards for the Remediation of Contaminated Land and Soil Quality in the Republic of South Africa (GN R 37603, May 2014) promulgated in terms of NEM: WA for SSV1 and SSV2. However, S9 exceeded the Norms and Standards for SSV1.

The impact assessment from the findings of this report indicates that most of the proposed activities pose a low to moderate probability of impacting the soils and wetlands over the longer term. The potential impacts associated with the project on soils include:

- Erosion due to exposed soil surfaces;
- Compaction of soils due to movement of heavy machinery and vehicles; and
- Soil contamination through hydrocarbon or oil spillages machinery and vehicles.

The followings actions are recommended to minimise adverse effects of mining and the proposed activities on soils:

- Runoff must be controlled and managed by use of proper stormwater management measures;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place. Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place at regular intervals and after high rainfall events;
- Establishment of effective soil cover and adequate protection from wind and water;
- Soil chemical and physical amelioration to enhance the growth capability of the soils;
- Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical;

- Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated;
- Minimise unnecessary removal of the natural vegetation cover;
- All vehicles must be regularly inspected for potential hydrocarbon leaks;
- No re-fuelling is allowed on site; and
- Fuel and oils spills should be remediated using commercially available emergency clean up kits. For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site.

16 References

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Sasol Mining (Pty) Ltd. 2018. Rehabilitation Strategy and Implementation Plan (RSIP) Including Decommissioning Activities for Twistdraai Mine.

South African Sugar Association. 1999. Identification and Management of the Soils of the South African Sugar Industry. Mount Edgecombe, Durban, South Africa.

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Wet-Earth Eco-Specs cc. 2017. Block 3 Mines: Dry Season Biomonitoring Assessment Report for Sasol Mining (Pty) Ltd.

Wetland Consulting Services (Pty) Ltd. 2018. Baseline Wetland Delineation and Assessment for the Sasol Twistdraai Mine.

Appendix A: Laboratory Certificate

Agricultural Services

Portion 113, Farm Elandsfontein,
District Bapsfontein, Johannesburg, 1510J,
South Africa

intertek
Total Quality. Assured.

SOIL ANALYSIS REPORT

CERTIFICATE OF ANALYSIS

Certificate Number : AGRI 12_18-0118

Report Date : 12/12/2018

Customer :Digby Wells

				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Cmol H+/Kg Soil	%	%	%	%	Calculation	Calculation	Calculation	Calculation	Calculation (Ca+Mg+K+Na)	Calculation	Calculation (Ca+Mg+K+Na+H)	g/ml	mg/kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	Digby Wells Order No: SAS5544	
																						*	*	*	*	*	*	*	*	*	*		
Batch Seq Number	Land Ref	Stikker No	pH (KCl)	PBray1	Na	K	Ca	Mg	Exchngeable acid	%Ca	%Mg	%K	%Na	Acid Saturation	Ca:Mg	(Ca+Mg)/K	Mg:K	S-Value	Na:K	CEC	Digtheid	S	Clay	Sand	Silt	Cu (DTPA)	Fe (DTPA)	Mn (DTPA)	Zn (DTPA)	Al	C	Date Received	Date Reported
AGRI 12_18-0118-1	Sample	S1	6.28	1	123	164	3912	2609	0	46.7	51	1	1.3	0	0.9	97.5	50.9	41.9	1.3	41.9	1.078	68.71	42	38	20	4.64	50.23	13.69	0.54	19912	1.4	2018/12/11	2018/12/12
AGRI 12_18-0118-2	Sample	S2	6.86	5	471	263	5165	3029	0	48.4	46.5	1.3	3.8	0	1	75.2	36.9	53.4	3	53.4	1.11	86.44	26	50	24	5.32	70.25	14.24	0.86	20407	1.1	2018/12/11	2018/12/12
AGRI 12_18-0118-3	Sample	S3	5.75	1	265	84	4880	3816	0	42.8	54.8	0.4	2	0	0.8	259.8	146	57	5.4	57	1.043	49.14	42	32	26	5.88	64.69	31.49	1.11	18255	1.6	2018/12/11	2018/12/12
AGRI 12_18-0118-4	Sample	S5	5.69	1	115	178	4158	4074	0	37.7	60.6	0.8	0.9	0	0.6	119.2	73.5	55.1	1.1	55.1	1.095	32.89	42	35	23	7.41	61.21	36.68	0.01	18938	1.3	2018/12/11	2018/12/12
AGRI 12_18-0118-5	Sample	S6	6.41	3	72	171	3163	1237	0	59.2	38	1.6	1.2	0	1.6	59.5	23.2	26.7	0.7	26.7	1.111	26.46	18	63	19	1.99	23.3	15.2	42.98	11218	7.4	2018/12/11	2018/12/12
AGRI 12_18-0118-6	Sample	S7	5.78	3	101	265	4165	2007	0	54.2	42.9	1.8	1.1	0	1.3	54.9	24.3	38.4	0.6	38.4	1.09	32.86	34	35	31	5.98	62.5	12.82	5.28	13495	1.9	2018/12/11	2018/12/12
AGRI 12_18-0118-7	Sample	S8	6.66	2	815	151	3741	2525	0	43.2	47.8	0.9	8.2	0	0.9	102.1	53.6	43.3	9.2	43.3	1.16	83.29	34	34	32	7.75	80.98	14.08	10.08	14041	1.3	2018/12/11	2018/12/12
AGRI 12_18-0118-8	Sample	S9	7.06	2	161	107	5657	1709	0	65.4	32.4	0.6	1.6	0	2	154	51	43.3	2.5	43.3	1.106	59.43	18	68	14	3.19	33.06	5.92	4.41	13022	1.4	2018/12/11	2018/12/12
AGRI 12_18-0118-9	Sample	S10	7.17	3	101	173	7012	2832	0	59.3	39.2	0.7	0.7	0	1.5	131.8	52.5	59.2	1	59.2	0.979	50.25	26	24	50	9.08	87.38	11.11	250.39	9393	4.2	2018/12/11	2018/12/12
AGRI 12_18-0118-10	Sample	S11	6	2	350	115	4243	1568	0	59.1	35.8	0.8	4.2	0	1.7	115.5	43.6	35.9	5.2	35.9	0.941	61.67	30	43	27	6.74	88.43	15.59	195.43	13271	3.5	2018/12/11	2018/12/12

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Nelson Motlhako
Technical Signatory

Results marked as not SANAS accredited (*) in this report are not included in the SANAS Schedule of Accreditation for this laboratory. Measurement of Uncertainty values are available upon request.

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sanas
testing laboratory

T0627

Appendix B: CV

Mr Siphamandla Madikizela

Manager: Rehabilitation & Soil Services

Digby Wells Environmental

1 Education

1.1 Formal

- 2012 – 2014: MSc in Soil Science – University of KwaZulu-Natal.
- 2011 – 2011: BSc Honours in Soil Science – University of KwaZulu-Natal.
- 2008 – 2010: BSc in Hydrology and Soil Science – University of KwaZulu-Natal.

1.2 Short Courses

- Certificate of Attendance: Wild Fire Suppression – Proto team (1-2 June 2015, Bathurst, Port Alfred).
- Certificate of Attendance: Basic Labour Relations (2 September 2015, Cape Town).
- Certificate of Attendance: Conflict Management Workshop (26 October 2015, Port Elizabeth).
- Certificate of Completion: Technical Report Writing (21 & 22 November 2016, Johannesburg).
- Certificate of Completion: Assessment and Remediation Techniques for Groundwater & Contaminated Soil (25 & 26 August 2017, Johannesburg).
- Wetland Management: Introduction and Delineation – Wetland Soils (12 – 16 November 2018, Johannesburg).

2 Language Skills

- English (2nd language).
- Xhosa (1st language).

3 Employment

- November 2017 – Present: Digby Wells Environmental - Manager: Rehabilitation & Soil Services
- March 2016 – October 2017: Digby Wells Environmental - Soil Scientist.
- August 2013 – March 2016: EcoPlanet Bamboo (Pty) Ltd - Assistant Plantation Manager.

- 2010 – 2013: University of KwaZulu-Natal - Student demonstrator (2nd and 3rd year student majoring in Soil Science).
- 2012: Jeffares & Green Consulting Company - Field Assistant.

4 Experience

Siphamandla Madikizela is a Soil Scientist, completed his MSc in Soil Science at University of KwaZulu-Natal and is a Professional Natural Scientist (Registration no. 400154/17) in the Republic of South Africa. Prior to his employment at Digby Wells Environmental, Siphamandla worked as an Assistant Plantation Manager at EcoPlanet Bamboo SA. He is the part of the Closure, Rehab and Soils Department at Digby Wells Environmental. His role involves conducting soil surveys; soil, land capability and land use environmental impact assessments; soil and agricultural potential studies; soil contamination assessments; interpreting results of soil samples; soil management plans and writing detailed scientific reports in accordance to local legislation and IFC standards and World Bank Guidelines. Siphamandla has worked in projects in South Africa, Democratic Republic of the Congo, Malawi and Mali.

5 Hydrocarbon Project Experience

Client Name	Project Name	Geographical Location
Harmony Gold Mining Company Ltd	Virginia 2 Shaft Closure – Soil Contamination Assessment	Virginia, Free State, South Africa
Kongskilde South Africa (Pty) Ltd	Contamination Assessment for Kongskilde Warehouse, Boksburg	Boksburg, Johannesburg, South Africa
Mota-Engil Africa	Environmental and Social Impact Assessment for the Liwonde Dry Port Project, Malawi (Soil Contamination Assessment)	Liwonde, Malawi
Sasol Mining (Pty) Ltd	Middelbult West Shaft Waste and Closure and Brandspruit 3E Service Shaft Waste Assessment (Soil Contamination Assessment)	Middelbult, Mpumalanga, South Africa
Sibanye Stillwater	Soil Management Plan – Cooke Operations	Randfontein, Johannesburg, South Africa
Holdings Limited	Land Contamination	Middelburg, Mpumalanga,

	Assessment: Elandspruit Colliery	South Africa
Wescoal Holdings Limited	Land Contamination Assessment: Intibane Colliery	Middelburg, Mpumalanga, South Africa
Wescoal Holdings Limited	Land Contamination Assessment: Wescoal Processing Plant (Goedehoop)	Ogies, Mpumalanga, South Africa
Wescoal Holdings Limited	Land Contamination Assessment: Khanyisa Colliery	Ogies, Mpumalanga, South Africa

6 Forestry Plantation Responsibilities

- Plant management including adaptive fertiliser applications, pest management and irrigation schemes.
- Managing daily operations including the oversight of large staff teams of unskilled and semi-skilled workers, scheduling of operations and maintenance of farm equipment.
- Managing a schedule of community development activities.
- Managing weekly activities in the nursery, including staff and overseeing the arrival and transplanting of new plants.
- Tracking and recording productivity data of the general workers and prepare the weekly KPI's for the corporate office.
- Adherence to international certification standards, in particular the Forest Stewardship Council (FSC), through plantation planning and administrative work.

7 Environmental Impact Assessment Project Experience

- Scoping and Environmental Impact Reporting for Proposed Palmietkuilen Colliery near Springs – Canyon Resources (Pty) Ltd – Soil Scientist.
- Scoping and Environmental Impact for an Environmental Authorisation Application in support of the Prospecting Right Applications – Anglo American Platinum Ltd – Soil Scientist.
- Scoping and Environmental Impact for Grootvlei TSF Reclamation Project - Ergo Mining (Pty) Ltd – Soil Scientist.
- Risk Assessment and Associated Water Use License Application for the Proposed KPSX Northern Bypass, in Mpumalanga – South32 SA Coal Holdings (Pty) Limited – Soil Scientist.

- Environmental and Social Impact Assessment Update for the Sadiola Sulphides Project (2016), Mali - Société d'Exploitation des Mines d'Or de Sadiola S.A – Soil Scientist.
- Environmental Impact Assessment for the proposed infrastructure expansion at Grootegeluk Coal Mine – Exxaro Reductants (Pty) Ltd – Soil Scientist.
- Gap analysis for the Environmental Authorisation for the Rietspruit Rehabilitation Project – South32 SA Coal Holdings (Pty) Ltd – Soil Scientist.
- Reviewing of the Soils, land capability and land use Environmental Impact Assessment for Hendrina Reserve – Glencore Operations South Africa (Pty) Ltd – Soil Scientist.
- Soil and Agricultural Potential Assessment for Training Facility and Firestation Project, Gauteng – Savannah Environmental (Pty) Ltd – Project Manager and Soil Scientist.
- Agricultural Potential Study, Gumu, Kibali, DRC – Randgold Resources – Project Manager and Soil Scientist.
- Basic Assessment for proposed Borrow Pits near Lephalale – Ledjadja Coal (Pty) Ltd – Soil Scientist.
- Klipspruit Environmental Management Programme Consolidation – South 32 SA Coal Holdings (Pty) Ltd – Soil Scientist.
- Extension on Farm Middelbult for the Universal Kangala Coal Mine – Universal Kangala Coal Mine – Soil Scientist.
- Soil, Land Capability and Land Use Assessment for Vaalkop Area, Mpumalanga – Sasol Mining (Pty) Ltd – Soil Scientist.
- Environmental and Social Impact Assessment for Bougouni Lithium Project, Mali – Birimian Gold Limited – Soil Scientist.
- Soil and Land Capability Environmental Impact Assessment for Muhlava Iron Ore, Tzaneen, Limpopo – Project Manager and Soil Scientist.
- Soils, Land Capability and Land Use Assessment Report for proposed Future Developments within the Sun City Complex – Soil Scientist.
- Soil Management Plan for Sibanye Still Water – Cooke Operations – Soil Scientist.
- Soil and Land Capability Assessment Report for the Proposed Active Water Treatment Plant at the Klipspruit Colliery – Soil Scientist.
- Soils and Land Capability Assessment Report for the Proposed Expansion of the Nomalanga Estate – Soil Scientist.
- Mining Pond E Water Seepage – Soil and Water Impact Assessment - Richards Bay Mining (Pty) Ltd – Project Manager and Soil Scientist.

- Assessment of the Soils and Agricultural Potential for Sasol Mooikraal Colliery, Free State - Sasol Mining (Pty) Ltd – Project Manager and Soil Scientist.
- Soils and Land Capability Assessment Report for the Proposed River Diversion and Flood Protection Berms - Sasol Mining (Pty) Ltd – Soil Scientist.
- Soils and Land Capability Assessment Report for the Amendment and Consolidation of the Mooikraal Colliery Environmental Management Programme - Sasol Mining (Pty) Ltd – Soil Scientist.
- Soils and Land Capability Assessment for the Decommissioning of a Conveyor Belt and Road at Twistdraai East Colliery, Secunda, Mpumalanga Province - Sasol Mining (Pty) Ltd – Soil Scientist.
- Soils and Land Capability Impact Assessment for Malingunde Graphite Project, Lilongwe, Malawi - Sovereign Metals Limited – Project Manager and Soil Scientist.
- Soils and Land Capability Impact Assessment Report for the Massawa Gold Project, Senegal - Randgold Resources Limited – Soil Scientist

8 Closure and Rehabilitation Project Experience

- Rehabilitation Guidelines for Sedibelo West, 2016 – Sedibelo Platinum Mines Limited – Rehabilitation Specialists.
- Metalloys Slag Cap and Closure 2018 Assessment – South32 – Samancor Manganese – Project Manager.
- Constructed Landfill Site for the Sierra Rutile Limited Mining Operation, Southern Province, Sierra Leone – Rehabilitation and Closure Specialist.
- Rehabilitation Strategy and Implementation Plan for Welgemeend Colliery – Mbuyelo Coal (Pty) Ltd – Project Manager and Rehabilitation Specialist.
- Financial Provision for the Ten PPC Operations, 2017 - Pretoria Portland Cement Limited (PPC).
- Financial Provision Assessment for the PPC Operations - 2018/2019 Update - Pretoria Portland Cement Limited (PPC).
- Review and Audit of Rehabilitation at Sedibelo West, 2016 - Sedibelo Platinum Mines Limited.
- Rehabilitation Audit of Sedibelo West, 2017 - Sedibelo Platinum Mines Limited.
- Rehabilitation Audit of Sedibelo West, 2018 - Sedibelo Platinum Mines Limited.

9 Research

- The Use of Hydrogel Application at Planting for *Bambusa Balcooa* Species at different rates – EcoPlanet Bamboo southern Africa – Assistant Plantation Manger.
- The Effect of Herbicide Application on *Bambusa Balcooa* – EcoPlanet Bamboo southern Africa – Assistant Plantation Manager.
- The Effect of Plastic Mulch on Growth and Yield on *Bambusa Balcooa* - EcoPlanet Bamboo southern Africa – Assistant Plantation Manager.
- Effect of Nitro-S fertilizer on growth and yield of *Bambusa Balcooa* and *Oxytenanthera Abyssinica*.

10 Professional Affiliations

- Soil Science Society of South Africa (SSSA).

11 Professional Registration

- 2017: Registered as a Professional Natural Scientist with The South African Council for Natural Scientific Professions. Registration number: 400154/17.