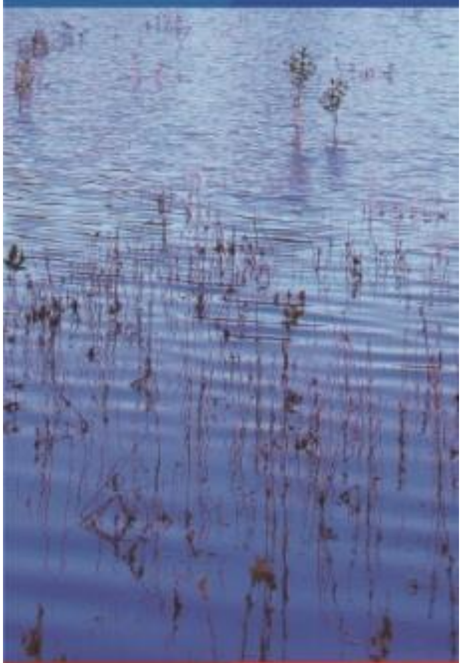

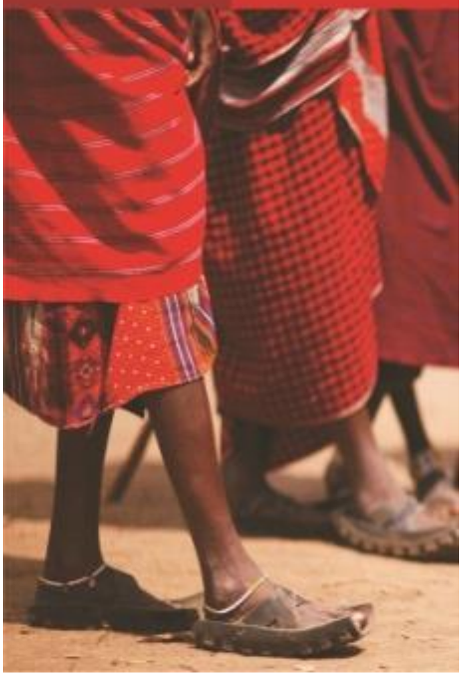

DIGBY WELLS
ENVIRONMENTAL

# Sasol Sigma Defunct Colliery Surface Mitigation Project: Proposed River Diversion and Flood Protection Berms

# Soils and Land Capability Assessment Report

**Project Number:**

SAS5250

**Prepared for:**

Sasol Mining (Pty) Ltd

September 2018

Digby Wells and Associates (South Africa) (Pty) Ltd
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This document has been prepared by Digby Wells Environmental.

| | |
|---|---|
| **Report Type:** | **Soils and Land Capability Assessment Report** |
| **Project Name:** | **Sasol Sigma Defunct Colliery Surface Mitigation Project: Proposed River Diversion and Flood Protection Berms** |
| **Project Code:** | **SAS5250** |

| **Name** | **Responsibility** | **Signature** | **Date** |
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# 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 this study, have presented the results and conclusion within the associated document to the best if my professional judgement.

| | |
|---|---|
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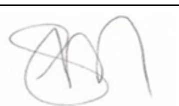
| **Signature:** |  |

# EXECUTIVE SUMMARY

## Introduction

Digby Wells Environmental (hereafter Digby Wells) was appointed by Sasol Mining (Pty) Ltd (Sasol Mining) as the Independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process required to implement the proposed surface mitigation measures at the Sasol Sigma Defunct Colliery (proposed project).

Sigma Defunct Colliery applied for mine closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan and Environmental Management Programme (EMP) to address all the significant risks and implement rehabilitation (remediation) measures which were required to obtain the needed closure certificate. As part of the risk report, mitigation measures have been proposed and grouped together as underground mitigation measures (ash backfilling) and surface mitigation measures (river diversions and berm constructions). The Surface Mitigation Measures proposed in the Risk Assessment Report, Jones and Wagener (J&W), 2018 requires environmental authorisation. Two rivers flow through the Sigma mining area namely the Rietspruit and the Leeuspruit.

To identify the soils accurately on site, it is necessary to undertake a soil survey. The aim is to provide an accurate record of the soil resources of the proposed river diversions and flood protections berms. Land capability, land use and agricultural potential are then determined from these results. This report presents the findings of a specialist soils and land capability assessment and the relevant project components include the following:

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

## Methodology

As part of the desktop assessment, baseline soil information was obtained from the South African land type data published with maps at a scale of 1:250 000 by the Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC). A free survey method was used where it starts with a detailed physiographic aerial imagery interpretation and the surveyor walks most of the landscape, usually in traverses “across the grain”, concentrating on the proposed infrastructure areas. The surveyor chooses sample points to systematically confirm a mental model of the soil-landscape relationships, draw boundaries and determine map unit composition.

Soils were investigated by augering to a maximum depth 1.2m 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 capability was determined by assessing a combination of soil, terrain and climate features. Land use was determined by aerial imagery, ground-truthed during the site visit.

The soils and land capability report discusses the approach and findings of a desktop and field survey carried out in 23rd and 24th of July 2018 on the study area. The following legislation was considered during the assessment:

- The National Environmental Management Act, 1998 (Act No.107 of 1998), NEMA; and
- The Conservation of Agricultural Resources Act, 1993 (Act No. 43 of 1993).

## Findings

The land type data indicated that the main land types were Ba23 and Dc7, all dominated by poorly drained soils. The soils are dominated by Avalon (yellow-brown) forms and (black and greyish) Rensburg forms.

The dominant land capabilities based on the soils, texture and fertility status found on the project area was grazing (yellow brown soils) and wetland (black and greyish soils). Yellow brown soils are known to have a high susceptibility to water or wind erosion, very slow permeability of the subsoil, low water-holding capacity and moderate salinity or sodicity.

Wetland capability represents the Rensburg soils. Although these soils are deeper, they have high expansible clay content and are physically difficult to manage.

The soil pH ranged from 4.5 to 6.5 and these soils are acidic to slightly acidic. Lime is required to counteract acidity, should agricultural activities take place. Calcium, potassium and magnesium levels in the soil were generally high and adequate for crop production or rehabilitation (grassing) and these nutrients are not limiting any production on the site or not considered as toxic. The sodium levels ranged from 50 to 1500 mg/kg and soils with sodium levels below 200mg/kg are considered not to be sodic (Sample 168, 203, 229 subsoils and 236 topsoil). These sodium levels are acceptable and are not of concern on the site.

Samples 165, 182, 224, 229 topsoil’s, 236 subsoil and 246 had higher sodium levels when compared with soil fertility guidelines and therefore classified as strongly sodic due to higher levels of sodium. Where high sodium values and sometimes also magnesium values are encountered, soil dispersion occurs, leading to a dense structure and drainage problems. The soils can be described as clay, sandy clay loam, loam, clay loam and loamy sand. 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.

## Impact Assessment

The risk assessment for the project indicates that most of the proposed activities pose a high risk of impacting the soils and wetlands over the longer term without mitigation measures being implemented. Based on the findings of this assessment and the proposed mitigation measures, the anticipated impacts of the project can be reduced to a moderate to minor level of significance through implementation of the proposed integrated mitigation and management measures.

## Recommendations

The followings actions are recommended to minimise adverse effects of mining on soils:

- Berms should be monitored for erosion monthly for the 1st year, quarterly for the 2nd year, and bi-annually for the 3rd year until sustainability is confirmed;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily;
- Slow release outlet pipes installed within the berm should be monitored to ensure that no blockages occur;
- Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil;
- Wetlands should be monitored monthly during construction;
- Topsoil of 0.3 m of the soil profile should be stripped first and stockpiled separately;
- The subsoil of 0.4 – 1.2 m will then be stripped and stockpiled separately and replace on berms in same sequence;
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to the Rehabilitation Plan); and
- Surface inspection on the fully rehabilitated flood protection berm and diverted 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.

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# 1 Introduction

Sasol Mining's Sigma Defunct Colliery (Sigma Defunct Colliery) occupies a mining area of approximately 11 643ha. Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR).

Sigma Defunct Colliery applied for mine closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan and Environmental Management Programme (EMP) to address all the significant risks and rehabilitation measures which were required to obtain the needed closure certificate. Jones and Wagener (J&W) were appointed to assist Sasol Mining in the compilation of a Risk Assessment Report for mine closure process to identify all the significant latent risks which Sigma Defunct Colliery have and rate them in accordance with the Sasol Risk Assessment Methodology. This report further proposed mitigation measures to be implemented to reduce the significant rated risks to an acceptable residue risk level. The report was compiled in 2015 and has now been updated in 2018.

As part of the risk report, mitigation measures have been proposed and grouped together as underground mitigation measures (ash backfilling) and surface mitigation measures (river diversions and berm constructions). The surface mitigation measures proposed in the Risk Assessment Report requires environmental authorisation. Two rivers flow through the Sigma mining area namely the Rietspruit and the Leeuspruit. Beneath the river courses or floodplains a potential for pillar failure exists which can result in subsidence and therefore various mitigation measures have been proposed to reduce the significant risks to these areas.

Digby Wells Environmental (hereafter Digby Wells) was appointed by Sasol Mining as the Independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process required to implement the proposed surface mitigation measures at the Sasol Sigma Defunct Colliery.

The aim of a soil survey is to provide an accurate record of the soil resources of an area. Land capability and land potential is then determined from these results. Therefore, soil mapping is essential to determine the types of soils present, their depths, their land capability and land potential. These results will then be used to give practical recommendations on preserving and managing the soil resources considering the proposed actions at Sigma Defunct Colliery. This report presents the findings of a specialist soils and land capability assessment that forms part of the Basic Assessment Process.

## 1.1 Project Background

Sigma Defunct Colliery commenced operations in 1952 with underground mining, holding mineral rights to several coal deposits in the Sasolburg district. Underground mining methods was the primary method of extracting these reserves and included mechanised board-and-pillar, rib pillar extraction and bottom coaling methods. Access to the underground operations was via several shafts, and the coal was conveyed to a 'dry' coal handling plant at 3 Shaft Complex where the coal was screened and fed to silos.

In 1992 the Wonderwater opencast mine was developed to extract coal from the north-eastern side of the reserves which occupied a mining area of approximately 385ha. The Wonderwater opencast mine was mined utilising truck and shovel methods. Mining ceased in 2005 after which the opencast mine was backfilled and rehabilitated. The final voids were left as part of the water management of the underground workings.

The Mohlolo Operations (underground mining method), situated adjacent to the Wonderwater opencast mine commenced with its activities in 1999 and occupied a mining area or approximately 264ha. The underground operations were accessed from the Wonderwater opencast mines highwalls in the north and the south which divided the operations into Moholo North and Mohlolo South. The underground mining was scaled down and ceased by 2006, the underground mine workings were left to be flooded.

According to the J&W Design Report, 2018 a total of 37 potentially significant risks (associated with underground mined panels where a high potential of pillar failure has been identified) were identified of which 36 are located within the Leeuspruit and only one within the Rietspruit. J&W's Design Report, 2018 sub-divided the Leeuspruit into four sections numbered in the direction of stream flow (from south to north).

The surface mitigation measures that were considered include full stream diversions, partial stream diversion and ash backfilling of mined panels or various combinations thereof. A description of the various diversion types is provided below:

- Full stream diversion:
  - Typically consists of a diversion canal which follows along a completely new alignment from the original stream alignment. The stream flow is diverted along the new route and discharges back into the existing stream downstream of the affected area. A diversion canal mitigates the risk by moving the stream away from the significant risk area.
- Partial stream diversion:
  - A partial stream diversion entails confining the stream flow by means of either channelling the stream or flood protection berms or both in order for it not to cross areas where a high chance of pillar failure which will result in subsidence could occur. The purpose of flood protection berms is to prevent the existing stream flow from entering significant risk areas. Where possible, flood protection berms are used in isolation, however if the position of a berm obstructs the natural stream flow (i.e. crossing existing watercourse centreline), flood protection berms are used in combination with channelling the stream. This prevents unnecessary secondary issues, for example backwater or ponding upstream of the berm, and allows unimpeded flow of the stream past the problem areas.

- Backfilling:
  - Ash backfilling is predominantly used where a full stream diversion or partial stream diversion alone does not mitigate the risk or where a diversion canal cannot avoid crossing over a significant risk area. In the case where a full diversion or partial diversion is not possible, only backfilling is proposed.
  - It must be noted that although mentioned, ash backfilling is being dealt with as a separate project and is not considered to be incorporated as part of this environmental authorisation process.

## 1.2 Project Locality

The Sigma Defunct Colliery is situated west to the town of Sasolburg in the Free-State Province of South Africa (Figure 1-1). It comprises of the main Sigma Underground Colliery, the Wonderwater strip mine and the Mohlolo Underground Colliery.

## 1.3 Infrastructure

The key infrastructure associated with the project includes various diversion canals and flood protection berms to channel the Leeuspruit and Rietspruit past high significant risk areas identified through the Technical Risk Assessment (J&W, 2018) (Figure 1-2). Further details associated with the specific infrastructure and mitigation actions are provided in the Section 2.

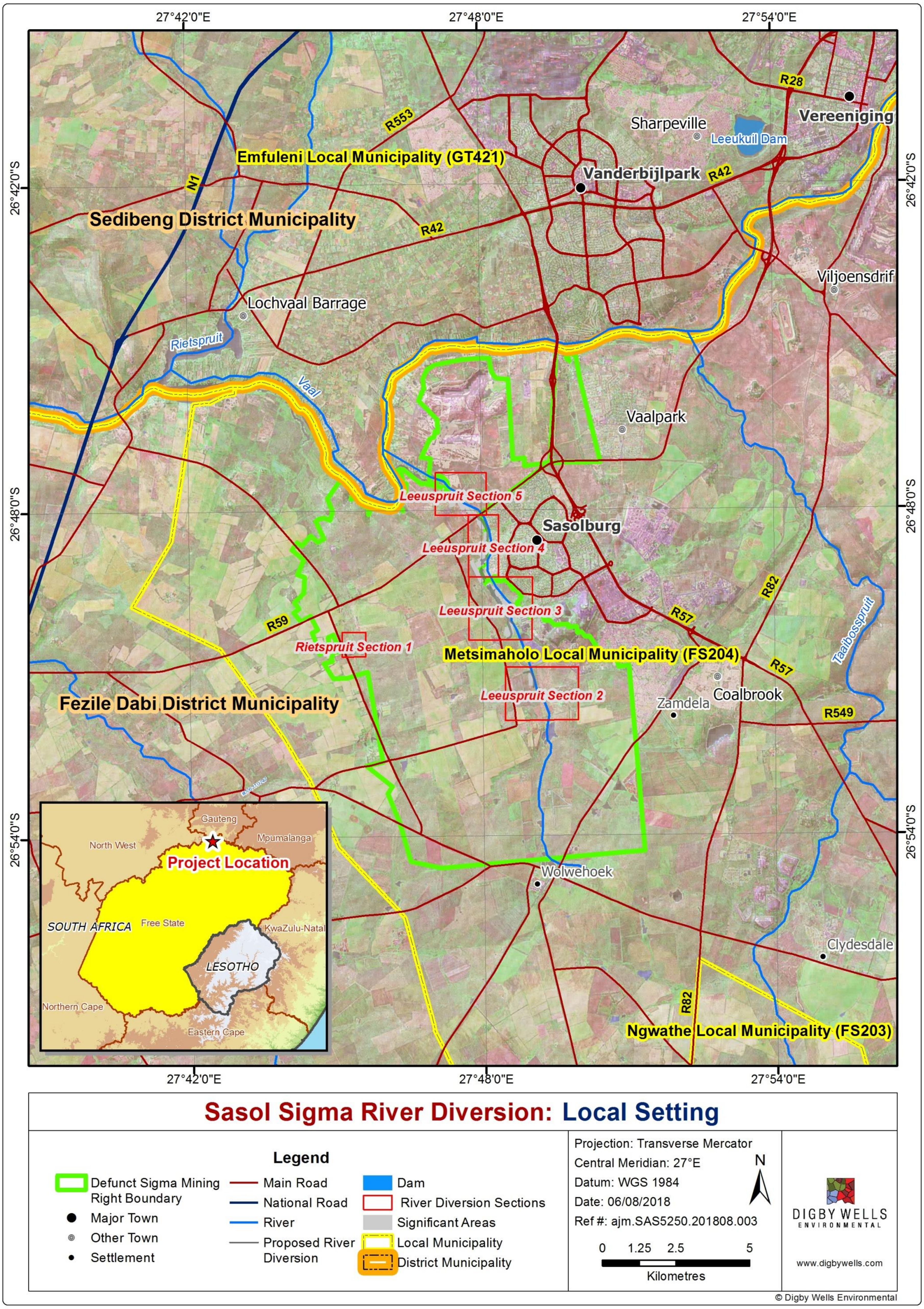


**Figure 1-1: Local setting at Sasol Defunct Colliery**

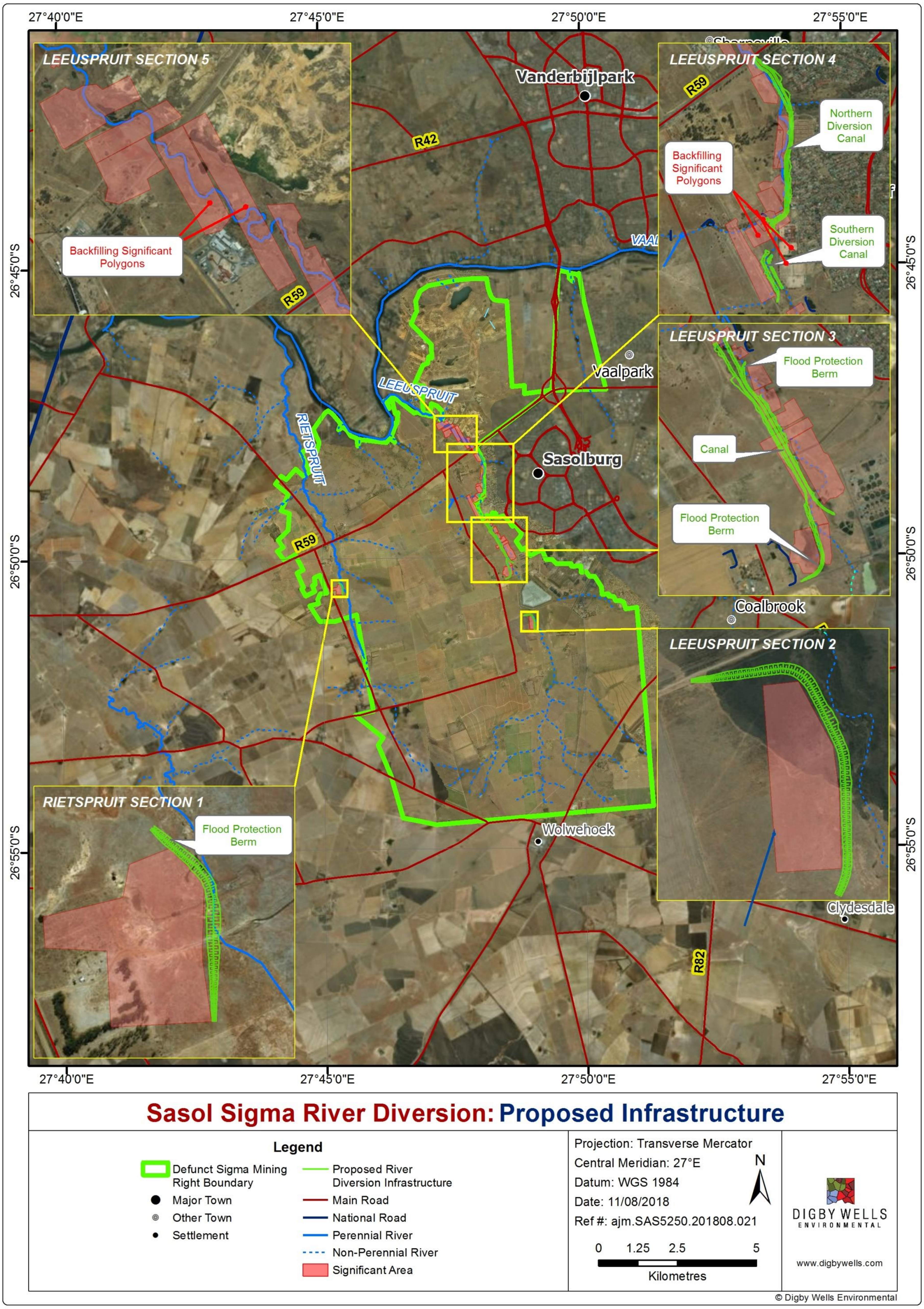


**Figure 1-2: Proposed infrastructure at Sasol Defunct Colliery**

# 2 Project Activities

The potential impacts/ risks identified in this section are a result of both the environment in which the project activities take place, as well as the actual activities. The potential impacts/ risks are discussed per aspect, river section and each phase of the project i.e. the Construction Phase. No Decommissioning Phase will be undertaken for this project. The reason for this is that once surface mitigation measures have been implemented these changes are permanent. The activities for the proposed river diversion project that will be assessed are listed in Table 2-1.

## Table 2-1: Listed project activities

| Significant Risk Area | Phase | Project Activity |
|---|---|---|
| Leeuspruit Section 2- 5 and Rietspruit Section 1 | General Construction Activities | ▪ Contractor Camp / Laydown Area Establishment;<br>▪ Site clearing, including the removal of topsoil and vegetation;<br>▪ Excavation of soils from water course;<br>▪ Stockpiling of soil once excavated;<br>▪ Construction activities within a water courses and wetlands (Heavy vehicles and excavators);<br>▪ Temporary storage of hazardous products, including fuel;<br>▪ Storage of waste; and<br>▪ Utilise existing roads to access the various river sections. |
| Leeuspruit Section 2 | Construction Phase | ▪ Construction of flood protection berm; and<br>▪ Vegetation of flood protection berm. |
| Leeuspruit Section 3 | Construction Phase | ▪ Construction of flood protection berm;<br>▪ Vegetation of flood protection berm; and<br>▪ Construction of formalised canal. |
| Leeuspruit Section 4 | Construction Phase | ▪ Construction of flood protection berm;<br>▪ Vegetation of flood protection berm; and<br>▪ Construction of formalised canal. |
| Leeuspruit Section 5 | Construction Phase | ▪ Ash backfilling has been assessed as a separate environmental authorisation project. Mitigation measures proposed from this project will be implemented in this section |
| Rietspruit: Section 1 | Construction Phase | ▪ Construction of flood protection berm; and<br>▪ Vegetation of flood protection berm. |
| Leeuspruit Section 2- 5 and Rietspruit Section 1 | Operational Phase | ▪ Revegetate area to ensure erosion does not occur;<br>▪ Maintenance and monitoring activities; |

| Significant Risk Area | Phase | Project Activity |
|---|---|---|
| | | ▪ Removal of all machinery and equipment utilised during construction phase;<br>▪ Rehabilitate areas affected by laydown area and machinery; and<br>▪ Removal of waste. |

## 2.1 Surface Mitigation Measures

A description of the surface mitigation measures associated with the four sections along the Leeuspruit and one section along the Rietspruit is provided in Table 2-2.

**Table 2-2: Surface mitigation measures**

| Significant Risk Area | Mitigation Measure Implemented | Description |
|---|---|---|
| Leeuspruit: Section 2 | ▪ Flood protection berm to be constructed to avoid one area of significant risk. | ▪ The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations. |
| Leeuspruit: Section 3 | ▪ Combination of diversion canals, flood protection berms and ash backfilling. | ▪ The proposed design comprises of two flood protection berms to direct the flow of water away from significant areas;<br>▪ A formalised canal to divert the stream flow away from the natural stream flow path (Armorflex or a similar approved lining); and<br>▪ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process. |
| Leeuspruit: Section 4 | ▪ Two Full stream diversion canals are proposed, namely the Southern diversion canal and Northern diversion canal;<br>▪ Flood protection berms will also be utilised; and<br>▪ Ash Backfilling will also be utilised. | ▪ This section is located immediately west of the Sasolburg residential area and comprises approximately 2.3km of the Leeuspruit, from the Afrikaans High Sasolburg up to the R59 provincial road; and<br>▪ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process. |

| Significant Risk Area | Mitigation Measure Implemented | Description |
|---|---|---|
| Leeuspruit: Section 5 | ■ This section's design comprises mainly of backfilling polygons due to surface restrictions on either side of the stream. | ■ Located on the south-western side of the area is private infrastructure and northeast is an operational sand mine; and<br>■ Some of these areas have already been backfilled. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process. |
| Rietspruit: Section 1 | ■ Only one significant risk area has been identified; and<br>■ A flood protection berm is proposed. | ■ Small diameter pipes will also be installed at low points along the berm to allow the slow release of water accumulated behind the berms. |

# 3 Details of the Specialist

The following is a list of Digby Wells' staff who was involved in the compilation and review of the soils and land capability report for Sasol Defunct 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. 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. (Full CV available in Appendix A)

**Leon Ellis**; is the Divisional Manager of the Mine Closure and Rehabilitation Division at Digby Wells. Leon completed his BSc. (Hons) in Geography and Environmental Management at the University of Johannesburg (UJ) in 2009. He joined Digby Wells in January 2013. When Leon joined Digby Wells, he was part of the Environmental Management Services (EMS) Department and since joined the Mine Closure Unit. He has eight years' experience in the environmental services sector with specialised focus on Environmental Liability Assessments, Mine Closure Plans, Performance Assessments and Risk Assessments, locally and internationally. He has also been involved in the undertaking of Environmental Impact Assessments (EIAs) and Environmental Management Programmes (EMPs). Leon also completed the Environmental Risk Assessment and Management course based on ISO 31000 at the Centre of Environmental Management (North West University) in 2016.

**Danie Otto**; is the Technical Director at Digby Wells. Danie holds an MSc in Environmental Management (Phytoremediation) with BSc Hons (Limnology, Geomorphology, GIS and Environmental Management) and BSc (Botany and Geography & Environmental Management). He is a bio-geomorphologist that specialises in ecology of wetlands and rehabilitation. He has been a registered Professional Natural Scientist since 2002. Danie has 20 years of experience in the mining industry in environmental and specialist assessments, management plans, audits, rehabilitation, and research.

# 4 Scope and Purpose of this Report

The following tasks were undertaken as part of the soils and land capability assessment:

- Review of all the existing information conducted by J&W, Rehabilitation Design & Construction Services (Pty) Ltd and Enviropulse CC;
- Soil survey: the soils occupying the project area were surveyed during a site visit. 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;
- Land use/cover: present land use/cover was mapped in conjunction with the soil survey which included the following information:
    - Evidence of land misuse with special reference to susceptible soils to erosion and compaction; and
    - Current land uses/covers associated with the respective project components.
- Description of soils in terms of soil fertility: 16 soil samples were collected at the proposed infrastructure areas (river diversions and flood protection berms);
- Identification and assessment of potential impacts on soils resulting from the project using the prescribed impact rating methodology; and
- Mitigation measures were recommended to minimise impacts associated with the project.

# 5 Environmental Law Applicable to Study

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

- Soils and land capability are protected under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). 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). The CARA requires that protection of land against soil erosion, the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained.

# 6 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 in July 2018 and information reviewed from previous studies;
- A total of sixteen (16) soil samples were collected at the proposed infrastructure areas; and
- The area surveyed is based on the preliminary layout presented by Sasol Defunct Colliery.

# 7 Methodology

This section provides the methodology used in the compilation of the soils report. To complete the proposed scope of work, there were several tasks which needed to be completed and these tasks are explained separately below.

## 7.1 Desktop Assessment and Literature Review

### 7.1.1 Desktop Assessment

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the Sasol Defunct Colliery. 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). These maps and their accompanying reports provide a statistical estimate of the different soils that can be expected in the area.

### 7.1.2 Literature Review

Digby Wells conducted a desktop review of the baseline data and findings related to the soil surveys and other relevant existing documentation. The following sources of information were reviewed and utilised for the compilation of this report:

- Sasol – Wonderwater Rehabilitation Plan. March 2010. Rehabilitation Design & Construction Services (Pty) Ltd;
- Sasol Wonderwater Mine – Rehabilitation Assessment (Soils, Infrastructure and Vegetation). April 2013. Enviropulse CC;
- Sasol Mining – Sigma Defunct Mine Closure Leeuspruit and Rietspruit Ingress Mitigations Feasibility Design Report. April 2018. J&W; and
- Sasol Sigma – Regional Wetland Assessment. June 2018. Wetland Consulting Services (Pty) Ltd.

## 7.2 Soil Classification

An assessment of the soils present at the proposed diversions and flood protection berm areas was conducted during a field visit on the 23rd and 24th of July 2018. The site was traversed on foot and a hand soil auger was used to determine the soil type and depth. Soils were investigated using a bucket auger to a maximum depth of 1.2m 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 identified using the South African Soil Classification System (Soil Classification Working Group, 1991).

## 7.3 Soil Sampling and Analysis

A total of sixteen (16) soil samples (topsoil and sub soil) were collected from the various proposed diversion and flood protection berm areas as shown in Figure 7-1. The soil samples were stored in plastic bags and sent to a certified laboratory for analysis. The topsoil (0 – 0.3m) and the subsoil (0.3 – 0.8m) analyses included the following:

- Soil pH;
- Exchangeable cations (Ca, Mg, K and Na) (Ammonium acetate extraction);
- Phosphorus (Bray No.1 extractant);
- Soil Organic carbon; and
- Soil Texture (Clay, Sand and Silt).

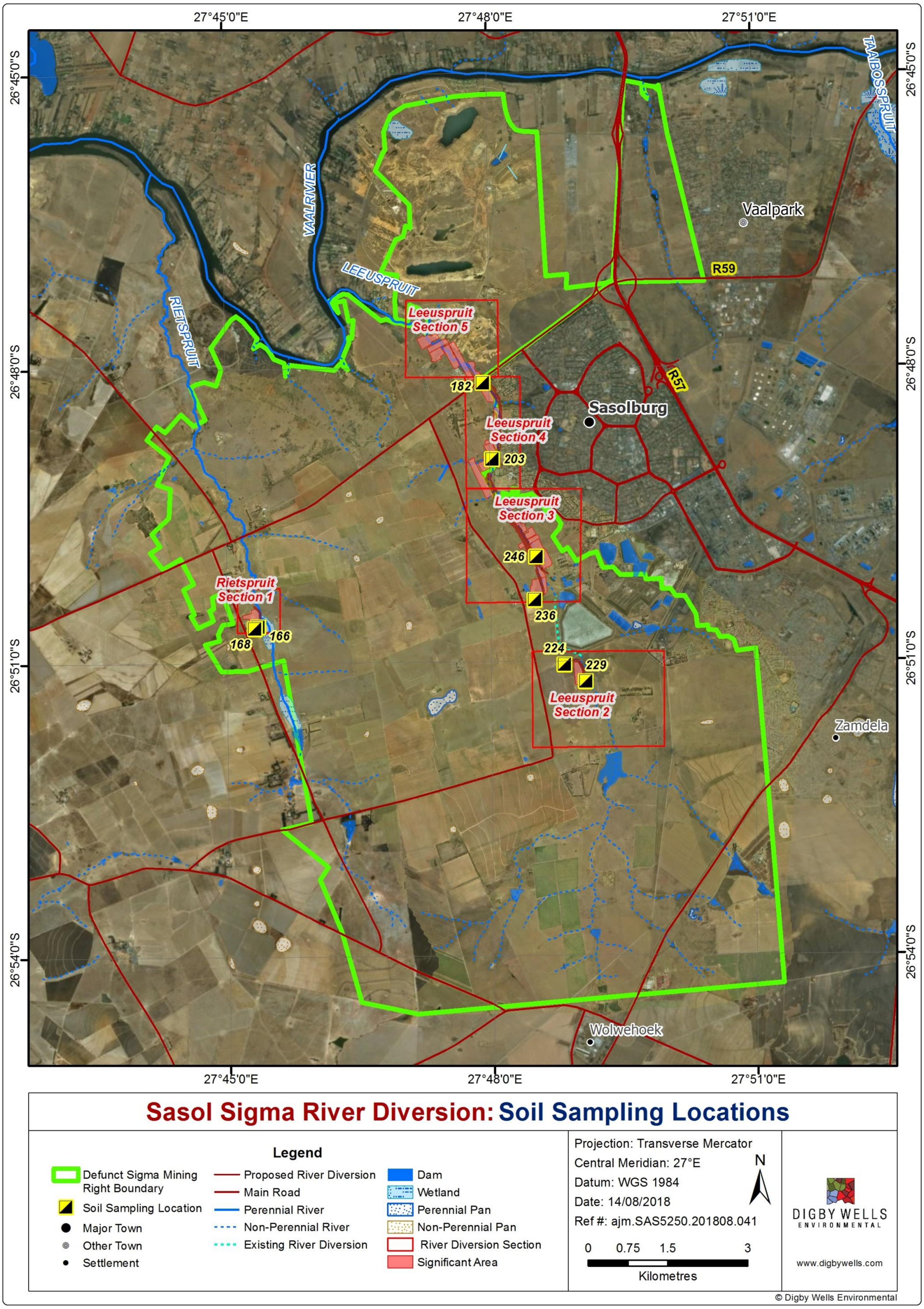


**Figure 7-1: Soil sampling locations at Sasol Defunct Colliery**

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, sandy clay loam, etc. 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.

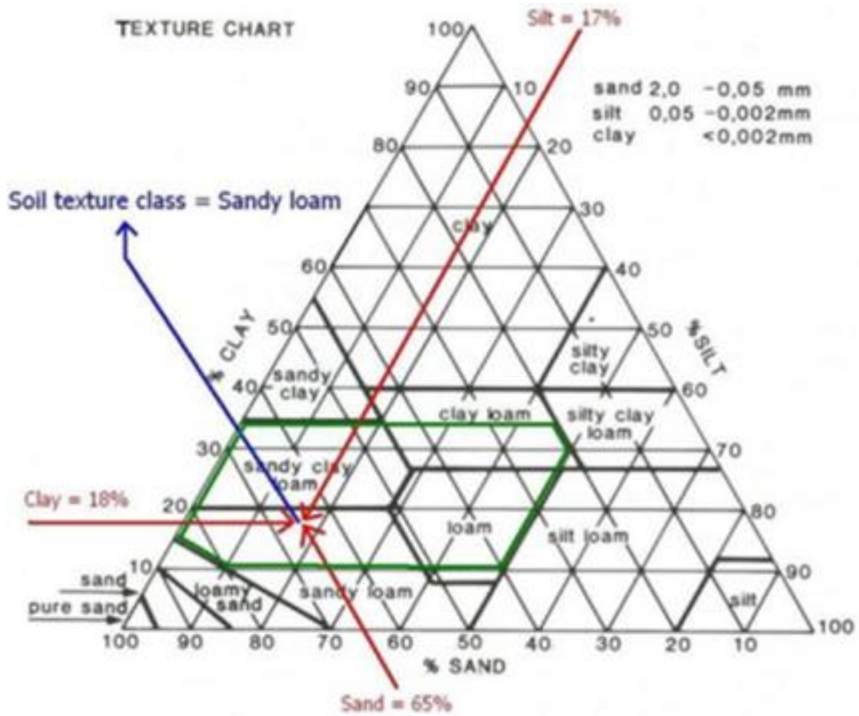


**Figure 7-2: Soil textural triangle (SASA, 1999)**

## 7.4 Land Use

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

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

# 8 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 gathered suggested that the project area was dominated by land types Bb23 and Dc7 (Figure 8-1). Further information related to the soil within the project area is discussed in Section 8.1

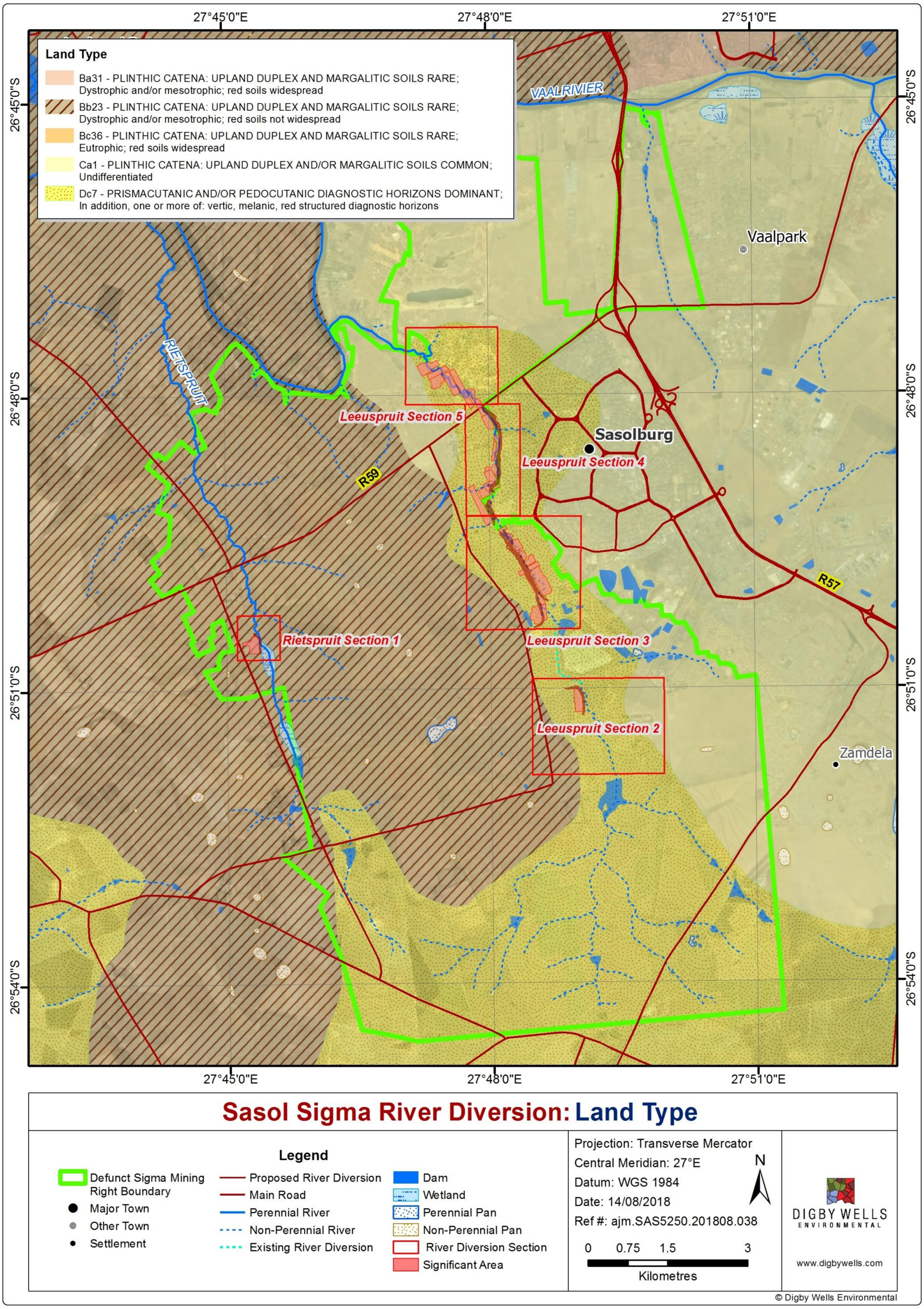


**Figure 8-1: Land type at Sasol Defunct Colliery**

## 8.1 Land Type and Soil Forms

Table 8-1 shows dominant land type and soil forms found on the site with visual representation depicted in Figure 8-2 and Figure 8-3.

**Table 8-1: Dominant land type and soils**

| Land Type | Description |
|---|---|
| Bb23 | Unit Bb (dystrophic and/or mesotrophic, red soils not widespread) accommodate land where valley bottom is occupied by Rensburg and Arcadia soil forms. |
| Dc7 | Unit Dc accommodate land where duplex soils are dominant. Also, the land type is made up of soils that have one or more of the following diagnostic horizons: vertic, melanic & red structured. |

### 8.1.1 Rensburg Form

The Rensburg soil form is characterised by dark brown/black Vertic topsoil over a G-horizon. Rensburg soil forms are high in clay and have a sticky texture. These soils develop surface cracks and crusts in the dry state due to swelling pressures caused by water uptake. The G horizon is permanently wet, has still retained some clay and iron oxides or mottling and has a grey or gleyic colour pattern. Vertic soils are difficult to work with for crop production due to their shrink and swelling properties. However, success has been ascribed for the cotton plant as its rooting system can withstand shrinking and swelling movement in the soil.

### 8.1.2 Avalon Form

The Avalon Soil form consists of Orthic topsoil, on a yellow-brown apedal B, over a soft plinthic B horizon. Avalon soils are freely draining and chemically active. Manganese and iron oxides accumulate under conditions of a fluctuating water table forming localised mottles or soft iron concretions of the soft plinthic B horizon. Mottling in the samples found within the study area was yellow-brown in colour and occupied at least 10% of the horizon. Avalon soils are highly suitable for crop production, particularly for growing maize. Fey *et al*. (2010) explains that this is due to the freely draining nature of the soil and soft plinthic B horizon which traps water and makes it available for root uptake.

**Figure 8-2: Vertic soils found at Rietspruit (Section 1) and Leeuspruit (Section 2, 3 and 4)**

**Figure 8-3: Yellow brown soils at Rietspruit (Section 1) and Leeuspruit (Section 3)**

## 8.2 Land Capability

The approach used for the land capability assessment is used in agriculture and is recommended by Schoeman *et al* (2000) who defined land capability in terms of the combined effects of soil, terrain and climatic features. The defined land capability shows the most intensive long-term use of land for rain-fed agriculture and at the same time indicates the permanent limitations associated with different land use classes. The classification system is made up of land capability classes and land capability groups.

Land capability was determined by assessing a combination of soil, terrain and climate features. The dominant land capabilities based on the soils, texture and fertility status found at the project area was grazing (yellow brown soils) and wetland (black and greyish soils) (Table 8-2). Grazing land capability has severe limitations that restrict the choice of plants, require very careful management or both. It may be used for cultivated areas, but more careful management is required and conservation practices are more difficult to apply and maintain. Wetland land capability has soils that are deeper; they have high clay content and shrink/swell properties, making them very difficult to manage from an agricultural perspective. Limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops.

**Table 8-2: Land capability classification**

| Land Type | Land Capability Class | Agricultural Potential |
|---|---|---|
| Bb23 | Grazing | *Low to moderate |
| Dc7 | Wetland | *Low |

*Potential rated low in a wetland context but can be high with suitable management.

## 8.3 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 underground mining and veld for grazing (Figure 8-4). The sampling points (166, 168, 182, 203, 224, 229, 236 and 246) were covered by grass and no current agriculture was taking place at the locations, however agricultural activities are taking place at other locations within the Sigma Defunct Colliery area.

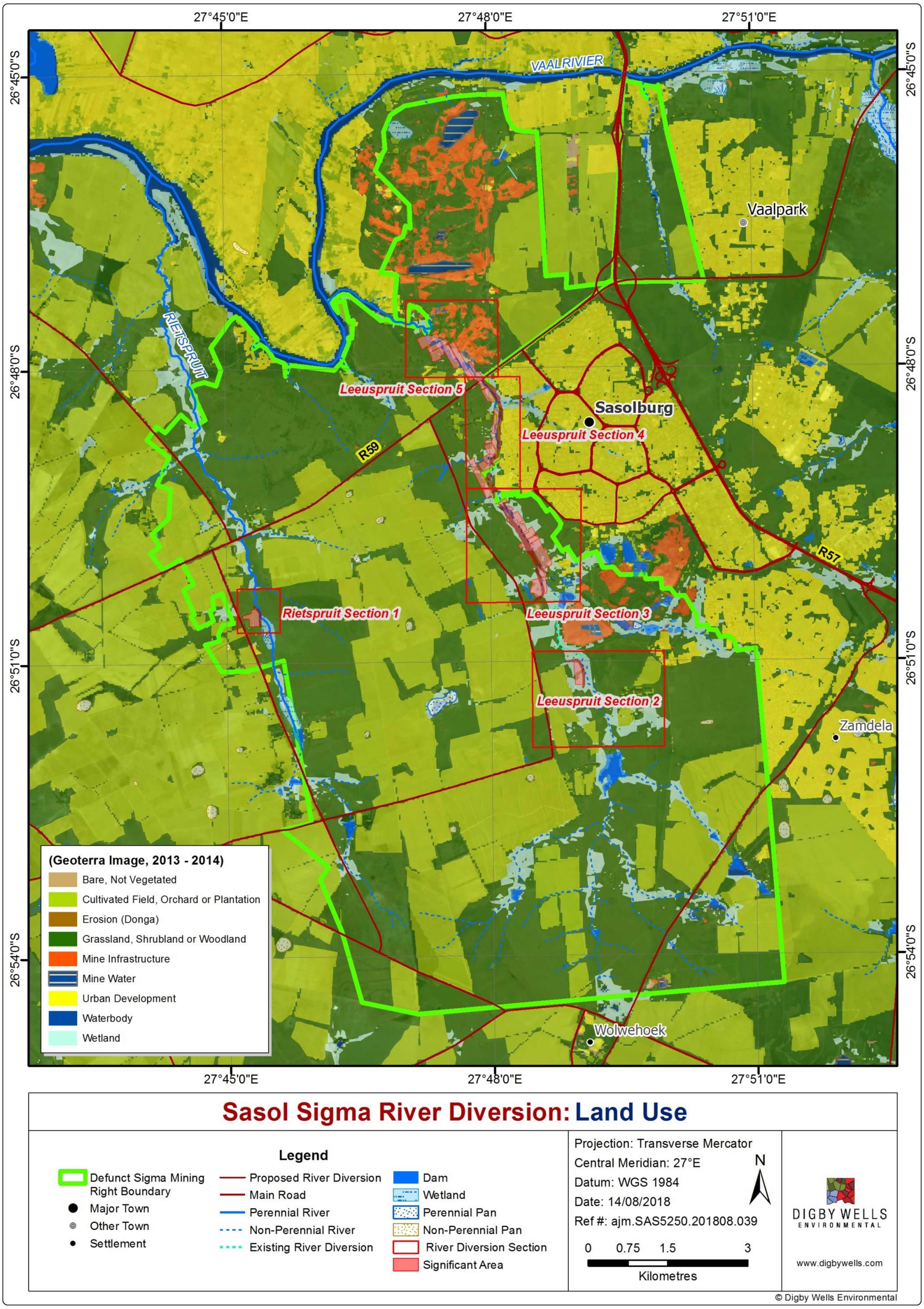


**Figure 8-4: Land use at Sasol Defunct Colliery**

## 8.4 Soil Chemical and Physical Characteristics

A total of sixteen (16) 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 which included:

- Chemical properties (pH, cations & phosphorus); and
- Soil texture (Clay, Silt & Sand).

### 8.4.1 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 manner:

- 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 pH was measured to determine the oxidation potential of the soils. The soil pH ranged from 4.5 to 6.5 as presented in Table 8-3. These soils are acidic to slightly acidic (Table 8-4). 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 the nutrients. Lime is required to counteract acidity and to increase plant growth performance, should agricultural activities have taken place.

### 8.4.2 Exchangeable Cations

The levels of the basic cations Ca, Mg, K and Na are determined in soil samples for agronomic purposes through extraction with an ammonium acetate solution. In general, the amounts of exchangeable cations normally follow the same trend as outlined for soil pH and texture. For most soils, cations follow the typical trend Ca>Mg>K>Na.

Calcium, potassium and magnesium levels in the soil were generally high (Table 8-3) and 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 levels of potassium during nutrient uptake by plants, should agricultural activities take place. The sodium levels ranged from 50 to 1500mg/kg and soils with sodium levels below 200mg/kg are considered not to be sodic (Sample 168, 203, 229 subsoils and 236 topsoil) (Table 8-3). These sodium levels are acceptable and are not of concern on the site. Soil dispersion is unlikely to occur and cause dense structure and drainage problems.

However, sample 165, 182, 224, 229 topsoil's, 236 subsoil and 246 had higher sodium levels when compared with soil fertility guidelines and therefore classified as strongly sodic due to higher levels of sodium.  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 phosphorus (P) status of the clayey soils reflects 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 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).

### 8.4.3 Phosphorus

The Bray 1 extraction and analysis procedure for phosphorus is preferred for soils with pH levels below 7. The P levels encountered in the samples from the site were all very low according to the guidelines in Table 8-4, with most values being 1mg/kg and the maximum 8mg/kg (Table 8-3). Phosphorus will be a limiting factor in terms ecosystem function and rehabilitation if the soil was going to be used for agricultural purposes and at least 15mg/kg would be required. Phosphorus fertilisation would have been required to establish good crop stand and growth, should agricultural activities have taken place.

### 8.4.4 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, loam, clay loam and loamy sand. 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.

**Table 8-3: Soil physico-chemical results**

| Sample ID Top (0–0.3m) & Sub (0.3–0.8m) | pH(KCl) | P(Bray1) | Na | K | Ca | Mg | Clay | Sand | Silt | Texture |
|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/kg | | | | | % | | | |
| 165 Topsoil | 5.31 | 1 | 303 | 139 | 1437 | 996 | 22 | 30 | 48 | Loam |
| 165 Subsoil | 6.21 | 1 | 1446 | 98 | 1416 | 1512 | 34 | 24 | 42 | Clay loam |
| 168 Topsoil | 5.01 | 3 | 178 | 187 | 671 | 480 | 14 | 37 | 50 | Loam |
| 168 Subsoil | 6.12 | 1 | 182 | 132 | 1818 | 1115 | 34 | 27 | 39 | Loam |
| 182 Topsoil | 5.33 | 2 | 360 | 203 | 4356 | 1480 | 38 | 38 | 24 | Clay loam |
| 182 Topsoil | 5.82 | 1 | 576 | 176 | 4587 | 1333 | 46 | 33 | 21 | Clay |
| 203 Topsoil | 6.25 | 3 | 50 | 140 | 2498 | 531 | 14 | 37 | 49 | Loam |
| 203 Topsoil | 6.47 | 1 | 139 | 163 | 2959 | 1662 | 26 | 30 | 44 | Loam |
| 224 Topsoil | 5.82 | 1 | 500 | 165 | 3713 | 1487 | 42 | 44 | 14 | Clay |
| 224 Subsoil | 4.85 | 5 | 510 | 341 | 3829 | 2112 | 46 | 25 | 29 | Clay |
| 229 Topsoil | 5.53 | 2 | 697 | 222 | 3130 | 2029 | 44 | 30 | 26 | Clay |
| 229 Subsoil | 4.77 | 3 | 161 | 133 | 1833 | 827 | 24 | 57 | 19 | Sandy clay loam |
| 236 Topsoil | 4.97 | 8 | 169 | 163 | 1024 | 363 | 12 | 81 | 7 | Loamy sand |
| 236 Subsoil | 6.30 | 1 | 1413 | 309 | 860 | 935 | 32 | 59 | 9 | Sandy clay loam |
| 246 Topsoil | 5.90 | 2 | 304 | 265 | 3312 | 2762 | 42 | 39 | 19 | Clay |
| 246 Topsoil | 6.46 | 1 | 789 | 204 | 3361 | 3839 | 46 | 38 | 16 | Clay |

**Table 8-4: Soil fertility guidelines (Fertiliser Association of South Africa, 2003)**

| Guidelines (mg per kg) | | | | | |
|---|---|---|---|---|---|
| **Macro Nutrient** | | | **Low** | **High** | |
| Phosphorus (P) | | | <5 | >35 | |
| Potassium (K) | | | <40 | >250 | |
| Sodium (Na) | | | <50 | >200 | |
| Calcium (Ca) | | | <200 | >3000 | |
| Magnesium (Mg) | | | <50 | >300 | |
| **pH (KCl)** | | | | | |
| **Very Acid** | **Acid** | **Slightly Acid** | **Neutral** | **Slightly Alkaline** | **Alkaline** |
| <4 | 4.1-5.9 | 6-6.7 | 6.8-7.2 | 7.3-8 | >8 |

# 9 No-go Alternative

The no-go alternative assumes that the proposed activity does not go-ahead, implying a continuation of the current situation or the status quo. The no-go alternative in this case refers to where the proposed surface mitigations are not implemented. If the proposed surface mitigation measures are not implemented there is a high probability of pillar failure which can result in subsidence which could lead to loss of wetland soils, subsequently leading to alterations/loss of flow regimes and water quality in both ground and surface water.

## 9.1 Impact Ratings

The no-go alternative impacts described are rated in Table 9-1.

**Table 9-1: Impact significance for the pillar failure resulting in subsidence**

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Potential surface subsidence from collapsed underground mine roof** | | | |
| **Impact Description:** Collapsed underground mine roof could potentially cause significant surface subsidence. This may restrict post mining land capability and agricultural productivity. Surface cracking and subsidence will occur due to large areas that could be affected by the high extraction. Due to this land capability will potentially alter reducing the capability to wilderness. | | | |
| ***Prior to Mitigation/Management*** | | | |
| **Duration** | 7 | Because of the mining method it is expected that the impact would be beyond the project life without mitigation adopted. | Major (negative) - 133 |
| **Extent** | 5 | Without mitigation the impact is expected to occur within the region. | |
| **Intensity** | 7 | Serious impacts to the land capability and land use will occur because of mining and adopting no mitigation because of potential for pillar failure which can result in subsidence. | |
| **Probability** | 7 | The impact on soils will occur. | |
| **Nature** | Negative | | |
| ***Mitigation Measures*** | | | |
| Implement the proposed surface mitigation measures which includes the construction of flood protection berms and canals | | | |
| ***Post-Mitigation*** | | | |

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Duration** | 6 | With mitigation the duration would be limited to the project life | Moderate (negative) - 96 |
| **Extent** | 4 | With mitigation the duration of the impact would be limited to the project area. | |
| **Intensity** | 6 | Even with mitigation being adopted there will be a serious loss of agricultural productivity | |
| **Probability** | 6 | It is expected that the impact is likely to occur. | |
| **Nature** | Negative | | |

# 10 Sensitivity

According to the Department of Water of 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 law (Figure 10-1).

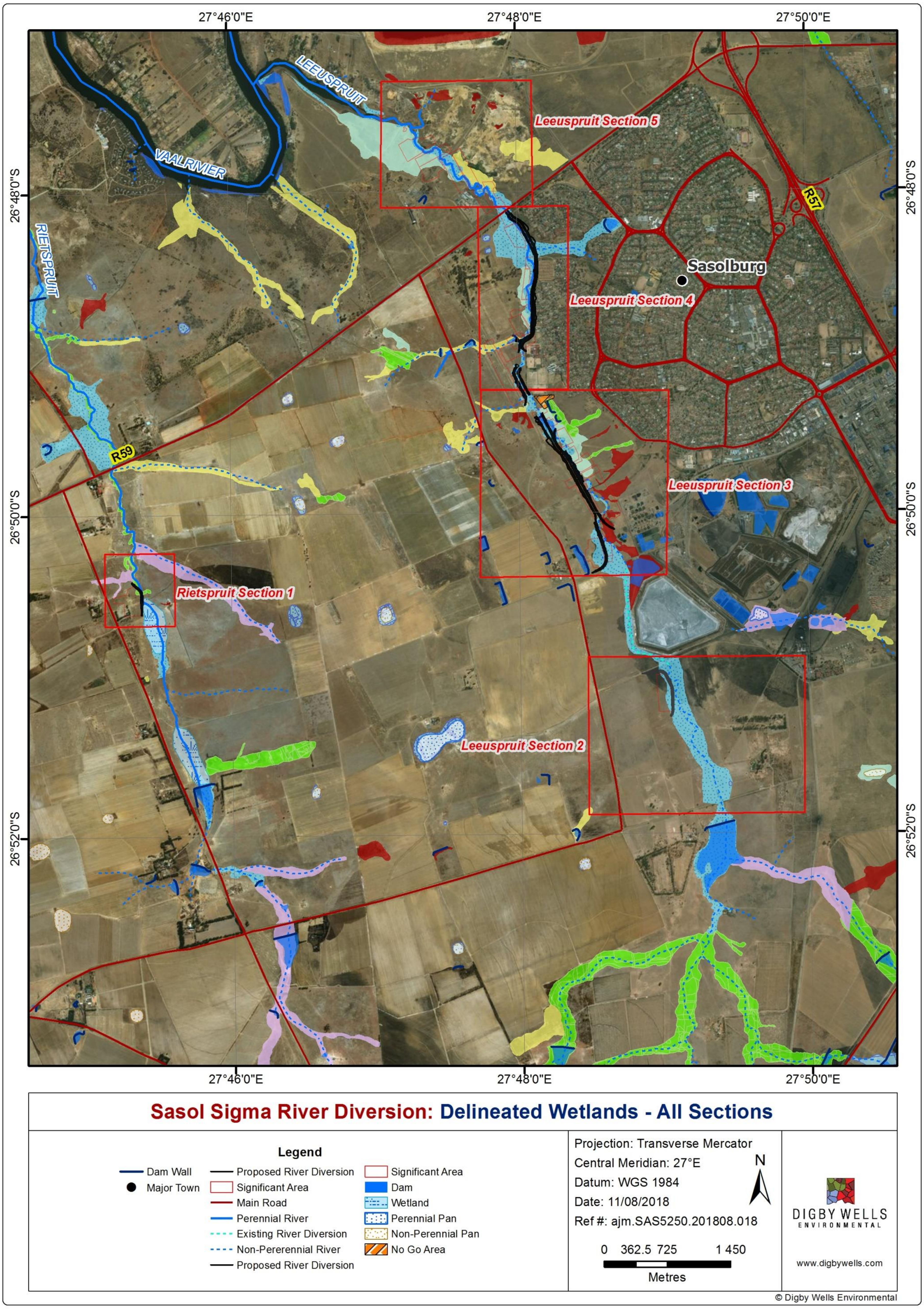


**Figure 10-1: Wetlands delineated on site**

# 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 construction machinery and from waste storage facilities during construction.

## 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;
- All machines should be serviced and refuelled which may not occur on site;
- If a spill occurs, it should be cleaned up immediately, reported to the appropriate authorities and recorded; and
- Contaminated soils, if not effectively remediated *in-situ*, must be disposed in a registered and licensed Waste Land Facility.

**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;<br>▪ All vehicles should be serviced at an off-site location specifically designed for servicing of machinery.<br>▪ Machinery must be parked within hard park areas and drip trays must be used. Further the machinery must be inspected daily for fluid leaks. |
| Hazardous substance spillage from waste storage | Soil Contamination | ▪ Prevent any spills from occurring;<br>▪ If a spill occurs it should be cleaned up (Drizit spill kit/ Enertech type spill kit, Oil or Chemical spill kit) immediately and reported to the appropriate authorities; and<br>▪ Emergency response plans should be in place. |

# 12 Impact Assessment

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, concluding in an impact significance 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 capability:

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

## 12.1 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 Environmental Management Plan (EMPr). 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 12-3. 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 12-2, which is extracted from Table 12-1. The description of the significance ratings is discussed in Table 12-3.

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 12-1: 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.<br>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<br>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.<br>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<br>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.<br>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<br>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. |
| 2 | **Minor loss and/or effects** to biological or physical resources or low sensitive environments, not affecting ecosystem functioning.<br>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<br>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 12-2: 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 |
| 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 12-3: 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) (-) |

## 12.2 Potential Impacts

The impacts that could affect the soils and land capability within the areas where activities will be undertaken are:

- Loss of the soil resource due to change in land use and removal of the soil;
- Loss of the soil resource due to wind and water erosion and which then leads to sedimentation of water streams/rivers;
- Change in soil characteristics (soil texture) due to compaction of areas during construction;
- Contamination of the soil resource due to hydrocarbons spillages; and
- Loss of the soil resource due to the disturbance and clearing of vegetation.

## 12.3 Project Activities

The impact assessment is aimed at identifying impacts related to the various activities listed, from a soils perspective. The impact assessment is aimed at identifying impacts related to the various activities listed in Table 12-4.

**Table 12-4: Proposed project activities**

| **Construction Phase** |
|---|
| Site clearing, including the removal of vegetation and topsoil.<br>Excavation of soils from water course.<br>Stockpiling of soil once excavated. |
| Contractor Camp / Laydown Area Establishment.<br>Construction activities within a water courses and wetlands (Heavy vehicles and excavators).<br>Temporary storage of hazardous products, including fuel.<br>Storage of waste.<br>Utilise existing roads to access the various river sections. |
| Construction of flood protection berm. Vegetation of flood protection berm. Construction of formalised canal. |
| Removal of all machinery and equipment utilised during construction phase. |
| Removal of waste. |
| **Operational Phase** |
| Rehabilitate areas affected by laydown area and machinery. |
| Revegetate area to ensure erosion does not occur. |
| Maintenance and monitoring activities associated with the proposed measures. |

## 12.4 Construction Phase

Construction activities on the site will lead to land clearing and disturbance of the soil. The clearing of vegetation, the exposing of soil during construction of the flood protection berms, canals and diversion, may lead to wind and water erosion. Vehicles will be utilised during construction of the flood protection berms and canals which may impact on the soil surface, thereby causing compaction of the soils. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil. The preparation of lay-down areas for stockpiling of soil removed will result in the impacting of soils around the area.

**Soils should be handled with care throughout the project specifically during construction phase.**

### 12.4.1 Leeuspruit Section 2

A flood protection berm will be constructed to avoid one area where there is a high probability of pillar failure which can result in subsidence. The flood protection berm will be comprised of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations sourced within the Sigma area. Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.

#### *12.4.1.1 Impact Ratings*

The construction phase impacts are rated in Table 12-5.

**Table 12-5: Impact significance for the clearing of the vegetation**

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Clearing of vegetation** | | | |
| **Impact Description:** Removal of vegetation may lead to dust generation and erosion, respectively. 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*** | | | |
| **Duration** | 2 | The impact on soil erosion will occur until the project has been completed | Moderate (negative) - 48 |
| **Extent** | 2 | Loss of soil will only occur within project area | |
| **Intensity** | 4 | Vegetation removal will result in erosion and compaction | |
| **Probability** | 6 | By clearing vegetation, soils will certainly be impacted on | |
| **Nature** | Negative | | |

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| ***Post-Mitigation*** | | | |
| **Duration** | 2 | Impacts on soil will probable occur, however mitigation measures (Armorflex, berm being vegetated) need to be implemented to reduce impact. | Minor (negative) - 35 |
| **Extent** | 2 | Loss of soil is limited only within project area | |
| **Intensity** | 3 | Loss of usable soil may result in loss of good productive soils | |
| **Probability** | 5 | If mitigation measures are followed it is likely that the impact will occur | |
| **Nature** | Negative | | |

### 12.4.2 Leeuspruit Section 3

A flood protection berm will be constructed to avoid one area where there is a high probability of pillar failure which can result in subsidence. The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations sourced within the Sigma area. Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction.

Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility. The removed soil will be stockpiled and can be lost if not managed correctly. Soil is susceptible to erosion because vegetation will be cleared before construction takes place in infrastructure area. Soil is susceptible to compaction from heavy construction equipment and vehicles when soil is stripped and stockpiled. Soil compaction reduces ability of plants to absorb water due to soil pores being decreased, reduces water infiltration rate and bulk density increases.

#### 12.4.2.1 Impact Ratings

The construction phase impacts are rated in Table 12-6 and Table 12-7.

## Table 12-6: Impact significance for the clearing of the vegetation

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Clearing of the vegetation** | | | |
| **Impact Description:** Removal of vegetation may lead to dust generation and erosion, respectively. 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*** | | | |
| **Duration** | 2 | The impact on soil erosion will occur until the project has been completed | Minor (negative) - 66 |
| **Extent** | 3 | Loss of soil will only occur within project area | |
| **Intensity** | 6 | Vegetation removal will result in erosion and compaction | |
| **Probability** | 6 | By clearing vegetation, soils will certainly be impacted on | |
| **Nature** | Negative | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 2 | Impact on soils would occur, however mitigation measures (Armorflex, berm being vegetated) need to be implemented to reduce impact. | Minor (negative) - 50 |
| **Extent** | 3 | Loss of soil is limited only within project area | |
| **Intensity** | 5 | Loss of usable soil may result in loss of good productive soils | |
| **Probability** | 5 | If mitigation measures are followed it is likely that the impact will occur | |
| **Nature** | Negative | Impact on soils would occur, however mitigation measures need to be implemented to reduce impact. | |

## Table 12-7: Impact significance for the excavation of the soils

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Construction of the flood protection berms and canal** | | | |
| **Impact Description:** Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. 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*** | | | |
| **Duration** | 6 | Topsoil and subsoil will be removed in preparation of the diversion. Removal of soil from profile reduces the land capability to non-existent, this impact is permanent | Moderate (negative) – 98 |
| **Extent** | 2 | Loss of topsoil will only occur on the project area | |
| **Intensity** | 6 | Loss of soils is very serious and will have negative impact. Loss of usable topsoil will result in loss of land capability and land use. Soil regeneration takes a very long time. | |
| **Probability** | 7 | By removing topsoil, the impact on land capability and land use is certain | |
| **Nature** | Negative | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 5 | Use of surplus soil to rehabilitate areas impacted. | Minor (negative) – 72 |
| **Extent** | 2 | Loss of soil will only occur within project area | |
| **Intensity** | 5 | Loss of usable soil will result in loss of good productive soils. Impact is serious on soils | |
| **Probability** | 6 | By excavating the soil it will certainly impact on soil | |
| **Nature** | Negative | | |

### 12.4.3 Leeuspruit Section 4

A flood protection berm and canal will be constructed to avoid areas with a high probability of pillar failure which can result in subsidence. The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations. Vegetation will be cleared during the construction of flood protection berm which leads to soils exposed and promoting erosion and compaction.

Topsoil and subsoil will be removed from a soil profile; the profile loses effective rooting depth, water holding capacity and soil fertility. The removed soil will be stockpiled and can be lost if not managed correctly. Soil is susceptible to erosion because vegetation will be cleared before construction takes place in infrastructure area. Soil is susceptible to compaction from heavy construction equipment and vehicles when soil is stripped and stockpiled. Soil compaction reduces ability of plants to absorb water due to soil pores being decreased, reduces water infiltration rate and bulk density increases.

#### *12.4.3.1 Impact Ratings*

The construction phase impacts are rated in Table 12-8 and Table 12-9.

### Table 12-8: Impact significance for the clearing of the vegetation

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Clearing of vegetation** | | | |
| **Impact Description:** Removal of vegetation may lead to dust generation and erosion, respectively. 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*** | | | |
| **Duration** | 5 | The impact on soil erosion will occur until the project has been completed | Moderate (negative) - 78 |
| **Extent** | 2 | Loss of soil will only occur within project area | |
| **Intensity** | 6 | Vegetation removal will result in erosion and compaction | |
| **Probability** | 6 | By clearing vegetation, soils will certainly be impacted on | |
| **Nature** | Negative | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 4 | Impact will probable occur, how mitigation measures need to be implemented to reduce impact. | Minor (negative) - 40 |
| **Extent** | 2 | Loss of soil is limited only within project area | |
| **Intensity** | 4 | Loss of usable soil may result in loss of good productive soils | |
| **Probability** | 4 | Impact will probable occur, however mitigation measures need to be implemented to reduce impact. | |
| **Nature** | Negative | | |

### Table 12-9: Impact significance for the excavation of soils

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Construction of the flood protection berms and canal** | | | |
| **Impact Description:** Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. 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*** | | | |
| **Duration** | 6 | Topsoil and subsoil will be removed in preparation of diversion. Removal of soil from profile reduces the land capability to non-existent, this impact is permanent. The soil will be moved, used for berms and in Armorflex and used for rehabilitation. | Moderate (negative) – 98 |
| **Extent** | 2 | Loss of topsoil will only occur on the project area | |
| **Intensity** | 6 | Loss of soils is very serious and will have negative impact. Loss of usable topsoil will result in loss of land capability and land use. Soil regeneration takes a very long time. | |
| **Probability** | 7 | By removing topsoil, the impact on land capability and land use is certain | |
| **Nature** | Negative | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 5 | No mitigation measures are possible and the impacts will be permanent | Minor (negative) – 72 |
| **Extent** | 2 | Loss of soil will only occur within project area | |
| **Intensity** | 5 | Loss of usable soil will result in loss of good productive soils. Impact is serious on soils | |
| **Probability** | 6 | By excavating the soil it will certainly impact on soil | |
| **Nature** | Negative | | |

### 12.4.4 Rietspruit Section 1

A flood protection berm will be constructed to avoid one area of where there is a high probability of pillar failure which can result in subsidence. The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations. Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction.

#### *12.4.4.1 Impact Ratings*

The construction phase impacts are rated in Table 12-10.

**Table 12-10: Impact significance for the clearing of the vegetation**

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Clearing of vegetation** | | | |
| **Impact Description:** Removal of vegetation may lead to dust generation and erosion, respectively. 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*** | | | |
| **Duration** | 2 | The impact on soil erosion will occur until the project has been completed | Moderate (negative) - 48 |
| **Extent** | 2 | Loss of soil will only occur within project area | |
| **Intensity** | 4 | Vegetation removal will result in erosion and compaction | |
| **Probability** | 6 | By clearing vegetation, soils will certainly be impacted on | |
| **Nature** | Negative | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 2 | Impact on soils would occur, however mitigation measures (Armorflex, berm being vegetated) need to be implemented to reduce impact. | Minor (negative) - 35 |
| **Extent** | 2 | Loss of soil is limited only within project area | |
| **Intensity** | 3 | Loss of usable soil may result in loss of good productive soils | |
| **Probability** | 5 | If mitigation measures are followed it is probably that the impact will occur | |

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Nature** | Negative | | |

### 12.4.5 Management Actions

The following mitigation and management measures have been prescribed for the construction phase (Leeuspruit Section 2, 3, and 4). Management actions include the following for the construction phase:

- Berms should be monitored for erosion monthly for the 1st year and quarterly for the 2nd year to ensure they are not being eroded;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily;
- Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed;
- Only the designated access routes are to be used to reduce any unnecessary compaction;
- All vehicles must be regularly inspected for potential hydrocarbon leaks;
- Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil;
- Topsoil to a depth of 0.3m should be stripped first and stockpiled separately;
- The subsoil of 0.4 – 1.2m will then be stripped and stockpiled separately and replace on berms in same sequence;
- Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place especially for soils that have high erosion potential;
- For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site; and
- In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution;
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan); and

- Surface inspection on the fully rehabilitated flood protection berm and diverted 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.

## 12.5 Operational Phase

Rehabilitation of impacted areas will need to include seeding flood protection berms, vegetating cleared areas and ripping compacted soils with a ripper.

### 12.5.1 Impact Ratings

The operational phase impacts are rated in Table 12-11.

**Table 12-11: Impact significance for the rehabilitation of disturbed areas**

| Dimension | Rating | Motivation | Significance |
|---|---|---|---|
| **Activity and Interaction: Rehabilitation of the disturbed areas** | | | |
| **Impact Description:** Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery. | | | |
| ***Prior to Mitigation/Management*** | | | |
| **Duration** | 7 | The impact on soils will be permanent | Minor (positive) + 70 |
| **Extent** | 2 | Impact will occur on a limited scale | |
| **Intensity** | 5 | The intensity of the impact is serious and soil profile will be reconstructed | |
| **Probability** | 5 | Impact will be likely to occur if mitigation measures are implemented | |
| **Nature** | Positive | | |
| ***Post-Mitigation*** | | | |
| **Duration** | 7 | If rehabilitation measures are implemented correctly impact will be permanent | Moderate (positive) + 78 |
| **Extent** | 2 | Impact will occur on a limited scale | |
| **Intensity** | 4 | The intensity will be reduced if mitigation measures are implemented | |
| **Probability** | 6 | Impact will be almost certain to occur if mitigation measures are implemented | |
| **Nature** | Positive | | |

### 12.5.2 Management Actions

The impacts on the soils during the operational phase can be mitigated and mitigation measures include the following:

- Effective soil cover and adequate protection from wind and water;
- Soil 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;
- Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed;
- Only the designated access routes are to be used to reduce any unnecessary compaction;
- Rehabilitate according to the rehabilitation plan;
- 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.

**Table 12-12: Soils and land capability mitigation and management plan**

| Activities | Phase | Impact | Size and scale of disturbance | Mitigation Measures | Compliance |
|---|---|---|---|---|---|
| Removal of infrastructure from site | Construction | Loss of topsoil, erosion and sedimentation | Infrastructure footprint and surrounding areas | ▪ If erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;<br>▪ Ensure that decommissioning activities are restricted to the area where the activities are being undertaken;<br>▪ Waste management plan must be in place during the decommissioning phase of the project; and<br>▪ Ensure that building rubble and all waste material that arises from the decommissioning phase is removed off site and disposed of at an appropriate facility. | NEMA<br>CARA<br>NEMWA |
| Site clearing and topsoil removal | Construction | Loss of topsoil, compaction, dust and erosion | Infrastructure footprint | ▪ Only the designated access routes are to be used to reduce unnecessary compaction.<br>▪ If any erosion occurs, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place.<br>▪ If possible, topsoil removal should occur during dry months as to reduce compaction. | NEMA<br>CARA |
| Site clearing and topsoil removal | Construction | Contamination of soil | Infrastructure footprint | ▪ Emergency spillage response plan must be in place.<br>▪ Spill kits should be in place and accessible to the responsible monitoring team.<br>▪ Waste management plan must be in place throughout the project life cycle. | NEMA<br>NEMWA |

| | | | | | |
|---|---|---|---|---|---|
| | | | | ▪ Ensure that building rubble and all waste material is removed off and disposed of at an appropriate facility. | |
| Monitoring | Post-construction/ operational | Compliance to applicable legislation and authorisation | Infrastructure footprint | ▪ Disturbed areas must be rehabilitated and be assessed once every 6 months for compaction and erosion.<br>▪ Compacted areas must be ripped to loosen the soil structure. | NEMA<br>CARA |

# 13 Monitoring Requirements and Responsibilities

## 13.1 Monitoring

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 monthly for the 1st year, quarterly for the 2nd year, and bi-annually for the 3rd year until sustainability is confirmed:

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

The following maintenance is required:

- Repair any damage caused by erosion;
- Vehicular movement across rehabilitated areas should be limited where possible while the vegetation is establishing;
- The area must be fenced and animals should be kept off the area until the vegetation is self-sustaining;
- Fertilize grassed area with nitrogen containing fertiliser after germination of seeds to promote good growth and development;
- If soil is polluted, treat the soil by means of *in-situ* bio-remediation; and
- If *in-situ* treatment is not possible then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Material and disposed at an appropriate, permitted or licensed disposal facility.

## 13.2 Responsibilities

Table 13-1 provides roles and responsibilities of the people that will be responsible for implementing excavations and stockpiling procedures. The responsibilities of the contractor need to be documented in contract documents.

## Table 13-1: Responsibilities

| Environmental Aspect | Measures and Actions | Responsibility | Timeframes |
|---|---|---|---|
| Waste management | Bins must be provided for disposal of waste during construction | Contractors, Environmental Control Officer and Project Manager | During construction phase |
| Equipment and storage areas | Equipment maintenance must be done offsite. Storage areas must be within the fenced area and located away from all sensitive areas | Contractors, Environmental Control Officer and Project Manager | During construction phase |
| Hazardous materials | Spillage plan must be developed. Refuelling must be done offsite to prevent potential soil pollution from spillage | Contractors and Environmental Control Officer | During construction phase to end |
| Soil erosion and sediment control | Clearing activities must be restricted to the footprint of berms and canals | Contractors, Environmental Control Officer and Project Manager | During construction phase |
| Erosion and sediment control | Removed soil must be stored away from drainage areas | Contractors, Environmental Control Officer and Project Manager | During construction phase |
| Stockpile management | Stockpiled soils must not be located far away from replacement areas. Must be protected from potential erosion and limit the height. Must be kept clear of weeds and alien vegetation. | Contractors, Environmental Control Officer and Project Manager | During construction phase |
| Excavations | Excavations must be undertaken carefully and taking into | Contractors, Environmental Control Officer and Project | During construction phase |

| Environmental Aspect | Measures and Actions | Responsibility | Timeframes |
|---|---|---|---|
| | consideration of the weather conditions. If high rainfalls are expected, excavations should be put on hold. | Manager | |
| Soil management | Topsoil and sub soil must be stored separately. Soil must not be stockpiled for more than 6 months. However, if stockpiled for more than 6 months the topsoil must be ameliorated prior to remediation. | Contractors, Environmental Control Officer and Project Manager | During construction phase |

# 14 Consultation Undertaken

The project manager/personnel were contacted prior to the soil assessment and on the day of the site visit on the 23rd and 24th of July 2018. Also, the farm owners were contacted prior to the soil survey and on the day of the site visit. This was to obtain the required permission to enter the property and explain the purpose of the study.

# 15 Conclusions and Recommendations

The finding of the soil assessment suggested that the land type associated with the project area was dominated by land types Bb23 and Dc7. The soils are dominated by Avalon (yellow-brown) forms and (black and greyish) Rensburg forms. The dominant land capabilities based on the soils, texture and fertility status found on the project area was grazing (yellow brown soils) and wetland (black and greyish soils). Yellow brown soils are known to be highly susceptible to water or wind erosion, very slow permeability of the subsoil, low water-holding capacity and moderate salinity or sodicity. Wetland areas are characterised by Arcadia soils. Although these soils are deeper, they have high expansible clay content and are physically difficult to manage.

The fertility status of the soils is generally considered high. The soil pH ranged from 4.5 to 6.5 and these soils are acidic to slightly acidic. Lime such as dolomitic lime is required to counteract acidity, should agricultural activities have taken place over these areas. Calcium, potassium and magnesium levels in the soil were generally high and adequate for crop production and these nutrients are not limiting any production on the site or not considered as toxic.

The sodium levels ranged from 50 to 1500 mg/kg and soils with sodium levels below 200mg/kg are considered not to be sodic (Sample 168, 203, 229 subsoils and 236 topsoil). These sodium levels are acceptable and are not of concern on the site. Samples 165, 182, 224, 229 topsoil's, 236 subsoil and 246 had higher sodium levels when compared with soil fertility guidelines and therefore classified as strongly sodic due to higher levels of sodium. Where high sodium values and sometimes also sodium values are encountered, soil dispersion occurs, leading to a dense structure and drainage problems. The soils can be described as clay, sandy clay loam, loam, clay loam and loamy sand. 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.

The impacts associated with the project on soils include:

- Loss of topsoil during clearing of vegetation;
- Erosion due to exposed soil surfaces;
- Compaction of soils due to construction vehicles; and
- Soil contamination through hydrocarbon spills.

The risk assessment from the findings of this report indicates that most of the proposed activities pose a high probability of impacting the soils and wetlands over the longer term. Based on the findings of this of this report and the proposed mitigation measures, the anticipated impacts of the project can be reduced to a moderate to minor level of significance through implementation of the proposed integrated mitigation and management measures. The following recommendations are made to minimise the impact on the soils:

- Berms should be monitored for erosion monthly for the 1st year and quarterly for the 2nd year to ensure they are not being eroded;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily;
- Slow release outlet pipes installed within the berm should be monitored to ensure that no blockages occur;
- Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil;
- Wetlands should be monitored monthly during construction;
- Topsoil of 0.3 m of the soil profile should be stripped first and stockpiled separately;

- The subsoil of 0.4 – 1.2 m will then be stripped and stockpiled separately and replace on berms in same sequence;
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to the Rehabilitation Plan); and
- Surface inspection on the fully rehabilitated flood protection berm and diverted 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.

# 16 Reasoned Opinion of the Specialist

Soil management measures should be followed as outlined in this report and disturbed land needs to be rehabilitated to prevent possible soil erosion, contamination and compaction. Based on the baseline of information and the impact assessment ratings of significance, it is the opinion of the specialist that this project is feasible and could be considered if the management and mitigation measures tabled are rigorously adhered to for the project to minimise potential impacts on the soils and to maintain their land capability for future land use.

# 17 References

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# Appendix A: CV

Mr Siphamandla Madikizela

Soil Scientist

Manager: Rehabilitation & Soil

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).
- Certificate of Completion: Assessment and Remediation Techniques for Groundwater & Contaminated Soil (25 & 26 August 2017).

# 2 Language Skills

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

# 3 Employment

- March 2016 – Present: 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-related 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 Assessment: Elandspruit Colliery | Middelburg, Mpumalanga, 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 Environmental Impact Assessment-related 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.
- Rehabilitation Guidelines for Sedibelo West – Sedibelo Platinum Mines Limited – 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.

# 7 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*.

# 8 Professional Affiliations

- Soil Science Society of South Africa (SSSA).

# 9 Professional Registration

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

# Appendix B: Laboratory Certificate

# AGRICULTURAL SERVICES

# SOIL ANALYSIS REPORT

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Farm Elandsfontein
District Bapsfontein
Gauteng, South Africa

## CERTIFICATE OF ANALYSIS

Certificate Number : AGRI 08_18-0032-0
Report date : 2018/08/08


### Customer : Digby Wells

| CN : AGRI 08_18-0032-0 | | | | 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 | % | % | % | Digby Wells | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S 003 | S 007 | S 009 | S 009 | S 009 | S 009 | * | * | * | * | * | * | * | * | * | * | * | * | S 003 | * | * | * | * | | |
| Batch Seq Number | Land Reference | Stikker No | pH (KCl) | PBray1 | K | Na | 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 | Date Received | Date Reported |
| AGRI 08_18-0032-1 | | 165 Top Soil | 5.31 | 1 | 139 | 303 | 1437 | 996 | 0.00 | 42.2 | 48.0 | 2.1 | 7.7 | 0.0 | 0.9 | 43.2 | 23.0 | 17.0 | 3.7 | 17.0 | 1.227 | 18.06 | 22 | 30 | 48 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0032-2 | | 165 Sub Soil | 6.21 | 1 | 98 | 1446 | 1416 | 1512 | 0.00 | 27.2 | 47.6 | 1.0 | 24.2 | 0.0 | 0.6 | 77.8 | 49.5 | 26.0 | 25.1 | 26.0 | 1.165 | 135.35 | 34 | 24 | 42 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0032-3 | | 168 Top Soil | 5.01 | 3 | 187 | 178 | 671 | 480 | 0.00 | 39.3 | 46.0 | 5.6 | 9.1 | 0.0 | 0.9 | 15.2 | 8.2 | 8.5 | 1.6 | 8.5 | 1.219 | 40.00 | 14 | 37 | 50 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0032-4 | | 168 Sub Soil | 6.12 | 1 | 132 | 182 | 1818 | 1115 | 0.00 | 47.0 | 47.2 | 1.7 | 4.1 | 0.0 | 1.0 | 53.9 | 27.0 | 19.4 | 2.3 | 19.4 | 1.199 | 19.20 | 34 | 27 | 39 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0032-5 | | 203 Top Soil | 6.25 | 3 | 140 | 50 | 2498 | 531 | 0.00 | 71.7 | 25.0 | 2.1 | 1.2 | 0.0 | 2.9 | 47.2 | 12.2 | 17.4 | 0.6 | 17.4 | 1.143 | 21.76 | 14 | 37 | 49 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0032-6 | | 203 Sub Soil | 6.47 | 1 | 163 | 139 | 2959 | 1662 | 0.00 | 50.3 | 46.3 | 1.4 | 2.1 | 0.0 | 1.1 | 68.2 | 32.7 | 29.4 | 1.4 | 29.4 | 1.191 | 26.51 | 26 | 30 | 44 | 2018/08/03 | 2018/08/08 |

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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.



Nelson Motlhako
Soil Section leader

# AGRICULTURAL SERVICES

Farm Elandsfontein
District Bapsfontein
Gauteng, South Africa

# SOIL ANALYSIS REPORT

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Certificate Number : AGRI 08_18-0033-0
Report date : 2018/08/08


# CERTIFICATE OF ANALYSIS

## Customer : Digby Wells

| CN : AGRI 08_18-0033-0 | | | | 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 | % | % | % | Digby Wells | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S 003 | S 007 | S 009 | S 009 | S 009 | S 009 | * | * | * | * | * | * | * | * | * | * | * | * | S 003 | * | * | * | * | | |
| Batch Seq Number | Land Reference | Stikker No | pH (KCl) | PBray1 | K | Na | 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 | Date Received | Date Reported |
| AGRI 08_18-0033-1 | | 182 Top Soil | 5.33 | 2 | 203 | 360 | 4356 | 1480 | 0.00 | 60.5 | 33.7 | 1.4 | 4.3 | 0.0 | 1.8 | 65.2 | 23.3 | 36.0 | 3.0 | 36.0 | 1.184 | 36.37 | 38 | 38 | 24 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-2 | | 182 Sub Soil | 5.82 | 1 | 176 | 576 | 4587 | 1333 | 0.00 | 62.3 | 29.7 | 1.2 | 6.8 | 0.0 | 2.1 | 75.3 | 24.3 | 36.8 | 5.6 | 36.8 | 1.223 | 56.40 | 46 | 33 | 21 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-3 | | 224 Top Soil | 5.82 | 1 | 165 | 500 | 3713 | 1487 | 0.00 | 55.7 | 36.5 | 1.3 | 6.5 | 0.0 | 1.5 | 72.9 | 28.9 | 33.4 | 5.2 | 33.4 | 1.245 | 41.21 | 42 | 44 | 14 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-4 | | 224 Sub Soil | 4.85 | 5 | 341 | 510 | 3829 | 2112 | 0.00 | 48.4 | 43.8 | 2.2 | 5.6 | 0.0 | 1.1 | 41.8 | 19.8 | 39.5 | 2.5 | 39.5 | 1.078 | 34.68 | 46 | 25 | 29 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-5 | | 229 Top Soil | 5.53 | 2 | 222 | 697 | 3130 | 2029 | 0.00 | 43.6 | 46.4 | 1.6 | 8.4 | 0.0 | 0.9 | 56.9 | 29.3 | 35.9 | 5.3 | 35.9 | 1.190 | 34.84 | 44 | 30 | 26 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-6 | | 229 Sub Soil | 4.77 | 3 | 133 | 161 | 1833 | 827 | 0.00 | 54.0 | 39.9 | 2.0 | 4.1 | 0.0 | 1.4 | 46.8 | 19.9 | 17.0 | 2.1 | 17.0 | 1.206 | 22.93 | 24 | 57 | 19 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-7 | | 236 Top Soil | 4.97 | 8 | 163 | 169 | 1024 | 363 | 0.00 | 55.4 | 32.1 | 4.5 | 8.0 | 0.0 | 1.7 | 19.4 | 7.1 | 9.2 | 1.8 | 9.2 | 1.262 | 22.40 | 12 | 81 | 7 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-8 | | 236 Sub Soil | 6.30 | 1 | 309 | 1413 | 860 | 935 | 0.00 | 22.8 | 40.5 | 4.2 | 32.5 | 0.0 | 0.6 | 15.1 | 9.7 | 18.9 | 7.8 | 18.9 | 1.170 | 57.67 | 32 | 59 | 9 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-9 | | 246 Top Soil | 5.90 | 2 | 265 | 304 | 3312 | 2762 | 0.00 | 40.2 | 55.0 | 1.6 | 3.2 | 0.0 | 0.7 | 57.7 | 33.4 | 41.2 | 1.9 | 41.2 | 1.110 | 37.32 | 42 | 39 | 19 | 2018/08/03 | 2018/08/08 |
| AGRI 08_18-0033-10 | | 246 Sub Soil | 6.46 | 1 | 204 | 789 | 3361 | 3839 | 0.00 | 32.2 | 60.3 | 1.0 | 6.6 | 0.0 | 0.5 | 92.4 | 60.3 | 52.2 | 6.6 | 52.2 | 1.144 | 43.11 | 46 | 38 | 16 | 2018/08/03 | 2018/08/08 |

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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.



Nelson Motlhako
Soil Section leader