PROSPECTING RIGHT APPLICATION

BASIC HYDROLOGICAL STUDY

REPORT PREPARED BY:

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Basic Hydrological Study for the proposed Prospecting Right Application on all portions of the farm ST Helena 67 HT, situated in the magisterial district of Mkhondo in Mpumalanga Province.

NOTRE Coal

DMRE REF: MP 30/5/1/1/2/ 17548 PR

Report Credentials.

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Project details

Report type	**Basic Hydrological Study for a prospecting right application**	
Project title	Basic Hydrological Study for the proposed prospecting right application on all portions of the farm ST Helena 67 HT, situated under the magisterial district of Mkhondo, Mpumalanga Province.	
Mineral (s)	Pseudocoal and Torbanite/oil shale	
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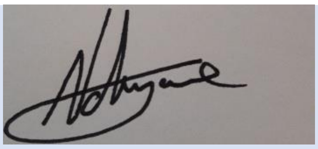
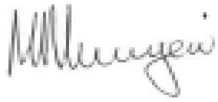
Compiled by	Fhatuwani Ndonyane (Hydrogeologist Intern) Singo Consulting (Pty) Ltd	
Reviewed by	Mutshidzi Munyai (Hydrogeologist) Singo Consulting (Pty) Ltd (Water Resources Science (Candidate Natural Scientist), Environment Science (Candidate Natural Scientist) (SACNASP Registration Number 122464)	
Final review and approval	Dr. Kenneth Singo (Principal Consultant of Singo Consulting (Pty) Ltd)	

Table 1: Critical Report Information

Critical Information incorporated within the Hydrological Study:	Relevant section in report
Details of the specialist who prepared the report	Project details, P: 3
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix A, P: 44
Project Background Information, including the proposed activities description	Introduction, P: 9
An indication of the scope of, and the purpose for which, the report was prepared	Scope of work, P: 10-11
An indication of the quality and age of base data used for the specialist report	Project details, P: 3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Surface water impact assessment, P: 34
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Project details, P: 3
A description of the methodology implemented in preparing the report or carrying out the specialised process comprehensive of equipment and modelling used;	Methodology, P: 34
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative;	N/A
An identification of any areas to be avoided, including buffers	Buffer zone, P: 24
A map overlaying the proposed activity including the associated infrastructures on the environmental sensitivities of the site including containing buffer zones	Buffer zone, P: 24
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Surface water impact assessment, P: 34
Any mitigation and conditions measures for inclusion in the EMPr	Stormwater management plan, P: 39
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Monitoring plan, P: 41
An analytic opinion as to whether the proposed activity or portions thereof should be Authorised-i.e. specific recommendations	Recommendations, P: 42
Regarding the acceptability of the proposed activity or activities; and	Refer to bar
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Stormwater management plan, P: 39
A description of any consultation process that was undertaken during carrying out the study	Refer to bar
Any triggered Water Uses according to section 21 of the National Water Act 36, 1998.	N/A
Any other information requested by the competent authority.	N/A

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1 INTRODUCTION

1.1 Project Background Information

According to the recent World Health Organization (WHO) report, the countries which still have limited access to water for drinking purposes are mainly those in the Sub-Saharan region (Verlicchi and Grillini, 2020). It is with this knowledge that the protection of surface water sources is ensured. According to WHO (2004), Surface water is any body of water that is above ground which includes but not limited to streams, lakes, dams, and wetlands.

Singo Consulting (Pty) Ltd was appointed by Notre Coal as an independent consulting company, to conduct a basic hydrological study. The basic hydrological study is being conducted in support to a prospecting right application for pseudocoal and torbanite/oil shale resources situated on all portions of the farm ST Helena 67 HT, situated under the magisterial district of Mkhondo, Mpumalanga Province.

Chapter 3 of the National Water Act (Act 36 of 1998) requires that a person who owns, control, occupies, uses the land is responsible for preventing pollution of water resources and is also responsible to remedy (correct) the effects of the pollution. It is with this Act that the hydrological report was deemed necessary for the site to gather all relevant information related to surface water and its related potential impacts.

The goal of this study:

- To assess the quality condition of surface water within and around the prospecting area, and to draft a water monitoring programme for the project site and provide recommendations.
- Prediction of the environmental impact of the proposed prospecting activity on the hydrological regime of the area.
- Forecasting the effects of the activity on the receiving environment.

1.2 Proposed Activities

Prospecting Right Activities which have the potential to impact the surface water and groundwater in the area includes:

- Core-logging.
- Core-Sampling.

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- Mapping.
- Core-Drilling.

Prospecting activities will be undertaken over a period of five (5) years and are designed in phases, each phase is conditional on the success of the previous phase. Both invasive and non-invasive methods will be implemented. Invasive are those activities which have footprint or cause harm (if not mitigated or managed properly) or those that have a physical impact on the environment, while non-invasive do not cause any harm or effects on the environment.

Non-invasive: Desktop study of the area has commenced, and this incorporates desktop geographical and geological mapping. This will be followed by detailed geochemical and geotechnical surveys. In turn, this is followed by detailed geophysical studies.

Invasive: A detailed drilling, sampling, assaying and mineralogical study will be carried out. Diamond method will be utilised to prospect pseudocoal and torbanite/oil shale deposits. To ensure or minimise impacts on the receiving environment, All the activities will be guided by the project's BAR & EMPr.

1.3 Scope of Work

- Baseline study
    - A desktop study was conducted to evaluate current and previous land uses to assess the implications for hydrology contaminations.
    - Site visit to correlate the information that was collected during the desk study.
    - Maps from the hydrology study will be used to indicate the catchment areas and any strategic points.
    - The Mean Annual Runoff (MAR), peak flow rates and volumes will be estimated for these catchments using WR2012 data.

- Impacts assessment
    - All surface water impacts will be described, and mitigation measures will then be proposed as normally required for the Environmental Impact Assessment/Environmental Management Plan (EIA/EMP), for the construction, operation, decommissioning, and post closure phases.

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1.4 Project Location

The locality map created by the QGIS illustrates the location of the proposed area is located on all portions of the farm ST Helena 67 HT, situated under the magisterial district of Mkhondo, Mpumalanga Province. The project area as seen on Figure 1 below, is situated approximately 1.75 km east of Dirkiesdorp, and approximately 32.39 km Northeast of Wakkerstroom. The project area is situated on **S -27.108456** and **E 30.420841** co-ordinates.

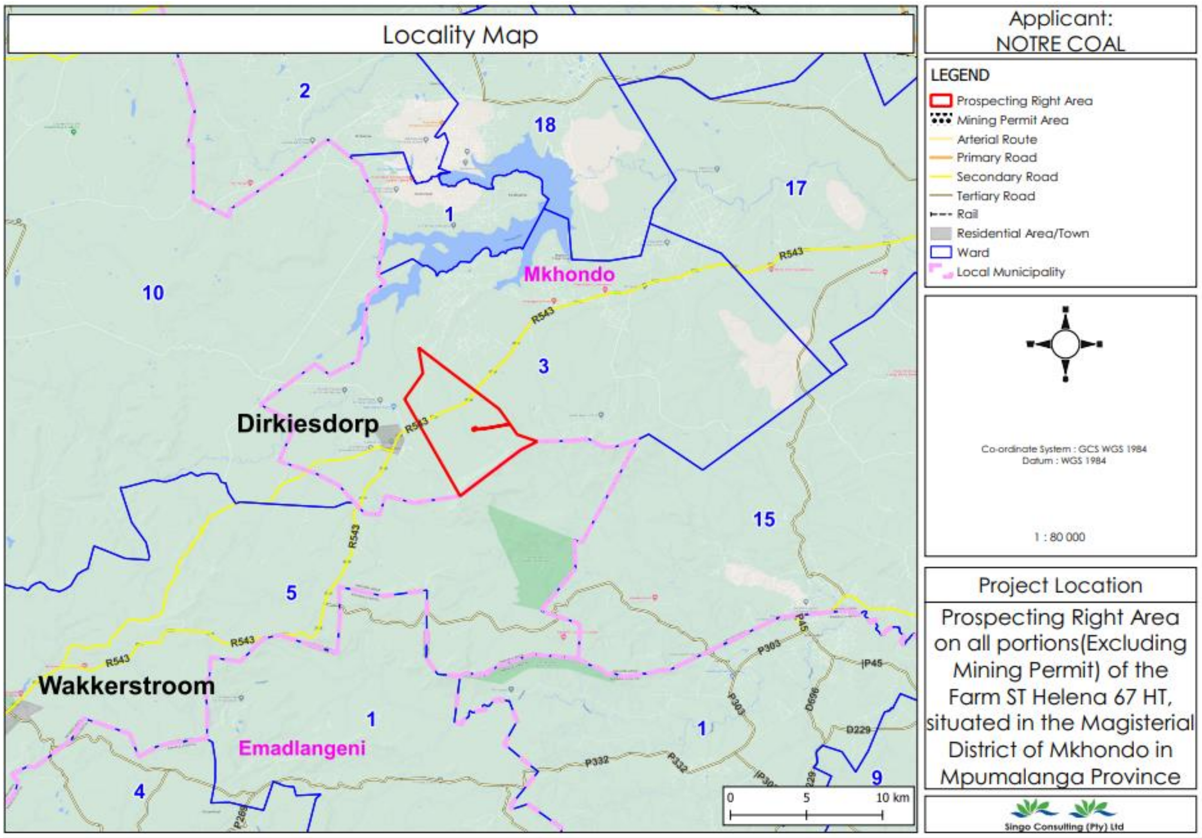

Figure 1: Locality map of the study area

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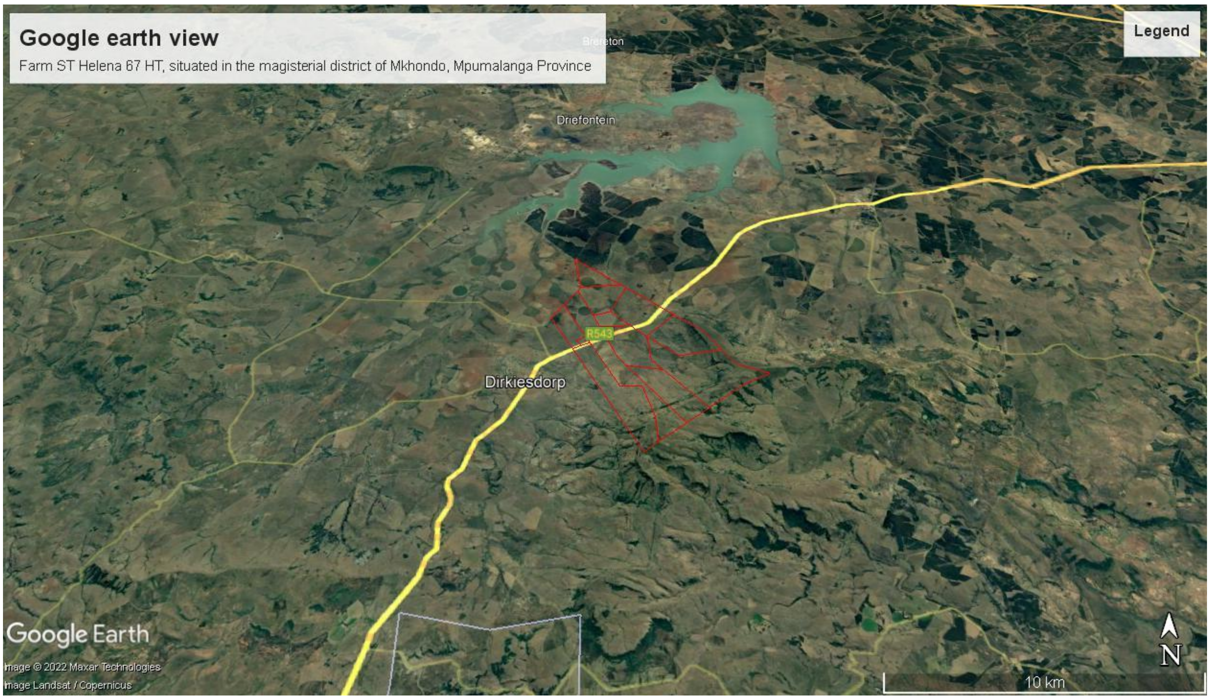

Figure 2: Google earth view of the project area

2 RELEVANT LEGISLATION AND STANDARDS

Government Notice 704 (Government Gazette 20118 of June 1999) (hereafter referred to as GN 704), was established to provide regulations on the use of water for mining and related activities aimed at the protection of water resources.

- **Condition 5** - which indicates that no residue or substance which causes or is likely to cause pollution of a water resource may be used in the construction of any prospecting work.
- **Condition 7** - which describes the measures which must be taken to protect water resources. All dirty water or substances which may cause pollution will be prevented from entering a water resource (by spillage, seepage, erosion etc) and ensure that water used in any process is recycled as far as practicable.

2.1 Legal Framework

DWA's vision for water quality management in South Africa is to:

- Ensure the continuous improvement of Water Quality Management.
- Become a recognized world leader in Water Quality Management.
- Be proactive, dynamic, efficient, and effective in its delivery of services to the public.
- Provide the necessary policies and systems to ensure integrated sustainable management of water quality.
- Promote cooperative governance across all spheres of management and
- Ensure a fully capacitated, loyal workforce to support its functions.

2.2 National Legislation

National legislation applicable to surface water management includes:

- Constitution of the Republic of South Africa, 1996 (No. 108 of 1996) – The Bill of Rights states that everyone has the right to an environment that is not harmful to their health or well-being.
- National Water Act, 1998 (Act 36 of 1998) – Provides for the protection of the quality of water and water resources in South Africa and provides for the establishment of Water Management.

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2.3 National Policy/Guidelines

National policy and guidelines applicable to surface water management includes:

- South African Water Quality Guidelines, First Edition, 1996 – These guidelines set out the minimum water quality requirements for a range of water quality parameters for each water user.
- Development of a Waste Discharge Charge System: Framework Document. Second Edition, 2000 – Provides a framework for the implementation of a system to charge for water use such as the discharge of waste that impacts on water resources.
- Best Practice Guidelines for the mining sector, DWAF 2006, 2008 dealing with aspects of DWA's water management hierarchy and deals with integrated mine water management, pollution prevention and minimisation of impacts, water reuse and reclamation and water treatment.
- Best Practice Guidelines for the mining sector, DWAF 2006, 2008 dealing with general water management strategies, techniques and tools which could be applied cross – sectorial and deals with storm water management, water and salt balances, water monitoring systems, impact prediction.
- Best Practice Guidelines for the mining sector, DWAF 2006-2008 dealing with specific mining activities and addresses the prevention and management of impacts from small scale mining, water management for Mine Residue Deposits, pollution control dams, water management for surface mines, and water management for underground mines.

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3 HYDROLOGICAL SETTING AND BASELINE HYDROLOGY

3.1 Climate

Climate is the state of the atmosphere over long time periods, such as over years, decades, centuries or greater and weather is defined as atmospheric conditions of an area over a short period of time (Naomi, 2004). Climate for the purpose of the study is chosen based on the fact that it does not change over a long period of time whereas weather conditions fluctuate more rapidly, and its data cannot be relied upon. The climate here is mild, and generally warm and temperate. According to Köppen and Geiger, this climate is classified as Cwb. In Mkhondo, the average annual temperature is 16.1 °C. About 954 mm of precipitation falls annually. Precipitation is the lowest in June, with an average of 12 mm. The greatest amount of precipitation occurs in December, with an average of 165 mm. At an average temperature of 19.5 °C, February is the hottest month of the year. The lowest average temperatures in the year occur in July, when it is around 11.0 °C. Between the driest and wettest months, the difference in precipitation is 153 mm. The variation in temperatures throughout the year is 8.4 °C.

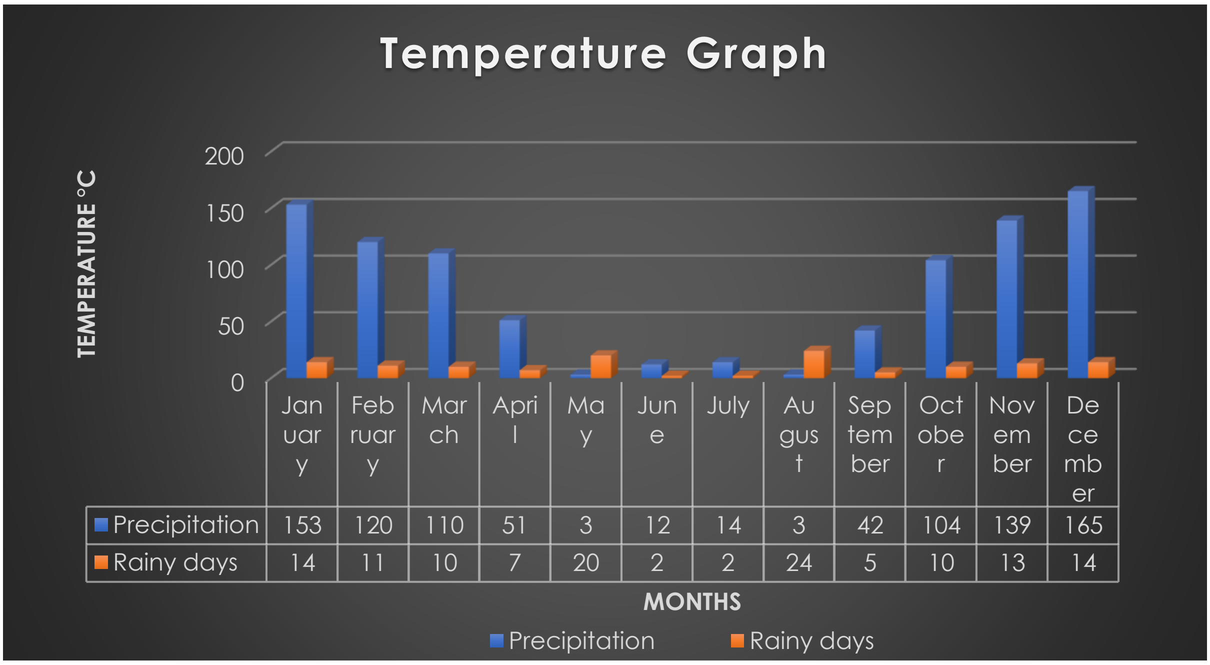

Figure 3: Monthly average temperature map

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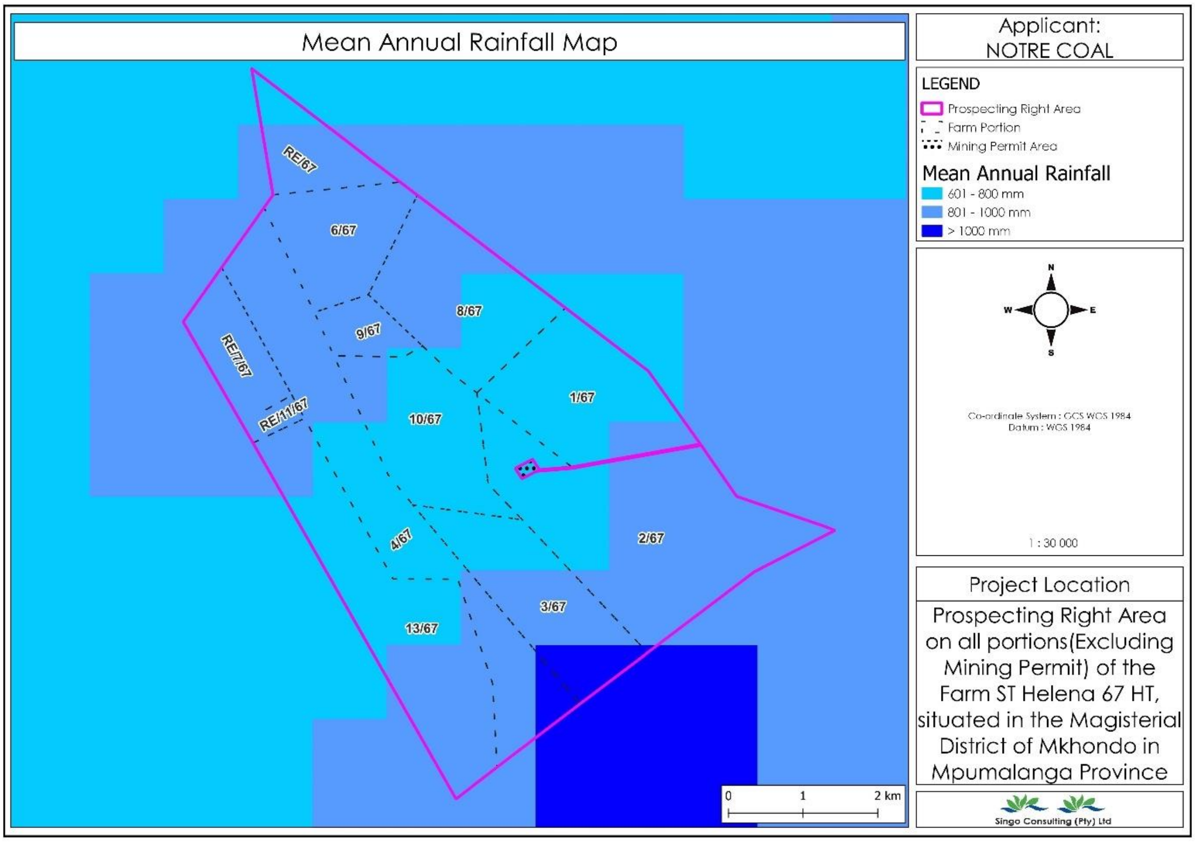

Figure 4: Mean annual rainfall map

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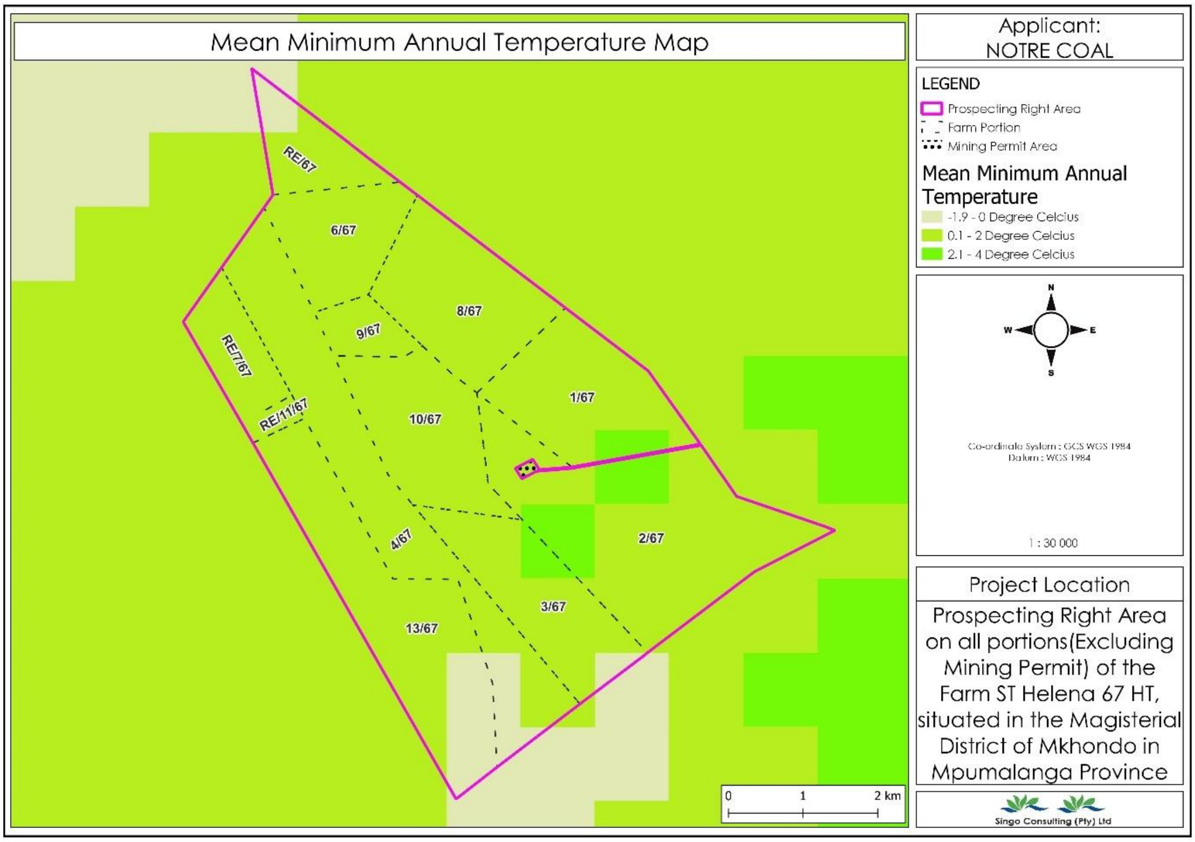

Figure 5: Mean minimum annual temperature map

3.2 Drainage and Topography

Topography is a field of geoscience and planetary science and is concerned with local detail in general, including not only relief but also natural and artificial features, and even local history and culture. The flow of water during rainy seasons flows from the area of high elevation to the area of low elevation. The Figure 6 below indicates that the following waterbodies exists within and nearby the prospecting right area:

- Perennial river.
- Dam.
- Non-perennial river.
- Channelled valley bottom wetland.
- Seep wetland.

The Figure 6: Hydrology and Topology map illustrates that contour lines are skewed to the Southeastern direction, indicating a steep surface, and the project area is situated on a slightly flat surface on the North and Northwestern side. On the Northern direction, the is a hill situated at about 1480 mamsl.

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A perennial river situated within the prospecting right area is flowing through the valley from the Southeastern direction towards the Northern direction. On the Northeastern side of the study area two dams are situated within a 2 km radius from the project area, these dams have dam walls in a direction against the flow of water (i.e., Dam situated on the eastern direction at about 1379 mamsl has a dam wall on the Northern direction, water flow is from the south towards the north).

Wetlands situated within the project area is only the depression wetland. Seep and channelled valley bottom wetlands are situated nearby the study area.

The Figure 7 below shows the landscape and waterbodies found within and nearby the project area.

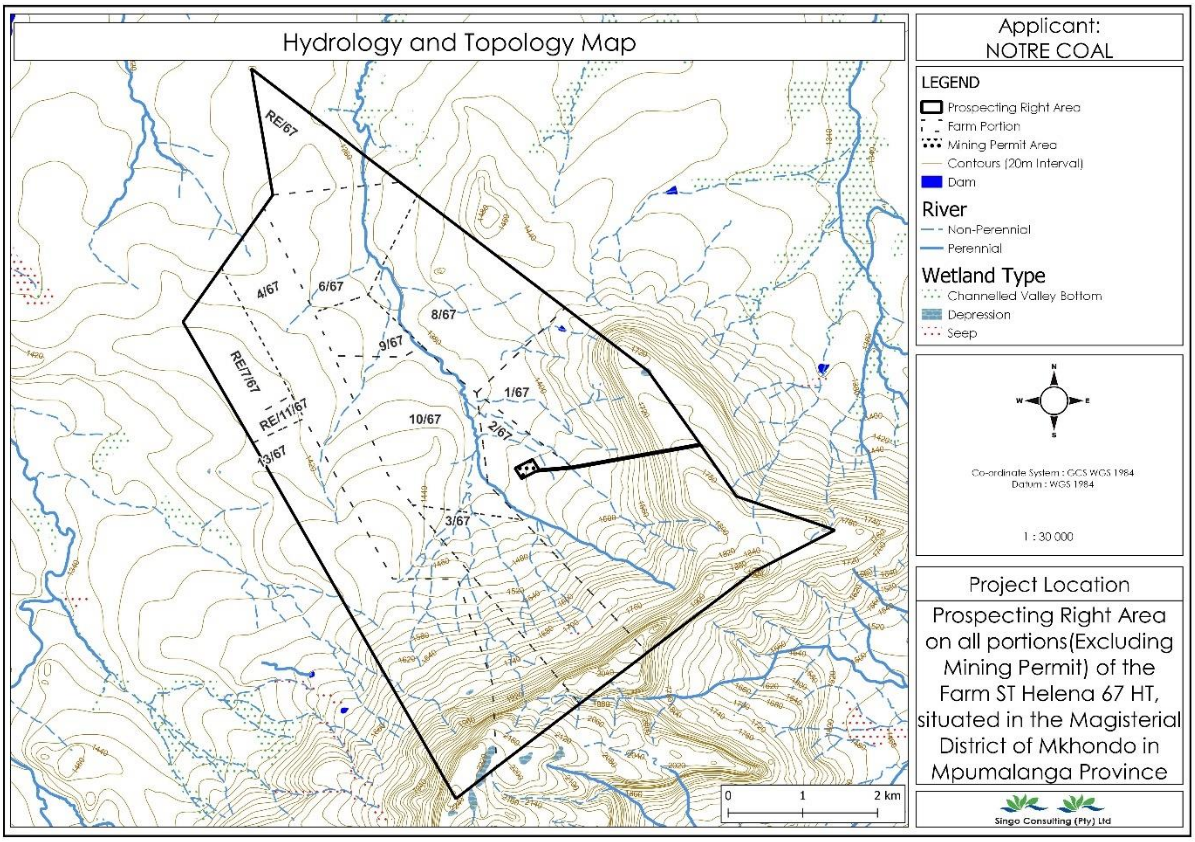

Figure 6: Hydrology and Topology map

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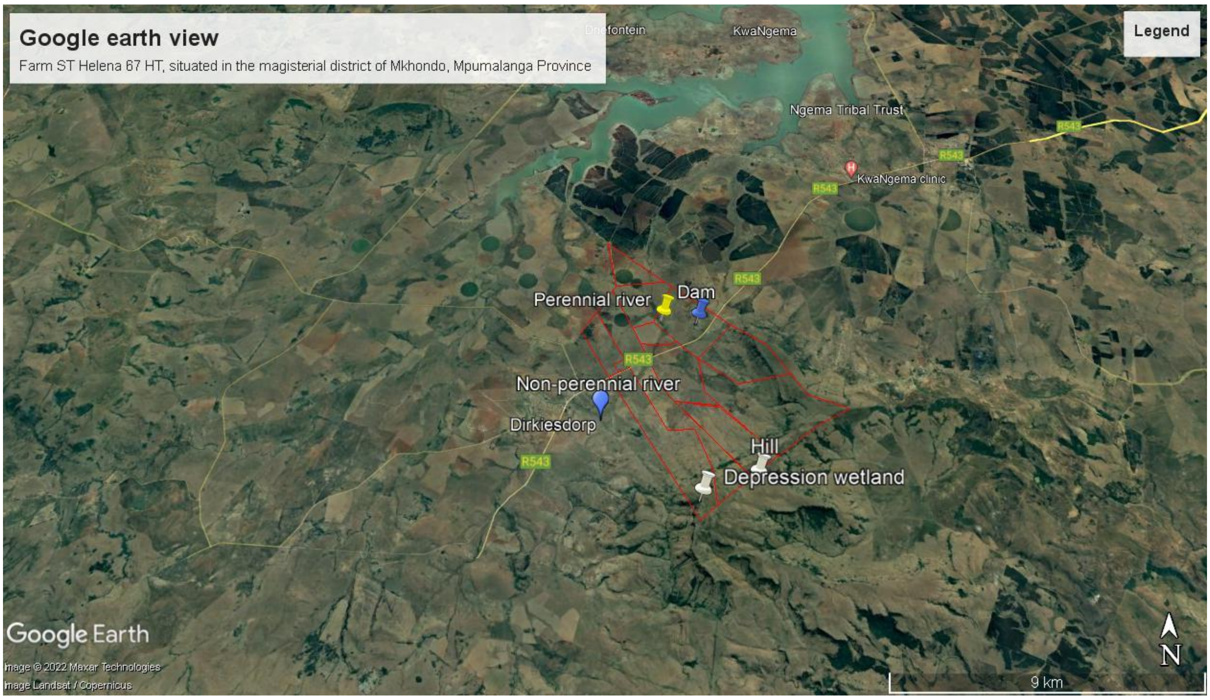

Figure 7: Landforms and waterbodies on site

3.3 Catchment Description

South Africa's water resources are divided into quaternary catchments, which are the country's primary water management units (DWAF 2011). In a hierarchical classification system, a quaternary catchment is a fourth order catchment below the primary catchments. The primary drainages are further classified as Water Management Areas (WMA) and Catchment Management Agencies (CMA). In accordance with Section 5 subsection 5(1) of the National Water Act, 1998, the Department of Water and Sanitation (DWS) has established nine WMAs and nine CMAs as outlined in the National Water Resource Strategy 2 (2013). (Act No. 36 of 1998). The purpose of establishing these WMAs and CMAs is to improve water governance in various regions of the country, ensuring a fair and equal distribution of the Nation's water resources while ensuring resource quality is maintained.

The prospecting area falls within the Inkomati-Usuthu Water Management Area (WMA). The quaternary catchment is W51B. The WRC 2012 study, presents hydrological parameters for each quaternary catchment including area, mean annual precipitation (MAP) and mean annual runoff (MAR).

Table 2: Quaternary Information data

Quaternary Catchment	Water Management Area	S-Pan Evaporation		Rainfall		Catchment Area
		Evaporation Zone	MAE (mm)	Rainfall Zone	MAP (mm)	
W51B	Inkomati-Usuthu	13A	1400	W5A	864	496

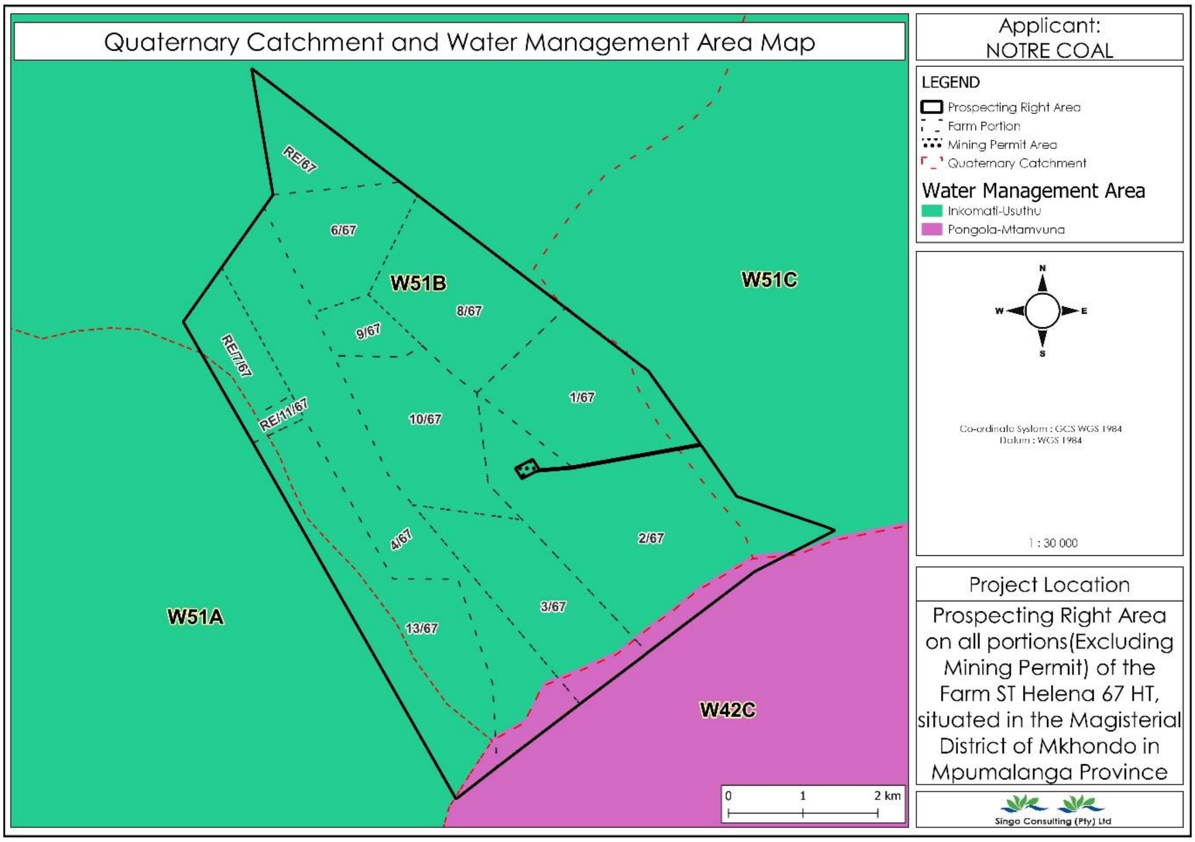

Figure 8: Quaternary Catchment and Water Management Area Map

3.4 Wetlands Delineation

According to National water Act 36 of 1998, a wetland is defined as Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil. Wetland delineation is the process of identifying outer edge of the temporary zone of the wetland.

Whilst the identification of a wetland is useful, normally the requirement (specifically for EIA and WULA applications) is for the wetland to be delineated – for its boundaries to be precisely determined so that it can be mapped out and indicated as a sensitive area. This edge marks the boundary between the wetland (water resource) and the adjacent terrestrial areas. This process is aided by using the various indicators which are used to identify a wetland, the indicators are as follows:

- The **position in the landscape**, which will help identify those parts of the landscape where wetlands are more likely to occur.
- The **type of soil form** (i.e., the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types.
- The presence of wetland **vegetation species.**
- The presence of **redoxymorphic soil features,** which are morphological signatures that appear in soils with prolonged periods of saturation (due to the anaerobic conditions which result).

To this study, redoxymorphic indicator will be used to delineate a wetland, this is because it is the most reliable, diagnostic indicator of wetland. These features develop due to prolonged saturation (and associated anaerobic conditions) and can be used to indicate zones of a permanently, seasonally, or temporarily high-water table, as described in the characteristics of the permanent, seasonal, and temporary wetland zones in the national water Act 36 of 1998.

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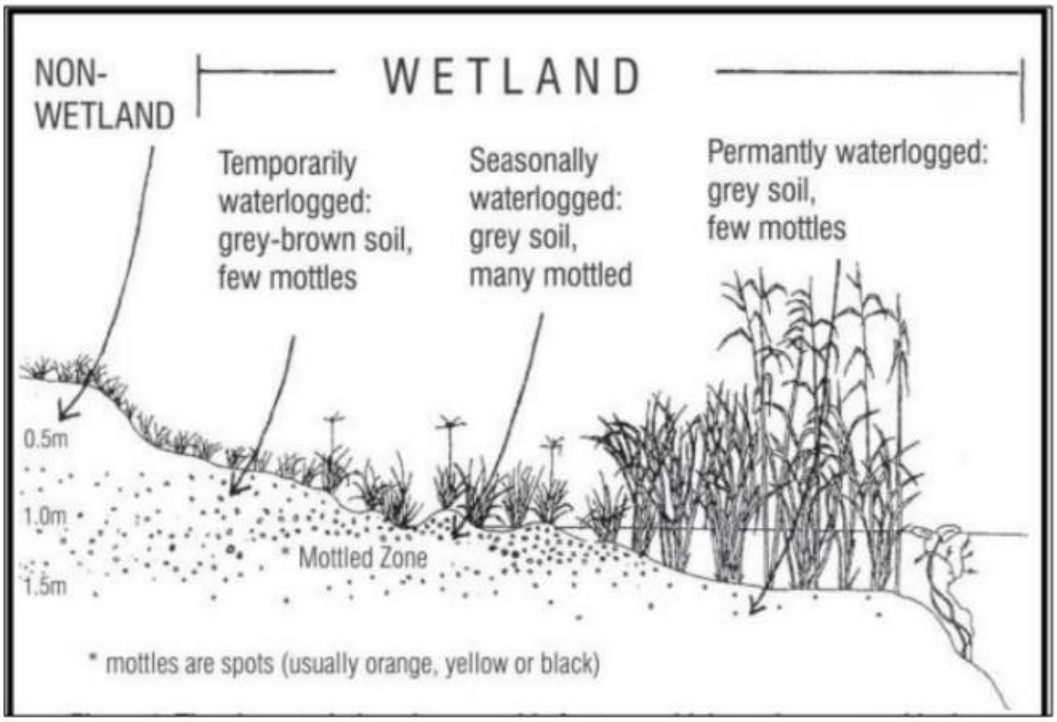

Figure 9: The characteristics of redoxymorphic indicator (DWAF, 2008)

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Redoxymorphic features as an indicator of a wetland presence.

Water is the most important criterion for defining land as a wetland, with "the water table at or near the surface, or the ground is occasionally covered with shallow water" being the most important. Unfortunately, due to southern Africa's very fluctuating climate, the water table may not always remain at or near the surface in a consistent, predictable manner year after year, or even seasonally predictable. The existence of the water table (or the extent of flooding) will not always be a highly useful criteria for detecting wetlands due to intra- and inter-annual fluctuations in the extent of saturation/inundation of wetlands. As a result, the fundamental wetlands classification criterion – a high water table and/or frequent flooding – cannot be accurately measured.

Roots and microorganisms eventually deplete the oxygen contained in pore spaces in soil that has been saturated for an extended period. The oxygen consumed in this fashion would be replaced by diffusion from the air at the soil surface in an unsaturated soil. However, because oxygen diffuses 10 000 times slower via water than it does through air, restoring depleted soil oxygen in a saturated soil takes much longer. As a result, once the oxygen in a saturated soil is gone, the soil becomes practically anaerobic. Long-term anaerobic soil conditions cause changes in the chemical properties of the soil's mineral constituents, which are visible as colour changes in the soil. As a result, even a high-water table. Although the frequency of flooding cannot be directly assessed, it is possible to analyse soil parameters for signs of saturation by looking for redoxymorphic traits that come from prolonged anaerobic conditions. The two important redoxymorphic features are mottling and gleying Figure 9; both features caused by prolonged saturated conditions in the soil and the subsequent development of anaerobic conditions.

Gleying: is characterised by the development of grey or blueish-grey colours in the mineral soil component. Certain soil components, such as iron and manganese, are insoluble under aerobic conditions. Iron is one of the most abundant elements in soils, and the iron oxide (rust) coatings over soil particles is responsible for the red and brown colours of many soils. However, under prolonged anaerobic conditions iron becomes soluble and can thus be dissolved out of the soil profile. Once most of the iron has been dissolved out of a soil, the soil matrix is left a greyish, greenish, or bluish colour, and is said to be Gleyed.

Mottling: follows the same initial process as gleying, in that the iron becomes soluble and dissolved under anaerobic conditions. A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic

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conditions in the soil. Lowering of the water table results in a switch from anaerobic to aerobic soil conditions, causing dissolved iron to return to an insoluble state and be deposited in the form of patches, or mottles, in the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these bright (orange or red) insoluble iron compounds. Thus, soil that is Gleyed but has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated.

Table 3: Greying and Mottling

Red colour spots indicate mottles on the soil	
Greying	

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Using redoxymorphic features to identify a wetland.

The outer edge of the temporary zone of the wetland should be determined. This should be done using a transect-based approach in the field. Starting from the wettest (central or lowest lying) part of the wetland, move perpendicularly upslope towards the surrounding terrestrial areas, sampling (with the aid of an auger or through other excavation means) the soil to a depth of at least 50cm. Note the presence of any gleying or mottling (Rountree et al., 2008). Ensure that the indicators observed meet the requirements prescribed for the redoxymorphic indicators of wetland soils. Continue moving outwards from the wetland until the redoxymorphic indicators of wetland soils can no longer be found within the top 50cm of the soil. This will be the outer edge of the temporary wetland zone. At this stage the boundary indicated by redoxymorphic features should be verified using the vegetation indicators.

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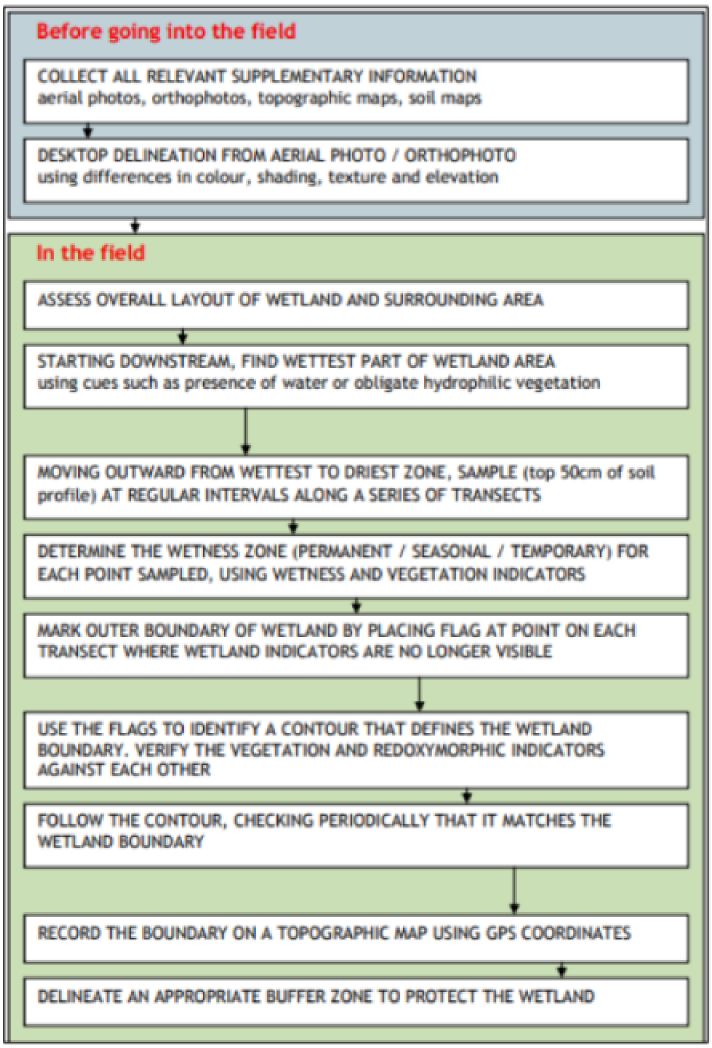

Figure 10: Wetland delineation process (DWAF, 2008)

3.5 Buffer Zones

During the prospecting right activities which will include, logging, sampling, mapping, and drilling. Caution must be taken with regards to the water bodies existing within and surrounding the proposed project area. This includes the implementation of buffer zones. Buffer zones as depicted by the map will be the areas where the prospecting team will be notified not to conduct any activities within the depicted 100m radius from the water bodies. No washing of any mechanical equipment's or vehicles will be allowed near the water resources, and all the water bodies will be buffered, a 100m buffer will apply.

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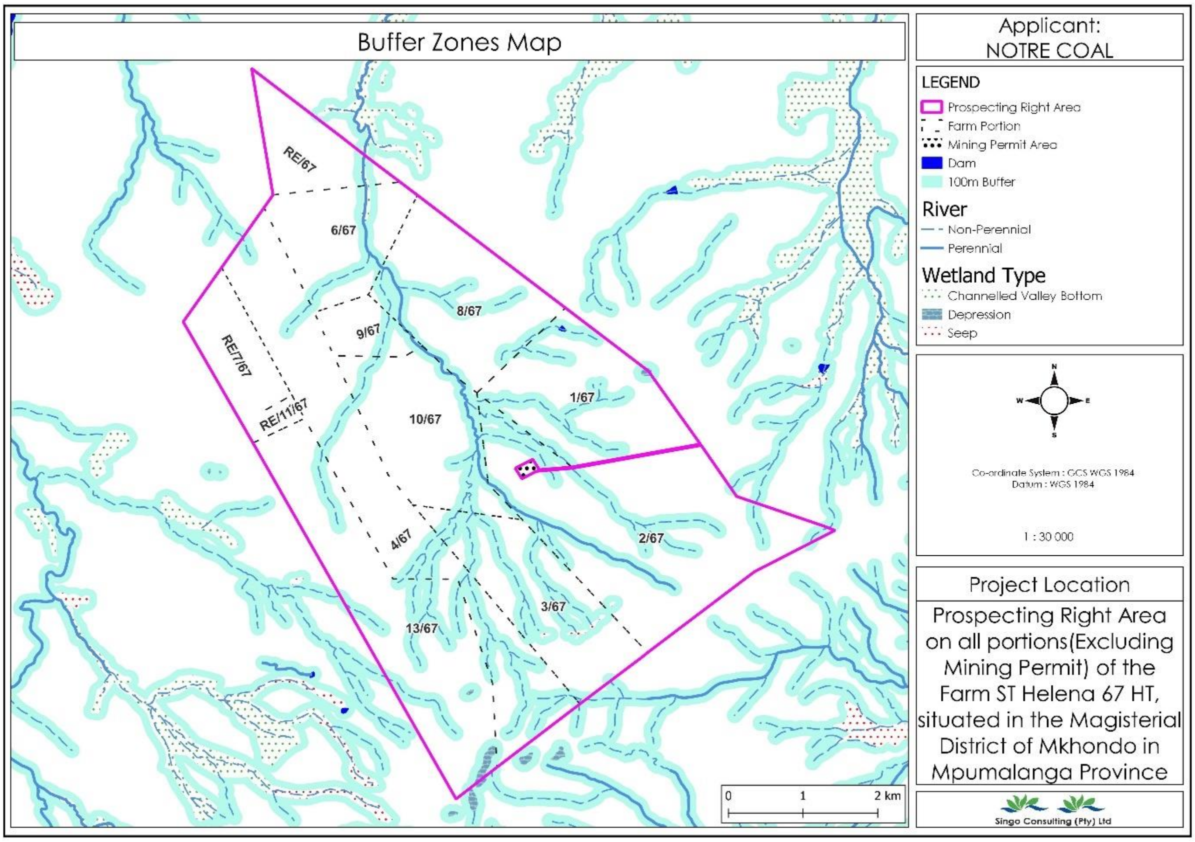

Figure 11: Buffer zone map of the study area

3.6 Vegetation and Soil

3.6.1 Vegetation

The study area is covered with wet cold Highveld Grassland, this grassland type is a wet grassland found largely on wet, deep, clayey, poorly drained, seasonally wet soils next to wetlands such as Vleis, spruits, and rivers, and is usually restricted to low plains or bottomlands. These ecosystems are frequently unstable because to seasonal flooding and drying, which, along with regular overgrazing, results in vegetation destruction.

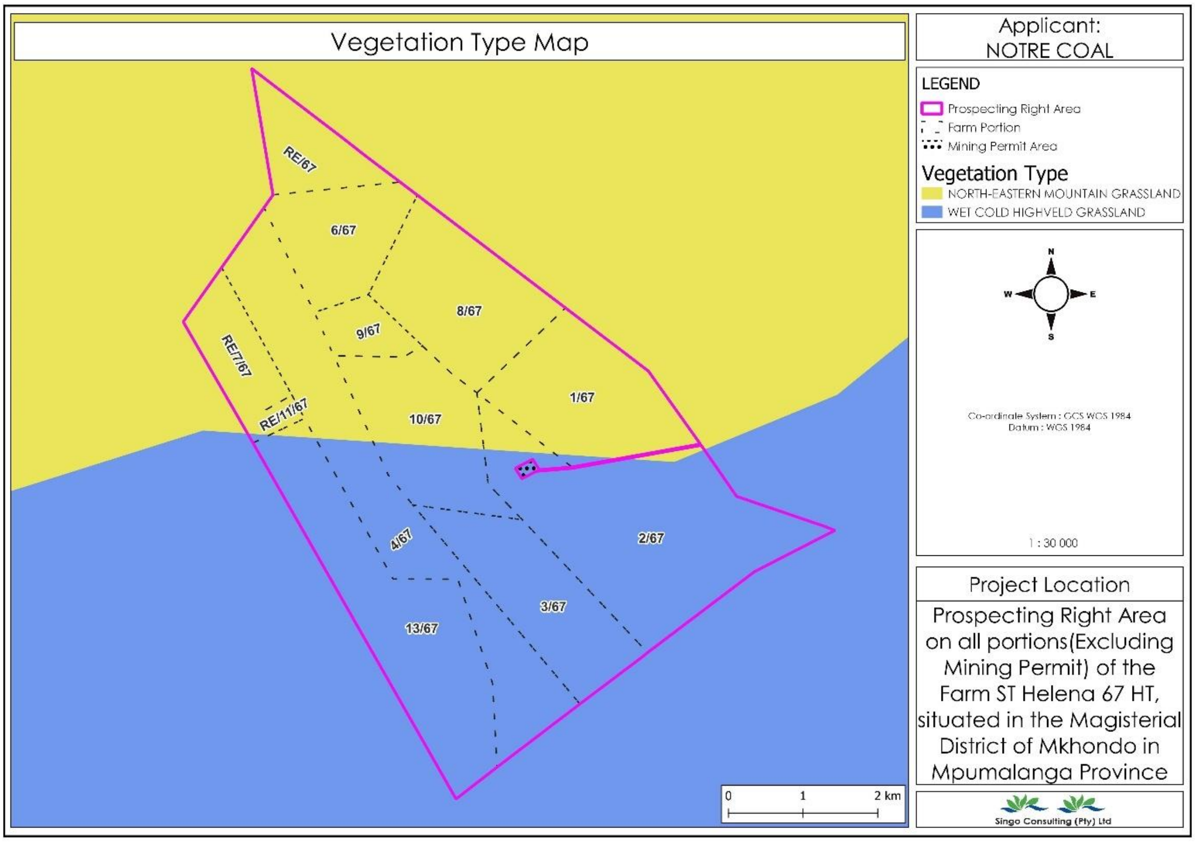

Figure 12: Vegetation type within the study area

3.6.2 Soil

The prospecting right area is covered by the **freely drained, structureless soils, Association of classes 1 to 4: Undifferentiated structureless soils, Association of classes 13 and 16: Undifferentiated shallow soils and land classes and the association of classes 17 and 18: structureless soils and clays**

freely drained, structureless soils and Association of classes 1 to 4: Undifferentiated structureless soils

Soil drainage

The Freely drained, structureless soils can be defined based on their soil depth, Soil Drainage, erodibility, and natural fertility.

Soil depth

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Depth of the soil profile is from the top to the parent material or bedrock. This type of soil can be classified as a restricted soil depth. A restricted soil depth is a nearly continuous layer that has one or more physical, chemical, or thermal properties.

Soil Drainage

Soil drainage is a natural process by which water moves across, through, and out of the soil because of the force of gravity. The soils in the proposed area have an excessive drainage due to the soils having very coarse texture. Their typical water table is less than 150.

Erodibility

Erodibility is the inherent yielding or non-resistance of soils and rocks to erosion. The freely drained structureless soils have high erodibility. A high erodibility implies that the same amount of work exerted by the erosion processes lead to a larger removal of material.

Natural Fertility

Soil fertility refers to the ability of soil to sustain agricultural plant growth, i.e., to provide plant habitat and result in sustained and consistent yields of high quality. The soil, as a nature of them, contains some nutrients which is known as 'inherent fertility'. Among the plant nutrients, nitrogen, phosphorus, and potassium is essential for the normal growth and yield of crop. The proposed area has a low natural fertility soil.

Association of classes 13 and 16: Undifferentiated shallow soils and land classes:

The Favourable properties of Association of Classes 13 and 16: Undifferentiated shallow soils are that the soil may receive water runoff from associated rock; water-intake areas. The soil has Restricted land use options.

Solum depth is less than 50 cm in shallow soils. They usually have a thin A horizon over the parent material or bedrock. The total depth of the A and B horizons does not exceed 50 cm if there is a B horizon beneath the A horizon. Moderately deep soils have a solum depth of 50–100 cm, whereas deep soils have a solum depth of greater than 100 cm. High Mountain and valley soils are typically quite shallow and devoid of considerable topsoil. They are easily eroded. Earlier soil classification systems referred to such shallow soils on bedrock as Lithosols.

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Association of classes 17 and 18: structureless soils and clays:

These soils class has the potential to shrink and swell. The swelling and shrinkage of these soils is influenced by:

- Soil Structure
- Density
- Confining pressure
- Moisture content
- Climate change

The clay soils are also referred to as 'expansive soils' and are associated with **"Heaving".**

Heave

During infiltration of water, clays tend to absorb the water and shrink as a result, however during dry seasons (no rainfall), high temperatures influence evaporation and the clay tend to shrink.

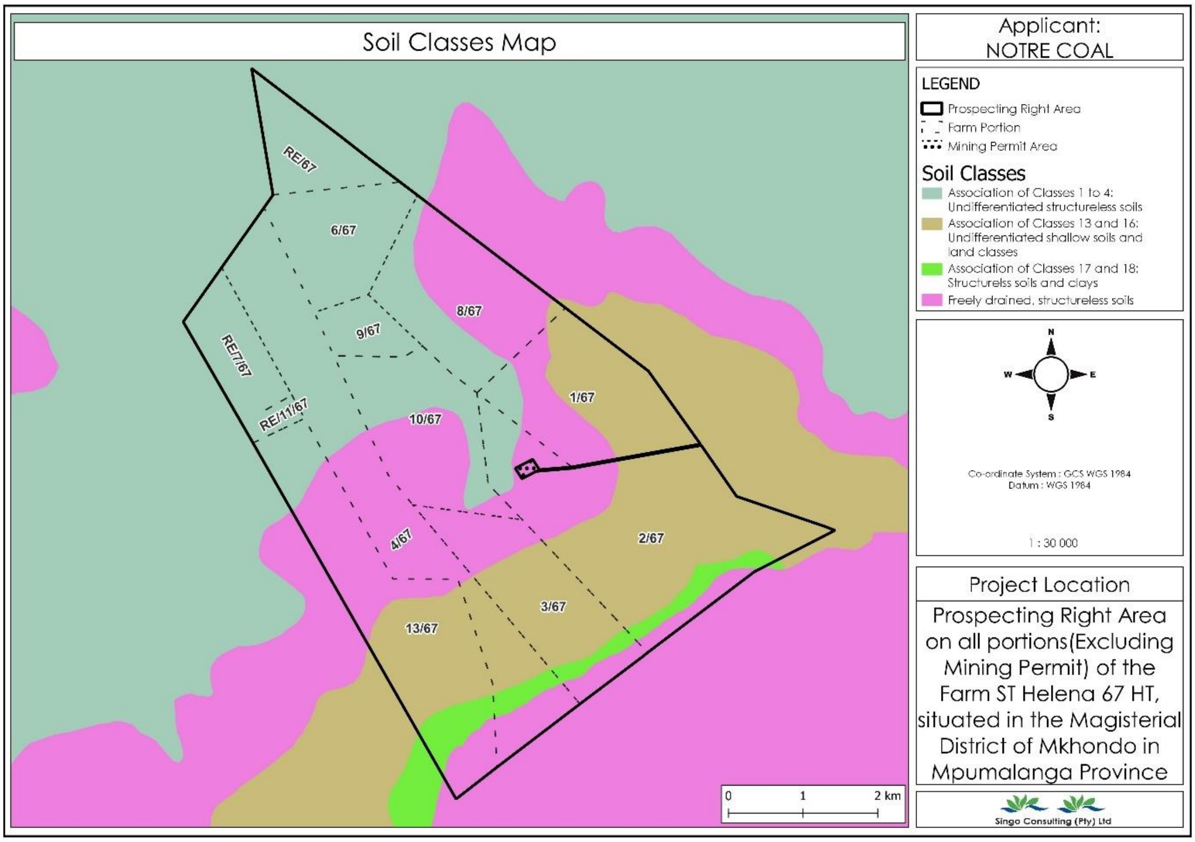

Figure 13: Soil class map

3.7 Geological setting

Regional Geology

Karoo Supergroup

he main Karoo Supergroup basin covers over 50% of South Africa's surface and consists of five age-based groups, which show a change of depositional environment in time. These groups are the Dwyka (glacial), Ecca (shallow marine and coastal plain), Beaufort (non-marine fluvial), Stormberg (aeolian) and the volcanic Lebombo or Drakensberg groups (Johnson et al., 2006). The proposed project area falls within the Ermelo Coalfield which hosts thinner seams that are more sedimentological and structurally complex. Sediments of Vryheid and Dwyka formations underlay the area which was deposited on a glaciated Pre-Karoo basement consisting of Rooiberg felsites. The deposit is preserved as an outlier underlying the small hill known as Vlooikop, surrounded by strata of the Dwyka Group (mainly tillites and varved mudstones/shales).

The Vryheid formation is essentially an interbedded succession of sandstone with lesser gritstone, siltstone, and mudstone, which contains five coal seams of the Ermelo coalfield, as shown in Figure 16 below.

Dwyka Group

The rocks of the Dwyka Group in South Africa are amongst the most important glaciogenic deposits from Gondwana. This Group is named for exposures along the Dwyka River east of Laingsburg and forms the basal succession of the Karoo Supergroup. Dwyka Group strata are mostly contained within bedrock valleys incised into Archean to lower Palaeozoic bedrock (Visser, 1990; Visser and Kingsley, 1982; Von Brunn, 1996). The lithologies in the areas underlying the coalfields of South Africa consist of a heterolithic arrangement of massive and stratified polymictic diamictites, conglomerates, sandstones, and dropstone-bearing varved mudstones. The easily identifiable lithologies form a good marker below the coal bearing Ecca Group. In the distal sector of the MKB these sedimentary strata accumulated largely as ground moraine associated with continental ice sheets and is generally composed of basal lodgement and supraglacial tills. These deposits are generally massive, but crude horizontal bedding occurs in places towards the top (Tankard et al., 1982).

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Ecca Group

In the 1970s several studies (Cadle, 1974; Hobday, 1973, 1978; Mathew, 1974; Van Vuuren and Cole, 1979) showed that the Ecca Group could be subdivided into several informal units based on the cyclic nature of the sedimentary fills. In 1980 the South African Committee for Stratigraphy (SACS, 1980) introduced a formal lithostratigraphic nomenclature for the Ecca Group in the northern, distal sector of the MKB, which replaced the previously used informal Lower, Middle and Upper subdivisions with the Pietermaritzburg Shale Formation, the Vryheid Formation, and the Volksrust Shale Formation.

In general, the coal deposits in South Africa are hosted in the Karoo Supergroup, which was deposited in the Gondwana basin that covered parts of Africa, Antarctica, South America, and Australia. The basal stratigraphy of the Karoo Supergroup comprises the Dwyka Group, which is a Late Carboniferous to Early Permian (~320 Ma) sequence of glacial and periglacial sediments, including diamictite, till moraine, conglomerate, sandstone, mudstone and varved shale. This is overlain by the Ecca Group, which is an Early to Late Permian (~260 Ma) sequence comprising sandstone, siltstone, mudstone and significant coal seams deposited in a terrestrial basin on a gently subsiding shelf platform.

In South Africa, based on the literature; only 19 coalfields are generally accepted which cover an area of approximately 9.7 million hectares (ha). The distinction between coalfields is based on geographic considerations and variations in the mode of sedimentation, origin, formation, distribution, and quality of the coals. (Hancox & Annette, 2014).

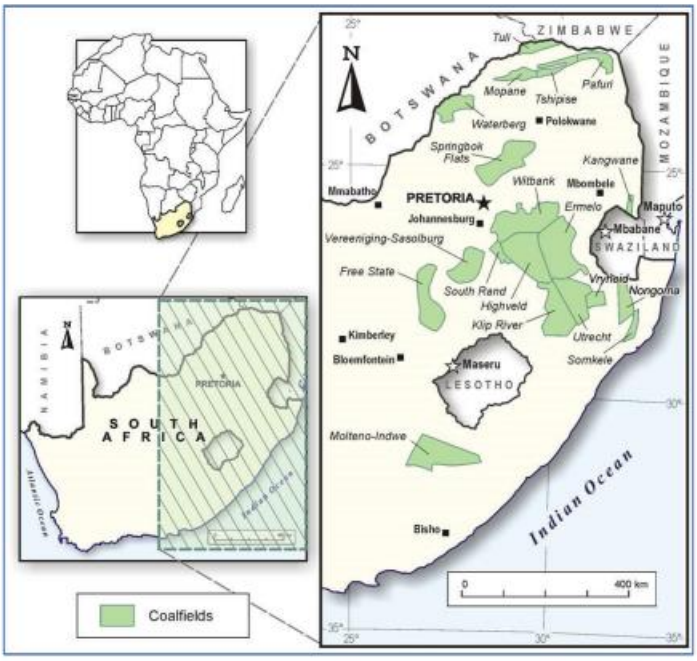

Figure 14: South Africa's Coalfields, Snyman (1998).

Ermelo Coalfield

The Ermelo Coalfield is located in the districts of Carolina, Dirkiesdorp, Hendrina, Breyten, Davel, Ermelo and Morgenzon in the southeast Mpumalanga Province. It extends approximately 75 km east-west, and 150 km north-south, covering an area of about 11,250,000 ha. The northern and eastern boundaries of the Ermelo Coalfield are defined by the sub-outcrop of the coal-bearing strata against pre-Karoo basement. In the west, the Ermelo Coalfield shares a boundary with the Witbank and Highveld coalfields, and to the south with the Klip River and Utrecht coalfields of KZN (Greenshields, 1986).

Rocks of the Permian Vryheid Formation and Jurassic aged dolerites dominate the surface exposures of the coalfield. As in the Witbank and Highveld coalfields the Vryheid Formation is the coal bearing horizon in the Ermelo Coalfield and five coal seams are also recognised within an 80-90 m thick sedimentary succession. Unlike in the Witbank and Highveld coalfields, the seams are given letters as codes and are named from the top to bottom the A to E seams (Wyburgh, 1928).

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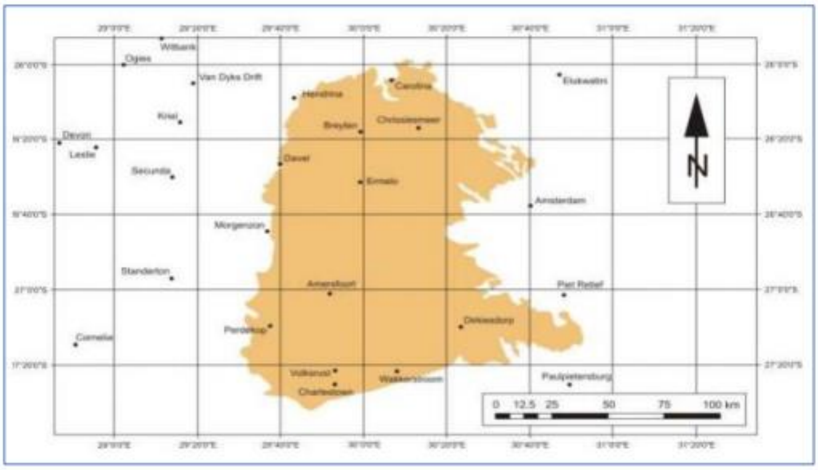

Figure 15: Geological extent of the Ermelo Coalfield

The coal seams in the Ermelo Coalfield are generally flat-lying to slightly undulating and as for the Witbank and Highveld coalfields, are separated by fine- to coarse-grained sandstones, siltstones and mudstones. The A, D and E seams are usually too important in the Carolina–Breyton area, and the B Seam group in the Ermelo area. Rapid seam thickness variations characterise the coalfield.

The E Seam may reach a thickness of up to 3m but is of economic importance only in isolated patches in the north of the Ermelo Coalfield (Greenshields, 1986). The coal is mostly bright and banded, has a competent sandstone roof and floor and is sometimes split by a thin sandstone or carbonaceous fines parting (Greenshields, 1986). In the central and southern part of the coalfield, it is developed as a torbanite or as a carbonaceous siltstone or mudstone unit, and locally becomes too thin for mining (Greenshields, 1986).

The coal of the D Seam is of good quality, but in general is too thin (0.1–0.4 m) to be of economic importance (Greenshields, 1986). The coal is not split by partings and consists of large amounts of vitrain and occasional durain bands (Greenshields, 1986; Jeffrey, 2005a). The C Seam group has been one of the main seam packages of economic importance throughout the Ermelo Coalfield. It is usually split by several partings which can lead to miscorrelation of the seams (Greenshields, 1986). In general, the C Seam is subdivided into the C Upper (CU) and C Lower (CL) seams. The CU Seam is well-developed over the entire coalfield and is often split by partings of different lithologies, such as sandstone, siltstone or mudstone, reaching a composite thickness of 0.7–4 m. It has historically been mined in several collieries of the Ermelo Coalfield, including the Golfview, Usutu, Goedehoop, Union, and Kobar collieries (Greenshields, 1986), as well as more recently at the Ferreira opencast mine.

The CL Seam is not developed throughout the entire coalfield, but where developed is between 0.5 and 2 m thick. It locally grades into carbonaceous siltstone and mudstone, which often form the roof of the seam, whereas the floor mostly consists of sandstone. It has historically been mined at the Savmore, Anthra, Ermelo, Golfview, and Wesselton mines (Greenshields, 1986; Paulson and Stone, 2002). Several other mines in and around the towns of Ermelo and Breyten have at times extracted coal from this seam including the Spitzkop, Bellevue, Grenfell, Usutu, Consolidated Marsfield, and Union collieries. The CL was also the main target seam at CCL's Ferreira opencast mine, and it is also currently being mined underground at their Penumbra mine, where it occurs at an average depth of around 100 m. It is the thickest of all the coal seams intersected here, reaching a thickness of more than 1.5 m over large parts of the project area. Locally seam floor rolls may negatively influence the thickness of the CL Seam in the Ermelo Coalfield.

The B Seam group varies in thickness from 1 to 2.7 m and may be split into three units. Greenshields (1986) terms these the B1, B and BX seams, but they are more commonly referred to as the B Lower.

Marsfield collieries, and was the seam mined at CoAL's Mooiplaats Colliery, where it is between 0.6 and 2.87 m thick. The BU was mined at the end of the mine life at the old Usutu Colliery, and the BL at the Ferreira mine. At Mooiplaats the BU Seam occurs at depths of between 90 and 140m and ranges in thickness between 0.15 m in the southeast to over 3 m in the north.

The A Seam occurs only in the northern and central parts of the coalfield, where it varies in thickness from 0 to 1.5 m (Greenshields, 1986). Wakerman (2003) provides a weighted average thickness of 0.94 m for the seam thin to be of economic interest and historically the C Seam group was the most in the Sheepmoor exploration area. Over most of the Ermelo Coalfield however this seam has been removed by erosion. Like in the Witbank and Highveld coalfields for the No. 5 Seam, the A Seam is overlain by a green glauconitic sandstone that forms a useful

marker horizon and denotes the transition from a fluvio-deltaic to a marine depositional environment.

Dykes are common throughout the coalfield and the frequency of sills increases southwards. Dolerite sills displace the coal seams causing structural complications and also cause devolatilization of the coal (destruction of quality).

The coal of the Ermelo Coalfield, while variable in quality, is generally bituminous with the following airdried raw quality parameters of; calorific value 24MJ/kg, 23% ash, volatiles 26 %, inherent moisture 3 %, fixed carbon of 48% and 1.2 sulphur. Table 1 summarises the average thickness and quality of the various coal seams within certain areas of the Ermelo Coalfield.

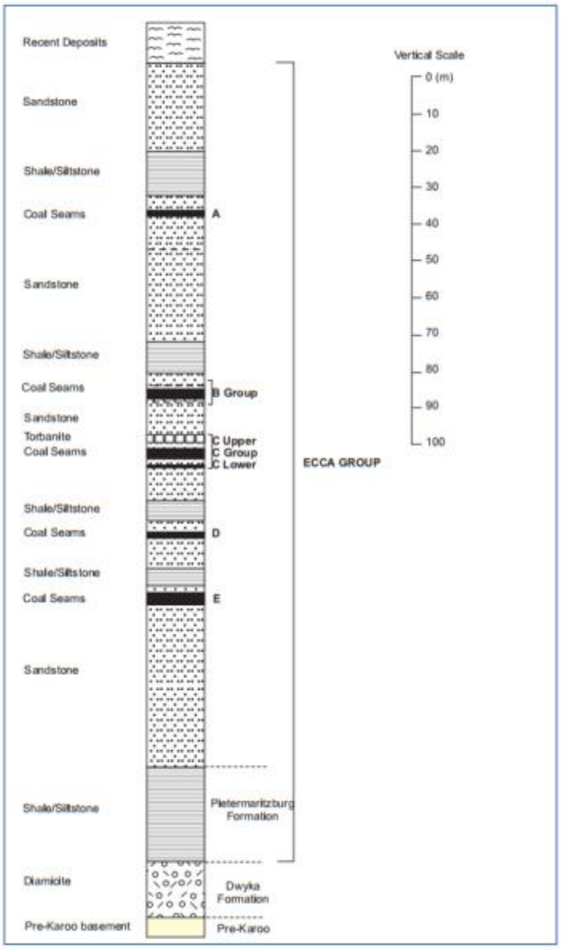

Figure 16: A typical representation of coal seams in the Ermelo Coalfield.

Local Geology

The geological formations in the project area includes Vryheid formation, Volksrust Formation and the Karoo Dolerite Suite.

Vryheid formation

This formation has been subdivided into three different lithofacies arrangements. They are dominated by fine-grained mudstone, carbonaceous shale with alternating layers of bituminous coal seams, and coarse-grained, bioturbated immature sandstones respectively. The rock sediments are predominantly arranged in upward-coarsening cycles, although some fining-upward cycles are found in this formation's easternmost deposits. The alternating rock types observed in the Vryheid Formation indicate seasonal variations of storms and fairer weather in a pro-delta setting. The carbonaceous shales were formed below the water surface in anoxic conditions and the coal formed from compacted plant matter deposited at the bottom of peat swamps. These swamps formed on abandoned alluvial plains where stagnant water accumulated. The Vryheid Formation reaches a maximum of 1030m in Nongoma, KwaZulu-Natal, within the Nongoma Graben.

The majority of the economically extracted coal in South Africa occurs in rocks of the Vryheid Formation, which ranges in thickness in the MKB from less than 70.0 m to over 500.0 m. It is thickest to the south of the towns of Newcastle and Vryheid, where maximum subsidence took place (Du Toit, 1918; Cadle, 1975; Whateley, 1980a; Stavrakis, 1989; Cadle et al., 1982) and where the basin was the deepest. The coal seams in the Ermelo Coalfield are generally flat-lying to slightly undulating and as for the Witbank and Highveld coalfields, are separated by fine- to coarse-grained sandstones, siltstones, and mudstones. The A, D and E seams are usually too thin to be of economic interest and historically the C Seam group was the most important in the Carolina–Breyton area, and the B Seam group in the Ermelo area. Coal qualities. The coal of the Ermelo Coalfield, whilst variable in quality, is generally of better quality than that of the Witbank and Highveld coalfields (Hancox and Gotz, 2014).

Volksrust Formation

SACS (1980) applied the name Volksrust Shale Formation to the old "Upper Ecca Beds", with the choice of name based on a description given by Blignaut et al. (1952). The general thickness of the unit is between 150-250 m, and it is dominated by dark grey-green siltstones and mudstones, with phosphatic/carbonate/sideritic concretions. Cadle (1975) documents

that the Volksrust Formation shows an overall coarsening-upward trend. Coals occur interbedded with the mudstones in places, The Volksrust Formation is postulated to have formed in shallow to deep water basinal conditions. Paleontologically the Volksrust Formation is probably best known for its low diversity trace fossil assemblage (Tavener-Smith et al., 1988) and various organic microfossils. Macrofaunal remains include only various insects (Van Dijk, 1981) and a rare bivalve assemblage (Cairncross et al., 2005). Plant remains and fossilised wood are also known.

Karoo Dolerite Suite

The Karoo dolerite, which includes a wide range of petrological facies, consists of an interconnected network of dykes and sills and it is nearly impossible to single out any particular intrusive or tectonic event. It would, however, appear that a very large number of fractures were intruded simultaneously by magma and that the dolerite intrusive network acted as a shallow stockwork-like reservoir.

Dolerite dykes, like many other magmatic intrusions, develop by rapid hydraulic fracturing via the propagation of a fluid-filled open fissure, resulting in a massive magmatic intrusion with a neat and transgressive contact with the country rock. This fracturing mechanism is in contrast to the slow mode of hydraulic fracturing responsible for breccia-intrusions (i.e., kimberlite). For the intrusion to develop the magma pressure at the tip of the fissure must overcome the tensile strength of the surrounding rock. Dykes can develop vertically upwards or laterally along-strike over very long distances, as long as the magma pressure at the tip of the fissure is maintained. The intrusion of dolerite and basaltic dykes are therefore never accompanied by brecciation, deformation or shearing of the host-rock, at least during their propagation.

The average thickness of Karoo dolerite dykes ranges between 2 and 10m. The country rock is often fractured during and after dyke emplacement. These fractures form a set of master joints parallel to its strike over a distance that does not vary greatly with the thickness of the dyke (between 5 and 15m).

One of the most prominent features of the present Karoo landscape is the large number of dolerite sills and ring-complexes. These structures often display a subcircular saucer-like shape, the rims of which are commonly exposed as topographic highs and form ring-like outcrops. The Karoo dolerite sills and ring-complexes have the same geographical distribution as the dolerite dykes, and they are by far the most common type of intrusion in the Karoo basin. The

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dolerite sills and dykes form a complex intrusive network that probably acted as a shallow magma storage system. The lithology of the country-rock strongly controlled the emplacement of the sills.

Normandien Formation

The Normandien Formation comprises three sandstone members (lower Frankfort, Rooinek, upper Schoondraai) each overlain by an argillaceous interval. Two informal plant fossil assemblage zones are distinguished in the field: a "Christina assemblage zone" defined by Morphotype Pnc1, Morphotype Pnc2, Morphotype Pnc3 and Morphotype Pnc7, between the Frankfort and Rooinek sandstones; a younger "Moorfield assemblage zone" between the Rooinek and Schoondraai sandstones, defined by Morphotype Pnm1, Morphotype Pnm2, Morphotype Pnm3, Rigbya arberioides and Sphenophyllum speciosum.

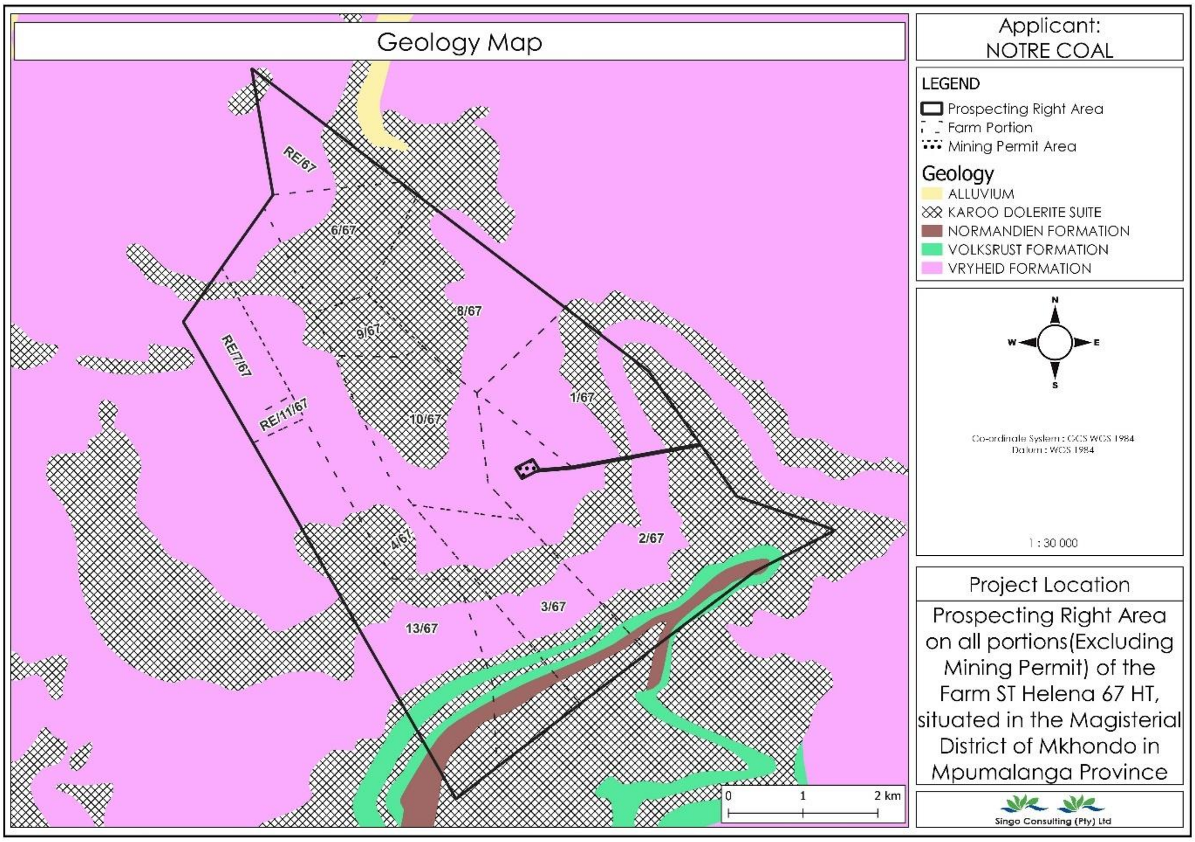

Figure 17: Geology map of the study area

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4 SITE ASSESSMENT

4.1 Locality Setting

The locality map created by the QGIS illustrates the location of the proposed area is located on all portions of the farm ST Helena 67 HT, situated under the magisterial district of Mkhondo, Mpumalanga Province. The project area is situated approximately 1.75 km east of Dirkiesdorp, and approximately 32.39 km Northeast of Wakkerstroom. The project area is situated on **S -27.108456** and **E 30.420841** co-ordinates.

4.2 Water Sampling

The process of collecting a representative portion of water, as from the natural environment or from an industrial site, for the purpose of analysing it for constituents.

Surface water sampling

Sampling using sampling Vessels:

Before sampling, the sampler must thoroughly clean the sampling vessel on site by rinsing it with water three to four times. Care must be taken to avoid contaminating the water used for sampling during rinsing. Gently submerge the collecting vessel, fill it with the water sample, and securely close it. If the obtained water sample can be frozen, leave some room for expansion equal to around 10% of the sampling vessel (Singh, 2015).

Surface water sampling was conducted by a specialist from Singo Consulting (Pty) Ltd, see Table 4: water sampling below.

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Table 4: water sampling

	
	

Groundwater sampling

Sampling using a Bailer:

A bailer is a hollow tube used to collect samples of groundwater from wells for monitoring. Bailers are tied to and lowered into the water column by a piece of rope or a piece of wire. When lowered, the bailer uses a simple ball check valve to seal a sample of the groundwater

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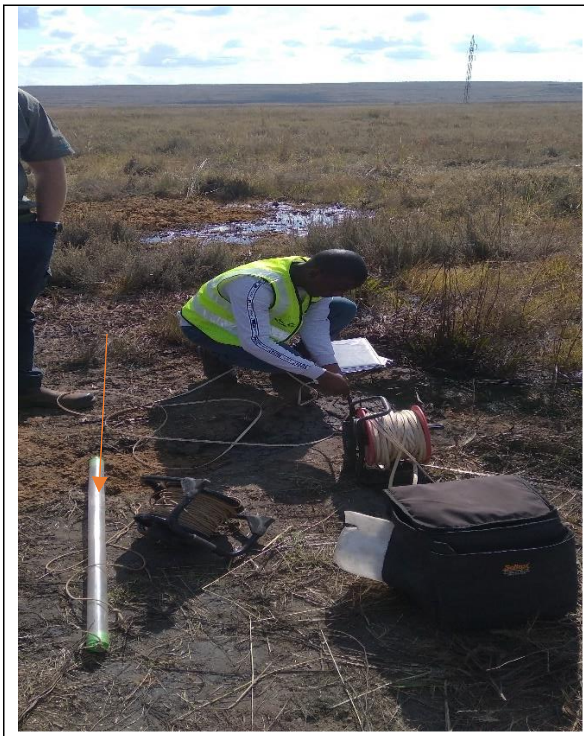
table at the bottom to raise it up. The bailers are made of polyethylene, PVC, FEP or stainless steel and can be disposable or reusable (Singh, 2015).

Bailers are easy and relatively inexpensive devices to use. In addition, bailers can be lowered to any depth although the depth of the well is sharply limited by pumps. Aeration of the water when the sample is collected, which could release volatile organic compounds that need to be tested, is the main downside to using bailers. This can also conflict with the proper seating of the ball check valve if there is a high volume of sediment or turbidity (Singh, 2015).

Table 5: Example of conducting borehole sampling

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5 SURFACE WATER IMPACT ASSESSMENT

5.1 Methodology

This section evaluates the potential impact of the proposed development on watercourses present within and around the prospecting site. Watercourse is a term used in the National Water Act (Act No. 36 of 1998) (NWA) that includes various water resources, such as different types of wetlands (both natural and artificial), rivers, riparian habitat, dams and drainage lines (e.g., natural channels in which water flows regularly or intermittently). Results and discussions of delineated watercourses are used as part of the impact assessment that considers both corridor alternatives separately. Expected watercourse impacts associated with the proposed development is assessed in detail for the construction and operational phases of the project using the approach provided in the Impact Assessment methodology Section below, which includes the provision of recommended mitigation measures. An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

5.1.1 Impact Status

Status of Impact

The impacts are assessed as either having a:

- Negative effect (i.e., at a `cost' to the environment).
- Positive effect (i.e., a `benefit' to the environment).
- Neutral effect on the environment.

5.1.2 Impact Extent

Extent of the Impact

- Site (site only).
- Local (site boundary and immediate surrounds).
- Regional.
- National.
- International.

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5.1.3 Impact Duration

Duration of the impact

The length that the impact will last for is described as either:

- Immediate (<1 year).
- Short term (1-5 years).
- Medium term (5-15 years).
- Long term (ceases after the operational life span of the project),
- Permanent.

5.1.4 Impact Probability

Probability of occurrence

The likelihood of the impact actually taking place is indicated as either:

- None (the impact will not occur).
- Improbable (probability very low due to design or experience).
- Low probability (unlikely to occur).
- Medium probability (distinct probability that the impact will occur).
- High probability (most likely to occur).
- Definite

5.1.5 Impact Intensity

Magnitude of the Impact

The intensity or severity of the impacts is indicated as either:

- None.
- Minor.
- (4) Low.
- (6) Moderate (environmental functions altered but continue).
- (8) High (environmental functions temporarily cease).
- (10) Very high / unsure (environmental functions permanently cease)

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5.1.6 Impact Significance

Based on the information contained in the points above, the potential impacts are assigned a significance rating (S). This rating is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact.

S= (E+D+M) P

The significance ratings are given below:

- (<30) Low (i.e., where this impact would not have a direct influence on the decision to develop in the area),
- (30-60) Medium (i.e., where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- (>60) High (i.e., where the impact must have an influence on the decision process to develop in the area).

5.2 Impact Assessment Ratings and Mitigation Measures

During the pseudocoal and torbanite/oil shale prospecting period the following impacts are envisioned:

- Clearing of vegetation leading to increased runoff and less infiltration.
- Diesel and oil spillages from the drill rig.
- Increase in volume of contaminated water that needs to be managed within the footprint.

Siltation on surface water

Footprint clearance will expose bare soil that could result in sheet wash into nearby watercourses during a precipitation event. In addition, dust can further be transported into watercourses or be deposited on infrastructure near watercourses thereby exacerbating the impact of siltation during rainfall events.

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Table 6: Siltation mitigation measures

Issue	Corrective measures	Impact rating criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Siltation of surface water resources	No	Negative	1	1	6	8	64
	Yes	Negative	1	1	2	4	16
Corrective Measures		➢ Stripping of vegetation for prospecting must occur in a phased manner and must be restricted to the prospecting footprint to reduce the risk of erosion during times of precipitation. ➢ The contractor shall be responsible for rehabilitating all eroded areas in such a way that the erosion potential is minimised after prospecting has been completed					

<u>Surface water contamination</u>

Truck oils and fuel could leak and spill to water resources. All oils and fuels must be stored in bunded areas, and any spillages must be managed immediately in accordance with the Emergency Response plan. The emergency response plan must be provided by contractors. This will reduce the risks from high to medium.

Table 7: Surface water contamination and mitigation measures

Issue	Corrective measures	Impact rating criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Surface water contamination (Truck oils and fuel could leak and spill)	No	Negative	1	1	6	8	64
	Yes	Negative	1	1	4	6	36
Corrective Measures	➢ In case of emergencies or unforeseen events, the problem must be remediated immediately and any spillage into any watercourses be reported to the Department of Water Affairs. ➢ Remove all project-related material / support equipment immediately on completion of any of the prospecting phases						

6 STORMWATER MANAGEMENT PLAN

6.1 Terminology

Stormwater management involves the control of that surface runoff. The volume and rate of runoff both substantially increase as land development occurs. Construction of impervious surfaces, such as roofs, parking lots, and roadways, and the installation of storm sewer pipes which efficiently collect and discharge runoff, prevent the infiltration of rainfall into the soil. Management of stormwater runoff is necessary to compensate for possible impacts of impervious surfaces such as decreased groundwater recharge, increased frequency of flooding, stream channel instability, concentration of flow on adjacent properties, and damage to transportation and utility infrastructure.

6.2 Stormwater Management Principles

The following principles for stormwater management shall guide the planning, design and implementation of stormwater facilities (Centre for watershed, 2010).

- The ecosystems to be protected and a target ecological state should be explicitly identified.
- The post development balance of evapotranspiration, stream flow, and infiltration should mimic the predevelopment balance, which typically requires keeping significant runoff volume from reaching the stream.
- Stormwater control measures (SCMs) should deliver flow regimes that mimic the predevelopment regime in quality and quantity.
- SCMs should have capacity to store rain events for all storms that would not have produced widespread surface runoff in a predevelopment state, thereby avoiding increased frequency of disturbance to biota.
- SCMs should be applied to all impervious surfaces in the catchment of the target stream.

6.3 Current Stormwater Management

- No current stormwater management put in place.

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6.4 Proposed Stormwater Measures

The proposed stormwater management during the drilling process are to ensure that the activity does not influence surface bodies contamination through stormwater. The following measures are proposed.

- The drilling area should be barricaded all around with plastic to ensure that the stormwater during drilling does not encounter wastewater from the drilling process.
- Around the drilling area, there should be an impervious surface made, this is to ensure that wastewater from drilling is efficiently channelled and collected. And, stormwater that may have entered the drilling segment area, is correctly harvested by the impervious material and channelled.

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7 MONITORING PLAN

The objective of the surface water management and monitoring measures is to minimise the impact on surface water dependent systems to be retained from disturbance within and adjacent to controlled sites; to maintain hydrological regimes of surface water so that the environmental values are protected and, to check compliance with license requirements and for reporting purposes.

Water dependent systems are parts of the environment in which the composition of species and natural ecological processes are determined by the permanent or temporary presence of flowing or standing surface water or groundwater. The in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, groundwater-dependent terrestrial vegetation are all examples of water dependent systems (Department of Water, January 2013). The objectives of these systems will be achieved if there is no impact on the in-stream and downstream fitness for use criteria.

7.1 Surface Water Quality

Sampling Method

One litre plastic bottle with unlined plastic caps is required for most sampling exercises; however, in cases where organic constituents are to be tested for, glass bottles are required. Sample bottles must be marked clearly with the borehole name, date of sampling, water level depth and the sampler's name. Purging must be done on each surface waterbody that needs to be sampled, this is to ensure cross contamination is prevented. Metal samples must be filtered in the field to remove clay suspensions. The pH and EC meter used for field measurements will be calibrated daily using standard solutions obtained from the instrument supplier. Samples will be kept cool in a cooler box in the field and kept cool prior to being submitted to the laboratory to maintain proper preservation thereof.

Sampling Locations

The main objectives in positioning the monitoring surface bodies are to:

- Monitoring of surface water within the project area.
- To detect any change in chemistry of the surface water and reference it with the baseline information, to make recommendations.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusion and Summary

Singo Consulting (Pty) Ltd was appointed by Notre Coal as an independent consulting company, to conduct a basic hydrological study. This study was conducted as a basic study aimed at assisting the EAP and interested parties involved to have a basic background about the project area and the surface water bodies that exist within and nearby the proposed project area. It can be concluded that the area is surrounded by various water bodies, however 100m buffers has been proposed, meaning no activities will take place within 100m from the water bodies.

- The study area is situated within the Inkomati-Usuthu water management area (WMA), under the W51B quaternary catchment.
- The farm area is overlain by freely drained, structureless soils, the association of classes 1 to 4: Undifferentiated structureless soils, association of classes 13 and 16: Undifferentiated shallow soils and land classes and the association of classes 17 and 18: structureless soils and clays.
- The prospecting right area is overlain the wet cold highveld grassland and the North-eastern mountain grassland.

8.2 Recommendations

- On site there should be regular maintenance of the mobile toilets.
- Once drilling, the team should rehabilitate the area and ensure the core is out of site
- Drilling within 100 meters of water resources should be avoided.
- Stormwater should be prioritised, and the management to prevent surface water contamination.
- Clearing of vast amount of vegetation should be avoided, this is to preserve infiltration.
- Stormwater measures which include the identified rivers and wetlands, should not be disrupted as they manage surface run off in an area.
- The drilling activity should also take into consideration the shallow and fractured aquifer in the area.
- No washing of vehicles on site should be allowed.
- Prohibition signs should be placed all around the prospecting area, such no ablution sign or site clearing.

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APPENDICES

Appendix A: Specialist's qualifications

Available upon request.

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