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Arnot South Environmental Authorisation and Water Use License Application

Soils, Land Use and Land Capability Impact Assessment

Prepared for:
Universal Coal PLC

Project Number:
UCD6802

July 2021

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Report Type:	Soils, Land Use and Land Capability Impact Assessment
Project Name:	Arnot South Environmental Authorisation and Water Use License Application
Project Code:	UCD6802

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Title/ Position:	Soil Scientist
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Experience (years):	5
Registration(s):	SACNASP: 117870

I **Willnerie Janse van Rensburg**, declare that: –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
  - I declare that there are no circumstances that may compromise my objectivity in performing such work;
  - I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant 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;
- All the particulars furnished by me in this form are true and correct; and

- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

	July 2021
Signature of the Specialist	*Date*

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

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EXECUTIVE SUMMARY

Digby Wells & Associates South Africa (Pty) Ltd (Digby Wells) has been appointed to conduct an Environmental Authorisation (EA) required for the proposed Arnot South Underground Coal Mining Project (Arnot South Project). The Prospecting Right, MP 30/5/1/1/2360 PR was issued to Exxaro Resources, and the Applicant for this process will be Exxaro Coal Mpumalanga (Pty) Ltd to mine coal. The extent of the Mining Right boundary is approximately 16,000 hectares (ha) in extent, but underground mining will not extend over the full boundary area.

This report should be read in conjunction with the other specialist studies of the EA and constitutes the Soil, Land Use and Land Capability Impact Assessment in support of the Environmental Impact Assessment (EIA) process and compilation of the Environmental Management Programme (EMPr), Integrated Water Use License Application (IWULA) and Integrated Water and Waste Management Plan (IWWMP).

The topography of the Project Area ranges from high elevations in the north and in the south to lower elevations in the east and central area associated with river systems. The high-lying areas are typically associated with shallow soils limiting cultivation, and often used for intensive cattle grazing. The low-lying areas were typically associated with shallow water tables, deep fertile soils, wetlands and often cultivated.

The land use was described as **Ba22** (Dominant), **Bb15** (Small section in the east of the Mining Right Area (MRA)) and **Ba19** (Small section in the South of the MRA). These land uses are typical of Red to Yellow-brown Apedal soils with plinthic subsoils. The Land Capability was measured as Class III for the entire Project Area, defined as arable land used for moderate cultivation and intensive grazing.

Due to the extent of the Project area, it was sought to group soil forms together by means of dominant soil horizon, functionality and land use. The soil forms included Cartref, Glenrosa, Clovelly, Avalon, Hutton, Pinedene, Glencoe, Mispah, Katspruit, Kroonstad, Rensburg, Arcadia and Witbank. The dominant land use was identified as cultivation, cattle grazing, grazing/wetland, wetlands/natural and infrastructure.

The average soil texture in the Project Area was **sand** to **loamy-sand**. Soil texture are a direct attribute from the parent material (dominantly sandstone) and affect the soil nutrients, EC, CEC, OC and fertility. Due to the sandy nature of the soils, intensive crop production and high rainfall in the vicinity of the Project Area, the soil fertility tends to decrease over time and require a liming and fertilizer programme to optimize crop production. Despite the average low soil fertility, the soils are deep, sandy and has a high land capability and therefore sensitive to impacts. Large areas of the Project Area consist of **High** sensitive areas and should be avoided, and impacts minimised as far as possible.

The overall impacts of the Project were determined to be **Major** to **Minor** prior-mitigation and will lead to irreversible impacts to the soils, land use and land capability. However, post-mitigation, the impacts should me **Moderate** to **Negligible.** Underground mining contains the risk of subsidence, dewatering, decanting and contamination which might impact the soils, land use and land capability significantly. The core recommendations to avoid, minimise and prevent impacts to the soils, land use and land capability include:

Surface infrastructure areas:

- Reduce the risk of erosion, compaction, and the creation of preferential flow paths by re-vegetating exposed areas, maintaining linear infrastructure and culverts and installing sediment traps and erosion berms;
- Soil pollution monitoring after spills should be conducted at selected locations on the project site to detect any extreme levels of pollutants; and
- Fence off rehabilitated areas from livestock until vegetation has established. Follow a grazing plan to prevent overgrazing, trampling and erosion. This will lead to improved soil fertility land capability.

Underground operations:

- Monitor possible decanting of Acid Mine Drainage (AMD), subsidence, contamination and dewatering and implement management measures as indicated in the Groundwater Impact Assessment (Digby Wells, 2021); and
- Soil/Land Offset should form part of a biodiversity (wetland) Offset plan that will have to be developed and implemented after the residual impacts have been determined.

Underground mining contains the risk of subsidence, dewatering, decanting and contamination which might impact the soils, land use and land capability significantly. However, if the project is to proceed, it is in the opinion of the specialist that that protection, mitigation and implementation of a wetland offsetting strategy will help improve and protect the soils, land use and land capability. Wetlands tend to be well vegetated (protecting the soils from erosion and loss of soil fertility), improve the water and soil quality, increase organic material and soil fertility and therefore increased land capability.

It is recommended to follow the mitigation hierarchy which includes firstly the avoidance of an impact. When it is not possible to avoid an impact, such as in the case of during the Construction and Operational Phases, the next step is or to minimise the impact and thereafter rectify or reduced the impact. When it is not possible to rectify or reduce the impact, offsets need to be implemented.

The soil, land use and land capability management and monitoring requirements as set out in Sections 12 and 13 and the recommendations in Section 15 should form part of the conditions for the EA. An offset strategy should be implemented to compensate for residual impacts due to possible subsidence.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

°C	Degrees Celsius
AIP	Alien Invasive Plant
AMD	Acid Mine Drainage
ARC	Agricultural Research Council
CARA	The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)
CEC	Cation Exchange Capacity
Digby Wells	Digby Wells Environmental
DEA	Department of Environmental Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation, previously Department of Water Affairs and Forestry (DWAF)
EA	Environmental Authorisation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIA Regulations, 2014	Environmental Impact Assessment Regulations, 2014 (GN R982 of 04 December 2014, as amended)
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EP	Environmental Practitioner
GN	General Notice
GPS	Global Positioning System
ha	Hectare
I&APs	Interested and Affected Parties
ISCW	Institute for Soil, Climate and Water
IWUL	Integrated Water Use License
IWULA	Integrated Water Use License Application
IWWMP	Integrated Water and Waste Management Plan
km	Kilometre

L	Litre
LoM	Life of Mine
m	Metre
m.a.m.s.l.	Metres above mean sea level
mm	Millimetre
MM	Mine Manager
MOP	Mining Operations Plan
Mt	Million tonnes
MPRDA	Mineral and Petroleum Resources Development Act 2002 (Act No. 28 of 2002)
NEM: WA	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
OC	Organic Carbon
PCD	Pollution Control Dam
PM	Project Manager
PPP	Public Participation Process
RoM	Run of Mine
SANAS	South African National Accreditation System
SEP	Stakeholder Engagement Process
STP	Sewage Treatment Plant
SSV	Soil Screening Values
SWMP	Storm Water Management Plan
TMP	Topsoil Management Plan
WML	Water Management License
WTP	Water Treatment Plant
WUL	Water Use License

Legal Requirement		**Section in Report**
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of-	xi
	(i) the specialist who prepared the report; and	xii

Legal Requirement		Section in Report
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	xii
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	1.7
cA	And indication of the quality and age of the base data used for the specialist report;	1.7
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	8
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	5
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	5
(f)	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 alternatives;	0
(g)	an identification of any areas to be avoided, including buffers;	0
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	1.2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	3
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	7
(k)	any mitigation measures for inclusion in the EMPr;	1
(l)	any conditions/aspects for inclusion in the environmental authorisation;	15
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	13
(n)	a reasoned opinion (Environmental Impact Statement) -	16
	whether the proposed activity, activities or portions thereof should be authorised; and	

Legal Requirement		Section in Report
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the Environmental Management Programme (EMPr), and where applicable, the closure plan;	13
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	14
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q)	any other information requested by the competent authority.	N/A

1. Introduction

Exxaro requested Digby Wells to conduct an EA required for the proposed Arnot South Project. The Prospecting Right, MP 30/5/1/1/2360 PR was issued to Exxaro Resources, and the Applicant for this process will be Exxaro Coal Mpumalanga (Pty) Ltd to mine coal on various farms covering approximately 16,000 ha in extent.

The Prospecting Right was renewed in September 2017 and lapsed on 10 September 2020. However, a MRA and Mine Works programme (MWP) for underground mining were submitted to the Department of Mineral Resources and Energy (DMRE) prior to the lapsing date (on 8 September 2020). The Applicant was issued reference number MP 30/5/1/2/2/10292 MR.

1.1. Terms of Reference

Digby Wells has been appointed by Exxaro to undertake an EA application process for the underground mining of various farm portions within the existing Arnot Mining Right Area (MRA). This report should be read in conjunction with the other specialist studies of the EA and constitutes the Soil, Land Use and Land Capability Impact Assessment in support of the EIA process and compilation of the EMPr, IWULA and IWWMP for the Project, in accordance with the following relevant legislation:

- EIA Regulations, 2014 (General Notice (GN) R982 of 04 December 2014, as amended) (the "EIA Regulations, 2014) promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- A Waste Management Licence (WML) in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM: WA); and
- An Integrated Water Use Licence (IWUL) in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

1.2. Project Background

The Arnot South Project is situated approximately 10 km east of the town of Hendrina, 25 km west of Carolina, and 50 km southeast of Middelburg in the Mpumalanga Province of South Africa. The proposed Project is close to two of Eskom's operating power stations; Hendrina (25 km) and Arnot (5 km).

The mineral reserve consists of one economically mineable underground block (No. 2 coal seam), producing approximately 2.4 million tonnes per annum (Mtpa) of Run of Mine (RoM) coal for approximately 17 years. Further drilling will be required to confirm a resource to the south of the Mining Right area. The potential future resource of the remaining RoM coal is approximately 32,912,300 tonnes, allowing an additional mining period of approximately 13 years. This application considers the use of underground board-and-pillar mining with continuous miners due to the depth and thickness of the reserve.

Due to the depth and thickness of the No. 2 coal seam, the Arnot South resource area shall be mined by underground mining methods. Underground bord and pillar mining utilising continuous miners and shuttle cars is considered as the optimal mining method for the mining of the initial reserve. The proposed development triggers Listed Activities in terms of the EIA Regulations, 2014 (GN R 982 of 4 December 2014 as amended by GN R326 of 7 April 2017) (EIA Regulations, 2014), as amended promulgated under the NEMA, 1998 (Act No. 107 of 1998). Digby Wells is the appointed Environmental Assessment Practitioner (EAP) to undertake the environmental applications in support of the proposed Project.

1.3. Study Areas

For the purpose of this report, the following applies:

- MRA defines the farms included in the Arnot South Project Area boundary (red outlined area on the maps);
- Project Area defines farm portions directly associated with Arnot MRA (red outlined area on the maps); and
- Infrastructure area refers to the area where the proposed surface infrastructure will be constructed (small zoomed in section in all the maps).

1.4. Project Locality

The Project Area falls under the jurisdiction of the Chief Albert Luthuli and Steve Tshwete Local Municipalities, located in the Gert Sibande and Nkangala District Municipalities respectively, Mpumalanga Province (Table 1-1; Figure 1-1).

There are five farm homesteads situated within the planned underground mining area. The target area for mining and mining-related infrastructure lies mainly on the farms Weltevreden 174 IS, Mooiplaats 165 IS, Vlakfontein 166 IS, and Schoonoord 164 IS.

Table 1-1: Summary of the Arnot South Project Area Project Location Details

Province	Mpumalanga	
District Municipality	Gert Sibande District Municipality Nkangala District Municipality	
Local Municipality	Chief Albert Luthuli Local Municipality Steve Tshwete Local Municipality	
Nearest Town	Hendrina (10 km), Carolina (25 km), Middleburg (50 km)	
Property Name and Number for the Arnot MRA	Groblersrecht 175 IS	Schoonoord 164 IS
	Mooiplaats 165 IS	Vlakfontein 166 IS
	Tweefontein 203 IS	Vryplaats 163 LQ
	Vaalwater 173 IS	Helpmakaar 168 IS
	Weltevreden 174 IS	Op Goeden Hoop 205 IS

	Nooitgedacht 493 JS Klipfontein 495 JS Leeuwpan 494 JS
Application Area (Ha)	~16,000 ha
Distance and direction from nearest town	50 km southeast of Middelburg
GPS Co-ordinates **(Relative centre point of study area)**	29.8634
	-26.0171

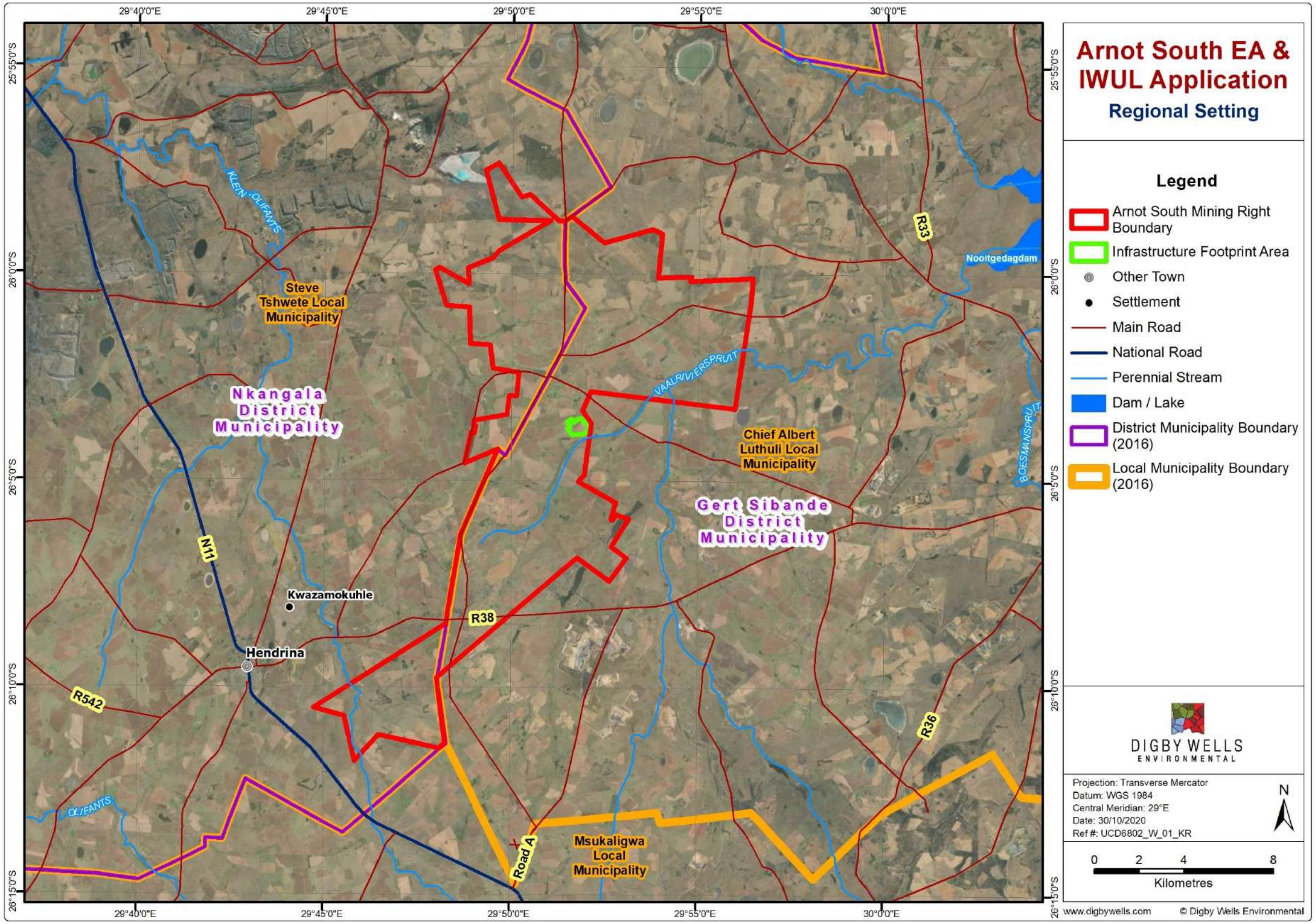


Figure 1-1: Regional Setting and Local Setting

1.5. Proposed Infrastructure and Activities

As indicated in Table 1-2 and illustrated in Figure 1-2 and Figure 1-3, proposed activities for the Arnot South Project will trigger listed activities under Listing Notice 1 (GN R983 of 04 December 2014, as amended) and Listing Notice 2 (GN R984 of 04 December 2014, as amended) of the EIA Regulations, 2014; and therefore, an EIA process must be undertaken and approval received prior to the activities commencing. Table 1-2 details the Project activities for the duration of the Construction, Operational and Rehabilitation Phases.

Table 1-2: Project Phases and Associated Activities

Phase	Activity
Construction	Site/vegetation clearance (52.28 ha)
	Diesel storage and explosives magazine
	Establishment of infrastructure (Infrastructure footprint - 13.28 ha; linear infrastructure - 51 501 m) Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office
	Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long
	Construction of Pollution control dam (PCD) (1.61 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)
	Stockpiling of soils, rock dump and discard dump establishment.
Operational	Operating STP (18.32 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant
	Mining of coal by underground mining (underground) (5 050.83 ha) Removal of rock (blasting). Rock/discard dumps, soils, ROM, discard dump (discard dump 2946 ha and Overburden stockpile 13716 ha)
	Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste
	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.
	Continue with exploration activities
Decommissioning	Demolition and removal of infrastructure.
	Post-closure monitoring and rehabilitation.
	Closure of the underground mine.

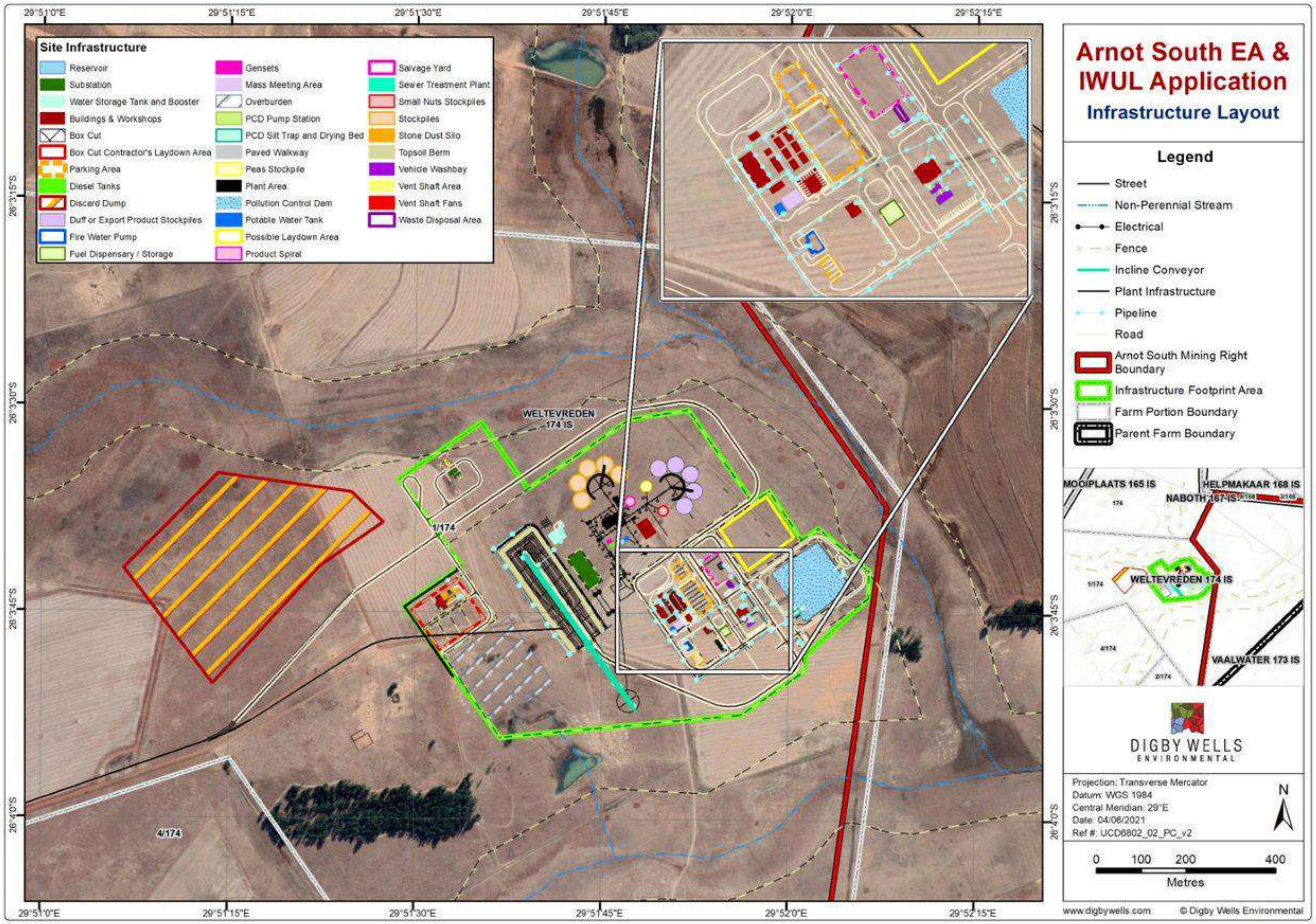


Figure 1-2: Preliminary Infrastructure Layout Plan

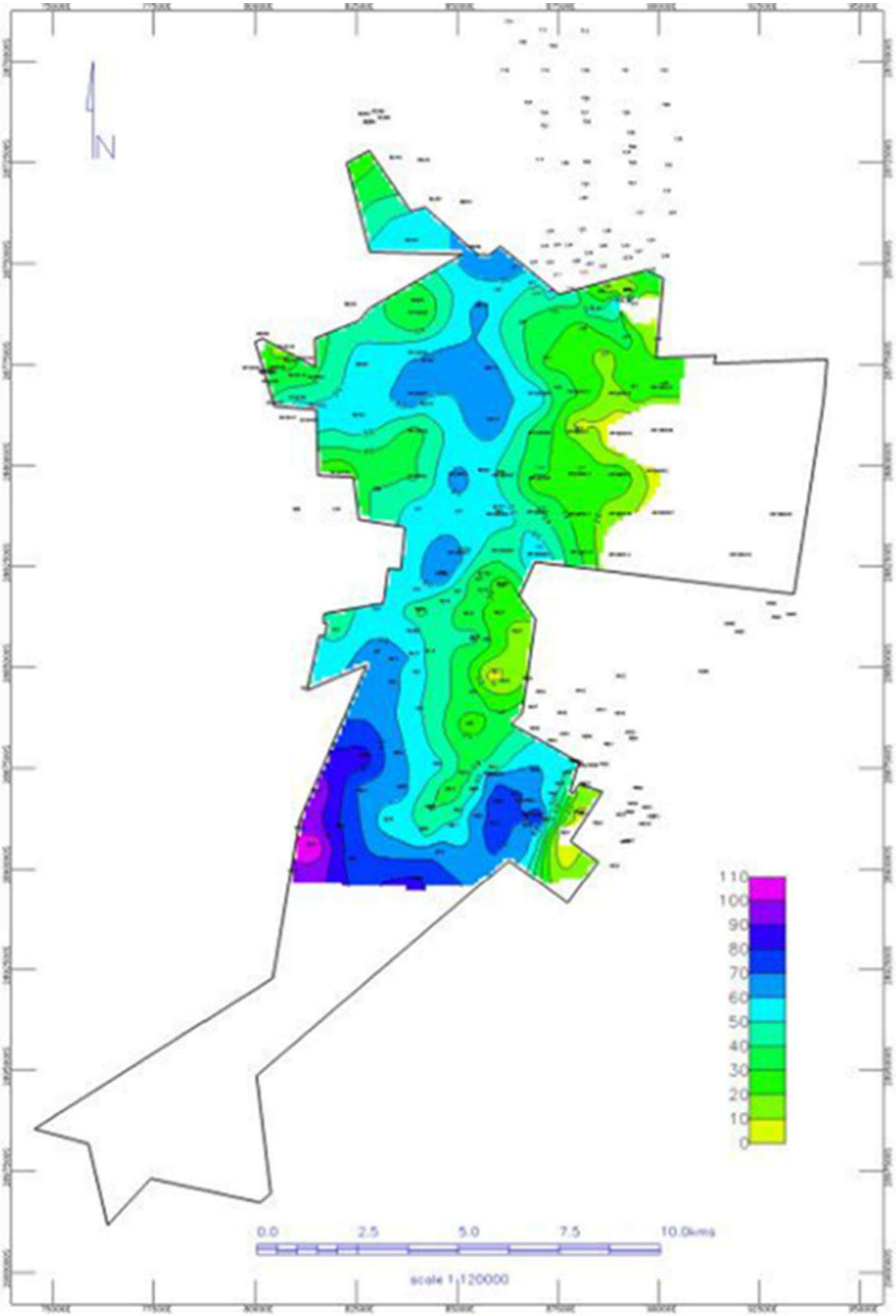


Figure 1-3: No. 2 Coal Seam Elevation (Source: Arnot South Mining Works Programme, 2020)

1.6. Alternatives Considered

Alternatives are different means of meeting the general purpose and need of a proposed activity. Alternatives also help identify the activity with the least environmental impact. Alternatives to be considered to ensure minimal impacts to the soil, land use and land capability are described in Table 1-3.

Table 1-3 Alternatives and Consequences

Alternative	Consequence
Location of the Project The location was dictated by Exxaro's Prospecting / Mining Right and therefore there are no feasible alternative locations for Exxaro.	The Project Area consist of various areas of high land capability (high agricultural potential soils) that might potentially be impacted by dewatering, decanting (soil contamination), subsidence and impacts from the proposed surface infrastructure. The proposed surface infrastructure is proposed to be in delineated wetlands that could lead to soil contamination, erosion and sedimentation.
Mining Method Alternatives Due to the depth of the No. 2 coal seam to be mined, the method of coal extraction will be by underground mine and bord and pillar mining with continuous miners and shuttle cars and not opencast mining.	Underground mining activities are proposed to have less impacts to the Soil, Land Use and Land Capability, than opencast mining, however, there might still be impacts to the surface i.e., potential dewatering, decanting (contamination), subsidence, and surface infrastructure related impacts.
Technology Alternatives The preferred technology for the Project is wet washing processing technology and not dry processing.	Wet washing of coal increases the potential of contamination of soils and water. This will lead to reduced land capability and deterioration of soil resources.
The "No-Go" Alternative The No-go alternative is the option of not mining coal in the area. This option also means that all potential negative impacts associated with the proposed mine and its associated infrastructure would not occur.	'No-go' areas (e.g., areas of high Land Capability and sensitive areas) will assist in protecting areas of high agricultural value and a sustainable future. 'No-go' areas are discussed in Section 0. However, dewatering, decanting and subsidence might still occur.
Do site inspections regularly to ensure maintenance, concurrent rehabilitation is followed, and waste management plans are in place.	This will assist in mine rehabilitaiton and closure and prevent unforeseen impacts to the Soil, Land Use and Land Capability.
Reduce waste materials and waste outputs.	This will reduce the impacts on the soils, land use and land capability as well as assisting with rehabilitaiton and mine closure.
Replenish native soils after decommissioning of the surface infrastructure.	This should be considered as this will assist with rehabilitaiton and mine closure as well as mitigate impacts to the Soils, Land Use and Land Capability.

1.7. Scope of Work

The field assessment for the Soil, Land Use and Land Capability Impact Assessment was carried out on the 20th to the 23rd of April 2021. The Scope of Work for the Impact Assessment included:

- **Desktop Review**: Review of all existing data for the collation of available information concerning the site and proposed work. Historical data of the Project Area was assessed regarding land use and identification of incidents (risks) that may have occurred, and could have impacted the soil, land use, and capability. Review of existing data relating to soil form, soil depth, soil texture, laboratory analysis data, and soil classification within the Project Area;
- **Soil Survey:** An initial soil desktop delineation was conducted before the site visit using historical data and Google Earth imagery. The soil delineation was verified during a three-day site visit. A hand soil auger was used to survey the soil depth and soil forms, with survey positions being recorded as waypoints. Due to time and budget constraints, focus was given to the proposed surface infrastructure areas and areas where extraction will be close to the surface;
- **Land Use**: Existing land use data was verified during the site visit. This was mapped in conjunction with existing soil survey data and land use/cover data;
- **Land Capability**: Land Capability was assessed using the soil classification, soil form, depth, drainage, terrain, and climatic features. A map delineating the areas was produced for a visual representation of the most suitable areas for crop production;
- **Impact Assessment:** Identification of historical, and current impacts on soils, land use, and land capabilities of the Project; and
- **Recommendations:** Mitigation recommendations to develop a rehabilitation and management plan for the Run of Mine (RoM).

2. Relevant Legislation, Standards and Guidelines

The Project is required to comply with all the obligations in terms of the provisions of the National legislations, regulations, guidelines and by-laws. The guidelines directing the Soil, Land Use and Land Capability Impact Assessment are detailed in Table 2-1.

Table 2-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). NEMA (as amended) was set in place in accordance with Section 24 of the Constitution. Certain environmental principles under NEMA must be adhered to, to inform decision making for issues affecting the environment.	Activities that will influence the Soil of the proposed Project Area are listed in Section 1.5 and has been identified as Listed Activities in the Listing Notices (as amended) and therefore require environmental authorisation prior to being undertaken.

Legislation, Regulation, Guideline or By-Law	Applicability
Section 24(1)(a) and (b) of NEMA state that: *The potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment, must be considered, investigated and assessed prior to their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity.* The NEMA requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and treated.	• The EIA process was undertaken to identify potential impacts to the soil, land use and land capability, including erosion, soil depth, soil form and areas dominated by Alien Invasive Plants (AIPs). • As part of the Assessment, applicable mitigation measures, monitoring plans and/or remediation were recommended to ensure that any potential impacts are managed to acceptable levels to support the rights as enshrined in the Constitution.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM: WA). The NEM: WA seeks to regulate waste management to protect health and environment by providing reasonable measures, including the provision of the remediation of contaminated land. Section 7(2)(d) of the NEM: WA sets the National Norms and Standards for the remediation of contaminated land and soil quality.	A Soil, Land Use and Land Capability Impact Assessment was undertaken as part of the EIA Phase. The Project activities were assessed to abide with the NEM: WA and the Soil Screening Values (SSV). The required mitigation measures are included in Section 15 to form part of the EMPr as part of the EIA.
The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA). The CARA is to provide control over the utilization of the natural agricultural resources to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants, and the matters connecting therewith. CARA defines the environmental conservation regulations as the 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.	A Soil, Land Use and Land Capability Impact Assessment was undertaken as part of the EIA Phase. The required mitigation measures are included in Section 15 to provide control over the natural agricultural resources to promote conservation of the soil, land use and land capability.

3. Assumptions, Limitations and Exclusions

The compilation of this Report is based on the following assumptions and limitations in Table 3-1.

Table 3-1: Limitations and Assumptions with Resultant Consequences of this Report

Assumptions and Limitations	Consequences
Due to the size of the Project Area, cost and time limitations: • Site assessment was mostly focused on the proposed surface infrastructure areas as well as the area of high extraction; • Soil samples were limited to these areas; and • Access to the entire MRA was not granted.	• Some discrepancies within the Project Area may occur such as the confidence level of soil delineations as soil types were extrapolated from scattered samples points taken during the assessment, contours, topography and specialist opinion; • Soil samples should be used as baseline information, reference data when impacts have occurred and rehabilitation purposes (e.g., soil contamination from spills); and • Field verification was limited to areas where access was granted.
Land suited for crop production (high agricultural capability) was assumed also to be suitable for other, less intensive uses such as pasture, natural grazing, forestry and wildlife.	The land identified to be of high agricultural importance for crop production, are also suitable for lower land use classes.
Soils are contiguous hence differentiation is not abrupt, and the transition zone cannot be completely captured during any given soil survey.	The soil distribution map of the Project Area may not be absolutely accurate.
The soils within the capability classes are similar only with respect to the degree of limitations in soil use for agricultural purposes or with respect to the impact on the soils when they are so used.	Not all soils have the same land use and are used according to their capabilities, each soil will react differently to the land use and impacts to the soils.
Due to historical and current land use activities (dominantly intensive agropastoral activities) some areas have been highly impacted, specifically the naturally occurring vegetation, hydrology and geomorphology.	Some discrepancies with the soil delineations may occur due to changing impacts on the land; for example, intensive vegetation clearing, sedimentation, water extraction, damming, excavations, stockpiling, overgrazing and cultivation.

4. Details of the Specialist

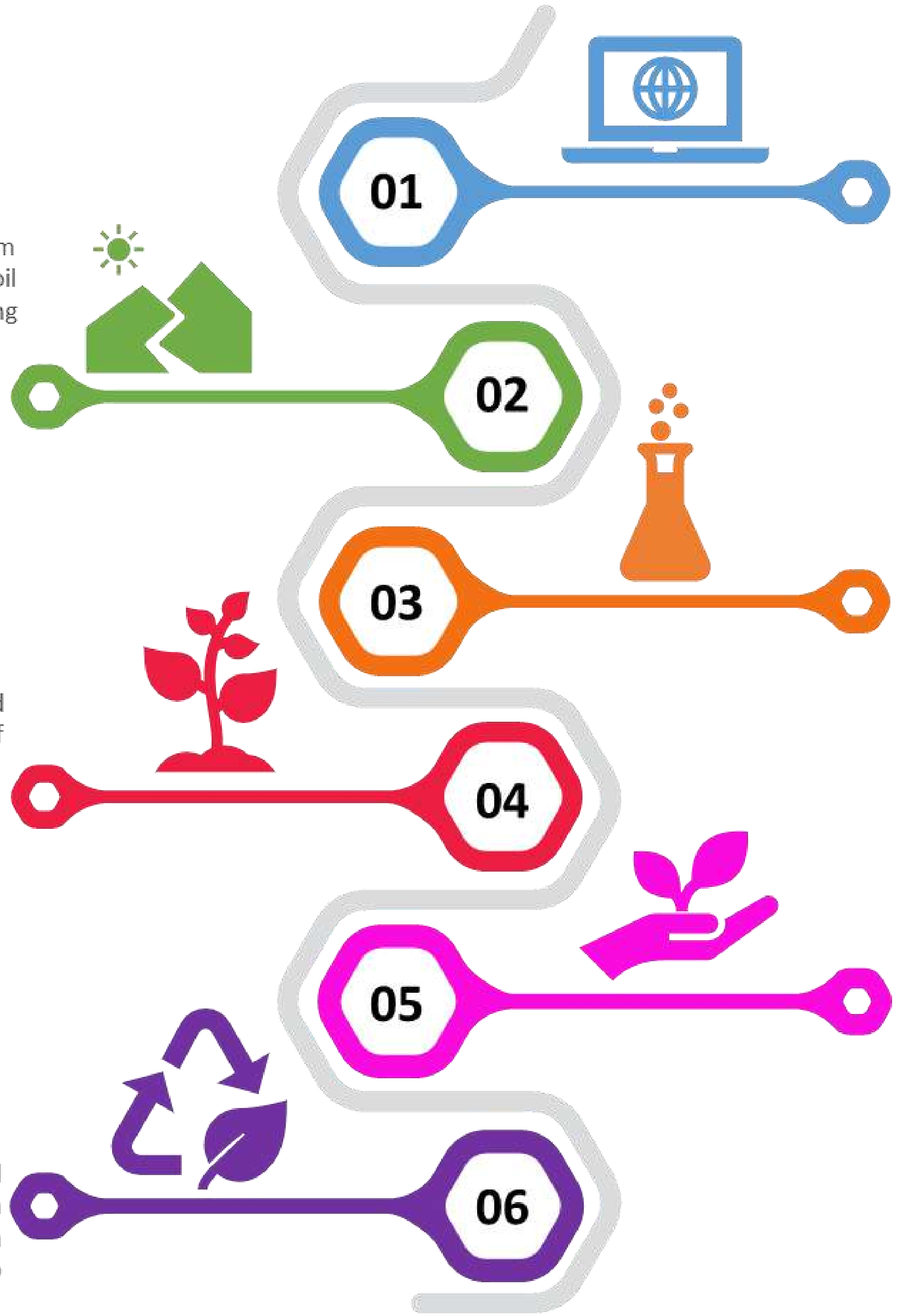
The following is a list of Digby Wells' staff who were involved in the Soil Impact Assessment:

- **Arjan van 't Zelfde** is a Senior Consultant with experience in soil science and hydrogeology. Arjan received a M.Sc. degree in Soil Science (SAQA approved) as part of the B.Sc./M.Sc. programme Soil, Water and Atmosphere, Wageningen University, The Netherlands. He specialises in soil capability assessments, soil contamination assessments and hydrogeological numerical groundwater flow modelling and has worked in multiple countries such as The Netherlands, Ireland, Senegal and South Africa. Arjan is a registered Professional Natural Scientist (Pr.Sci.Nat) with the South African Council for Natural Scientific Professions (Registration Number: 115656).

- **Willnerie Janse van Rensburg** is a Soil Scientist in the Rehabilitation, Closure and Soils Division at Digby Wells. She received her Bachelor of Science in Environmental Geography as well as her Honours degree in Soil Science from the University of the Free State. She has five years' experience in the fields of Soil Science and Environmental Science. She has experience in completing soil surveys, land capability assessments, irrigation scheduling and provides recommendations on soil amelioration. Willnerie also completes wetland delineations and assessments. She has undertaken work in Lesotho, Botswana and throughout South Africa. Willnerie is registered as a Candidate Natural Scientist with the South African Council for Natural Scientific Professionals.
- **Aamirah Dramat** is an Assistant Rehabilitation Consultant in the Rehabilitation, Closure and Soils Department at Digby Wells. She received her Bachelor of Science Degree in Applied Biology and Environmental and Geographical Science (EGS) as well as her Honours Degree in Biological Sciences from the University of Cape Town. She joined Digby Wells in 2020 as a Rehabilitation Intern and has since gained experience in the environmental services sector with specialised focus in Soils, Wetlands and Rehabilitation, both locally and internationally. She has been involved in the report compilation and undertaking of Baseline Assessments, Environmental Impact Assessments (EIAs), Rehabilitation and Closure Plans (RCPs), Rehabilitation Strategy and Implementation Plans (RSIPs), Alien Invasive Plant (AIP) Assessments, Re-vegetation Trial Studies and Monitoring Assessments.

5. Methodology

This section provides the methodology used in the compilation of the Soil, Land Use and Land Capability Impact Assessment. A detailed methodology is described in Appendix A and is summarized in Figure 5-1 below.



Desktop Assessment and Literature Review

The following sources were used to obtain baseline soil information such as generalised soil patterns and terrain types for the Project site:

- South African land type data by the Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC) (ARC, 2006);
- Aerial imagery;
- Land use and land capability data;
- Existing Land Type data (Land Type Survey Staff, 1972 - 2006); and
- Existing studies conducted in the area.

Soil Classification

A hand soil auger was used to determine the soil properties to a maximum depth of 1.2 m or to the first restricting layer. Soils were classified using the Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991). Soil Properties included:

- Topography, aspect and slope;
- Soil form and family;
- Soil depth;
- Estimated soil texture;
- Soil structure, coarse fragments, calcareousness;
- Underlying material; and
- Vegetation.

Soil Physical and Chemical Analysis

Representative soil samples were collected for analysis at a SANAS accredited laboratory. The analysis was done in accordance with the Handbook of Standard Soil Testing Methods for Advisory Purposes (Soil Science Society of South Africa, 1990).

Land Use

Land use was identified by aerial imagery during the desktop assessment and verified during the site-inspection. Land use maps indicate delineated areas of similar land use (Land Type Survey Staff, 1972 - 2006).

Land use categories are:

- Plantations;
- Natural;
- Waterbodies;
- Mines;
- Urban built-up; and
- Agriculture.

Land Capability

Land capability is defined by the most suitable land use under rain-fed conditions. Land capability was determined by assessing a combination of soil, terrain and climate features. The land was rated into 8 classes with subgroups that have the same relative degree of limitation or potential.

Land Suitability (Agricultural Potential)

Soil agricultural potential was determined by soil forms, land capability, soil analysis, hydrology and current land use. The process involved allocating terrain and soil factors to an area of land. The soil chemical analysis was considered in determining the final suitability of the soil. The suitability guidelines according to Schoeman et al., (2000) were used.

Figure 5-1: Soil, Land Use and Land Capability Assessment Methodology

6. Baseline Environment

Relevant literature was reviewed prior to the field assessment concerning the Soil, Land Use and Land Capability associated with the Project Area. Baseline and background information was researched and used to understand the Project Area prior to undertaking the fieldwork component and is described in Table 6-1 below.

Table 6-1: Baseline Environment of the Arnot South Project Area

Characteristics of the Highveld Ecoregion (Kleynhans, Thirion, & Moolman, 2005)		**Plant Species Characteristic of the Eastern Highveld Grasslands** (Mucina & Rutherford, 2012) **(**Figure 6-1**)**	
Terrain Morphology	Plains; Low Relief; Plains; Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief.	Graminoid Species	*Aristida aequiglumis, A. congesta, A. junciformis subsp. galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. capensis, E. curvula, E. gummiflua, E. patentissima, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata* subsp. *eckloniana, Andropogon appendiculatus, A. schirensis, Bewsia biflora, Ctenium concinnum, Diheteropogon amplectens, Harpochloa falx, Panicum natalense, Rendlia altera, Schizachyrium sanguineum, Setaria nigrirostris* and *Urelytrum agropyroides.*
Vegetation Types	Mixed Bushveld (limited); Rocky Highveld Grassland; Dry Sandy Highveld Grassland; Dry Clay Highveld Grassland; Moist Cool Highveld Grassland; Moist Cold Highveld Grassland; North-eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited).	Herb Species	*Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes, Pentanisia prunelloides* subsp. *latifolia, Selago densiflora, Senecio coronatus Hilliardiella oligocephala* and *Wahlenbergia undulata.*
Altitude (m.a.m.s.l.) (modifying)	1 100-2 100, 2 100-2 300 (very limited)	Geophytic Herb Species	*Gladiolus crassifolius, Haemanthus humilis subsp. hirsutus, Hypoxis rigidula* var. *pilosissima* and *Ledebouria ovatifolia.*
Mean Annual Precipitation (MAP) (mm) (Secondary)	400 to 1 000	Succulent Herb Species	*Aloe ecklonis.*
Coefficient of Variation (% MAP)	<20 to 35	Low Shrub Species	*Anthospermum rigidum* subsp. *Pumilum* and *Seriphium plumosum.*
Rainfall Seasonality	Early to late summer	Status	Endangered.
Mean Annual Temp. (°C)	12 to 20	**Topography and Slope (**Figure 6-2 **and** Figure 6-3**)**	
Mean Daily Summer Temp. (°C): February	10 to 32	The topography of the Project Area ranges from high elevations in the north and in the south of the Project Area to lower elevations in the east and central area associated with river systems. The elevation of the Project Area ranges from 1 565-1 745 metres above mean sea level (m.a.m.s.l.) which equates to a range of 180 m between the lowest and highest points of elevation within the Project Area. The high-lying areas are typically associated with shallow soils limiting cultivation, however, were often used for intensive cattle grazing. The low-lying areas were typically associated with shallow water tables, deep fertile soils, wetlands and often cultivated. The average slope of the entire Project Area is approximately 2.8 degrees (°), with scattered areas of ~13.9 – 10.0 ° associated with pans.	
Mean Daily Winter Temp. (°C): July	-2 to 22	**Geology (**Figure 6-4**)**	

Median Annual Simulated Runoff (mm)	5 to >250	The Arnot South Project Area is situated within the Witbank Coal Field, forming part of the Karoo Basin. The Karoo Basin extensively covers the central areas of South Africa with an area of 700 000 km^2 and a basin fill of more than 5 000 m of siliciclastic rocks. The Project Area is located within the siliciclastic rock lithology and above the coal-bearing Vryheid Formation which is part of the Ecca Group. The Vryheid formation consists of various sequences of sandstones, shales and siltstones with various coal seams located within them. Some indications of basement outcrops are present and are predominantly of the Proterozoic Transvaal Supergroup. These areas negatively impact coal deposition. The lithologies of the Project Area include: • Felsic and intermediate volcanic rocks; • Fine-grained felsic rocks (north, east and west scattered areas); and • Siliciclastic rocks (dominant).

Land Types and Dominant Soil Forms (Figure 6-5)

Land Type	Soil Form		Geology	Characteristics
Ba22 (Dominant)	• Avalon • Cartref • Clovelly • Glencoe • Glenrosa • Hutton • Katspruit	• Kroonstad • Longlands • Mispah • Rensburg • Wasbank • Willowbrook	• Shale, shaly sandstone, grit, sandstone and conglomerate of the Ecca Group and Karoo Sequence; and • Dolerite.	• Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise >33% of land type).
Bb15 (Small section in the east of the MRA)	• Avalon • Cartref • Clovelly • Glencoe • Hutton • Katspruit	• Kroonstad • Longlands • Mispah • Rensburg • Wasbank • Willowbrook	• Shale, shaly sandstone, grit, sandstone and conglomerate of the Ecca Group; and • Tillite and shale of the Dwyka Formation, Karoo Sequence.	• Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise <33% of land type).
Ba19 (Small section in the South of the MRA)	• Avalon • Clovelly • Dundee • Fernwood • Glenrosa • Hutton	• Katspruit • Longlands • Mispah • Pinedene • Wasbank	• Mainly shale, grit, sandstone and conglomerate (Ecca Group); • Volcanic rocks (Selonsrivier Formation, Rooiberg Group); • Granophyre (Rashoop Suite, Bushveld Complex); and • Ferro-gabbro, ferro-diorite and diorite (Rustenburg Suite, Bushveld Complex) and rhyolite (Damwal Formation, Rooiberg Group).	• Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise >33% of land type).

Land Capability (Figure 6-6)			**Land Use (Figure 6-7)**	

Class	Classification	Dominant Limitation Influencing the Physical Suitability for Agricultural Use	The land use was described as:
			• Predominantly:
			  • Grassland; and
			  • Cultivated Area.
			• Minor Areas:
			  • Wetland;
			  • Erosion (dongas);
			  • Low Shrublands;
			  • Water Areas;
				• Woodland/ Open Bush;
				  • Plantation/Woodlot;
				  • Thicket/Dense Bush;
				  • Urban Area; and
				  • Bare/Non-Vegetated.
				• Surface Infrastructure Area:
				  • Grassland;
				  • Cultivated Area; and
				  • Woodland/ Open Bush.

III (Entire MRA)	Arable Land – Moderate Cultivation / Intensive Grazing	Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.		

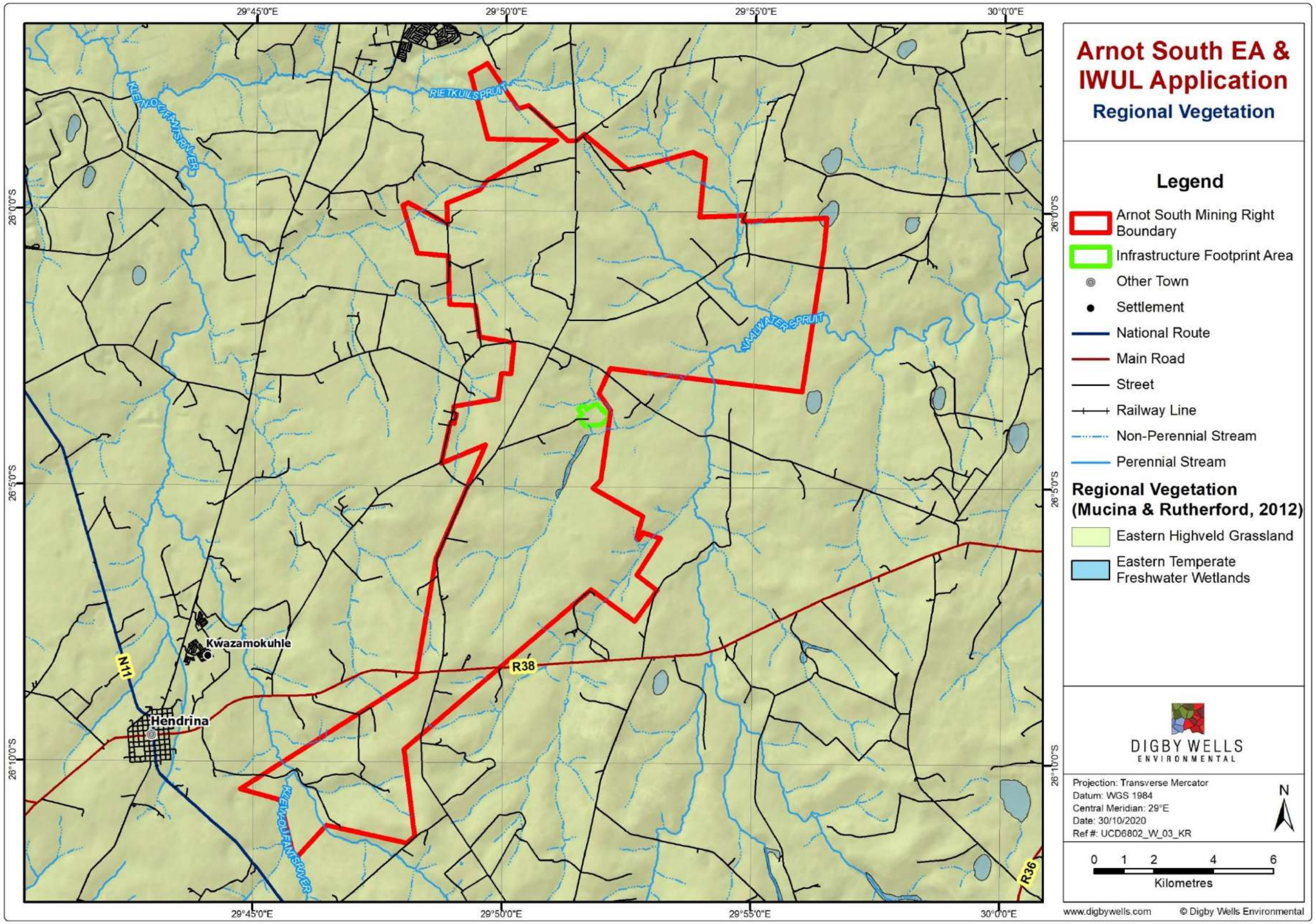


Figure 6-1: Regional Vegetation

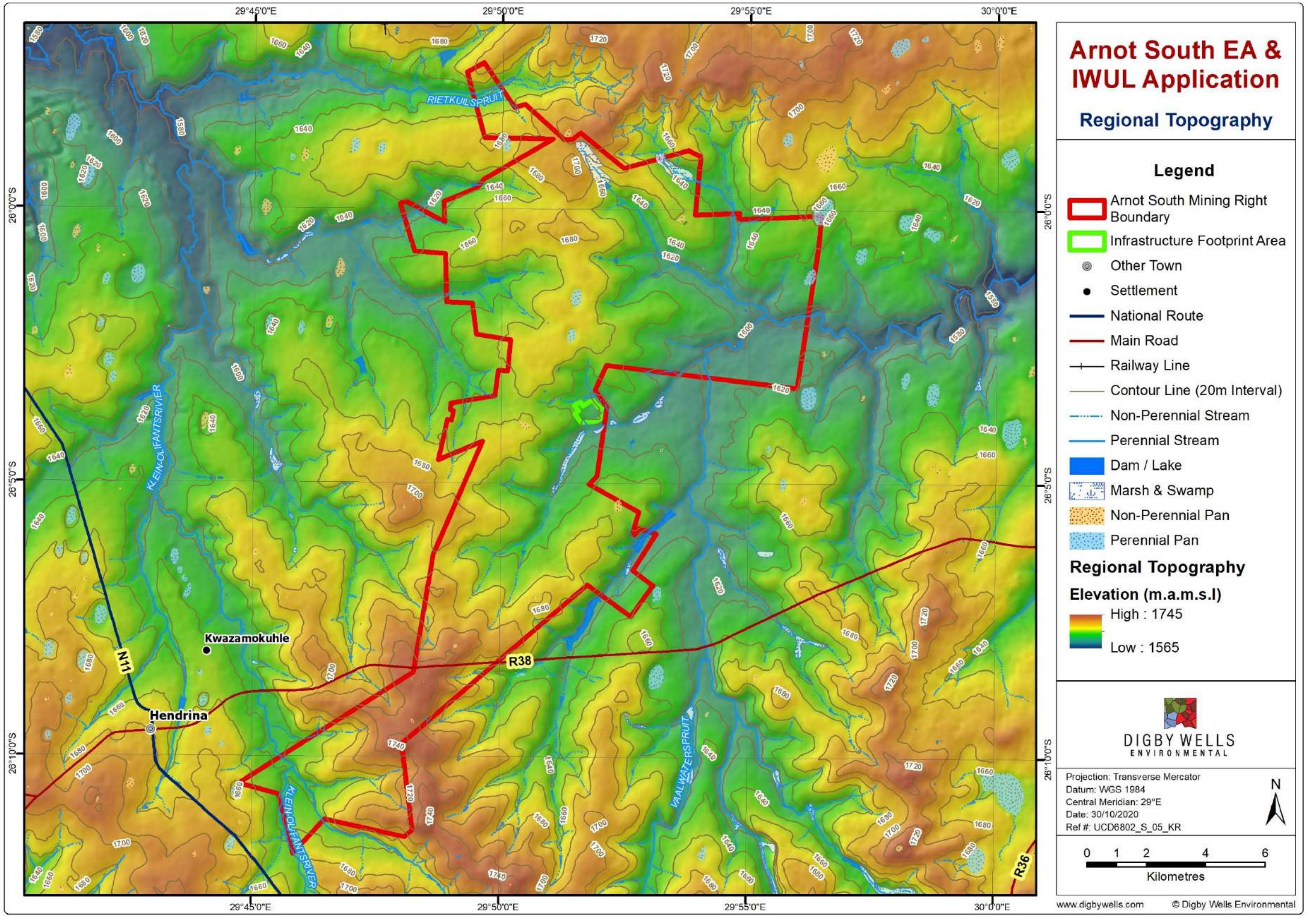


Figure 6-2: Regional Topography

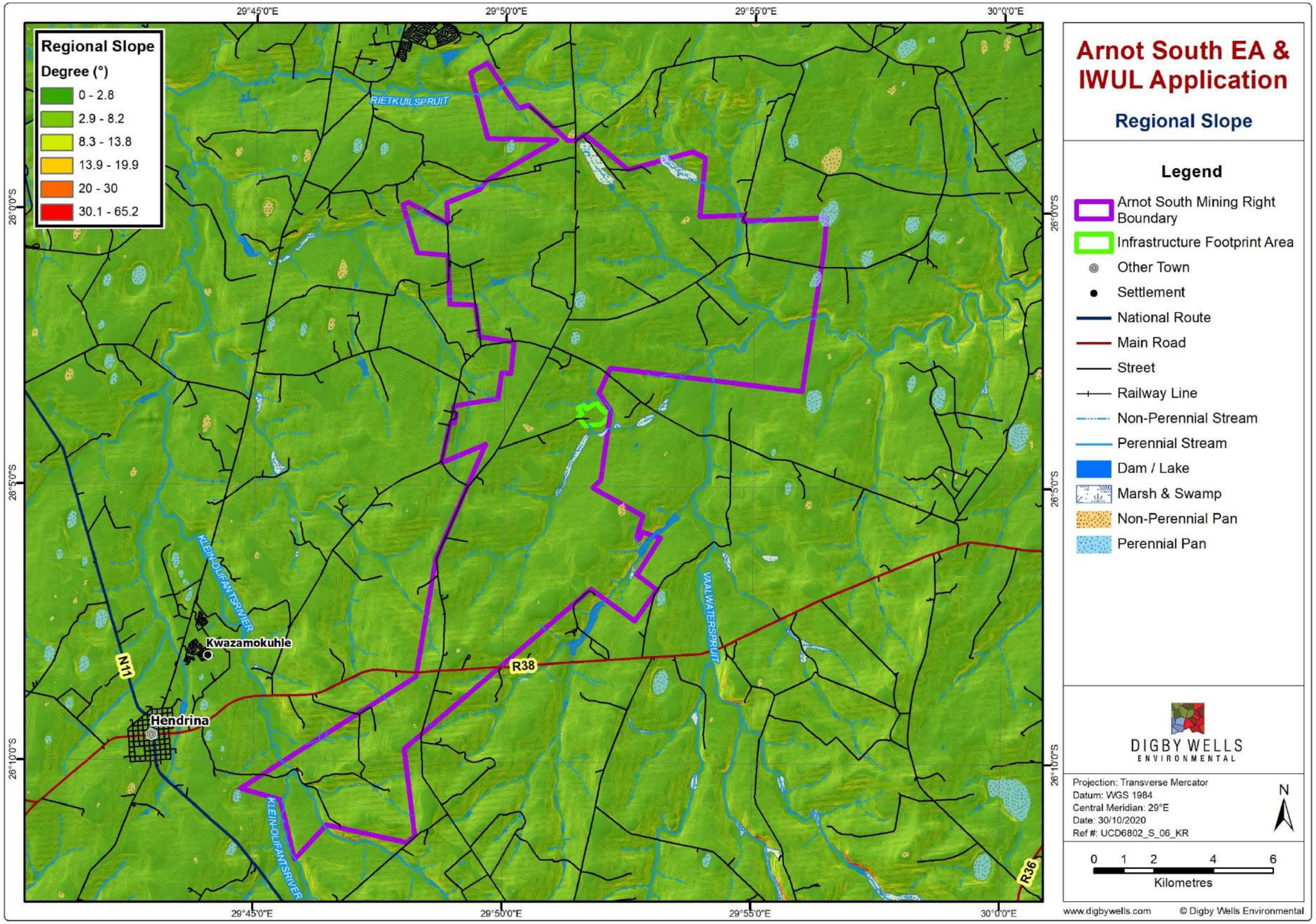


Figure 6-3: Regional Slope

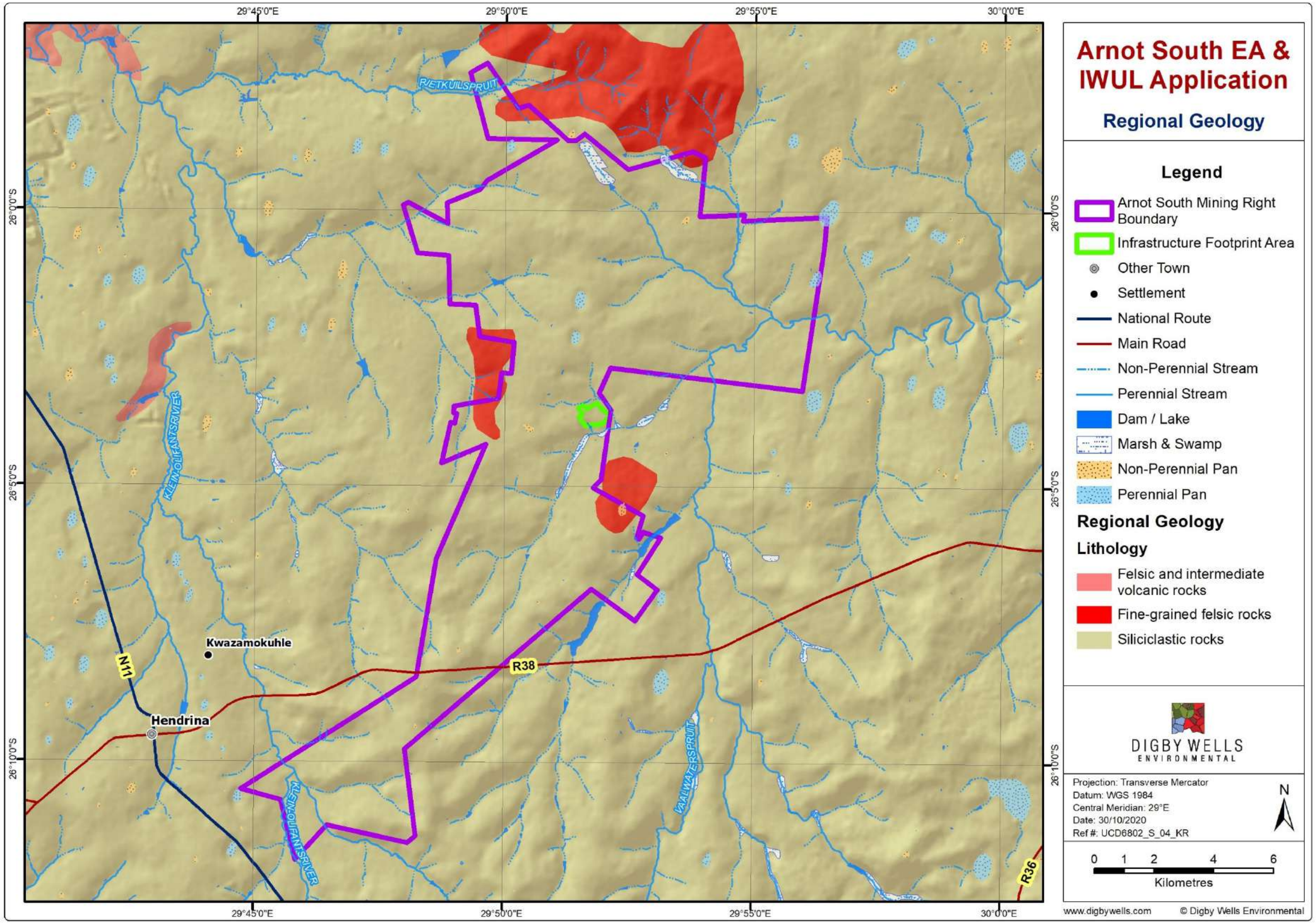


Figure 6-4: Regional Geology

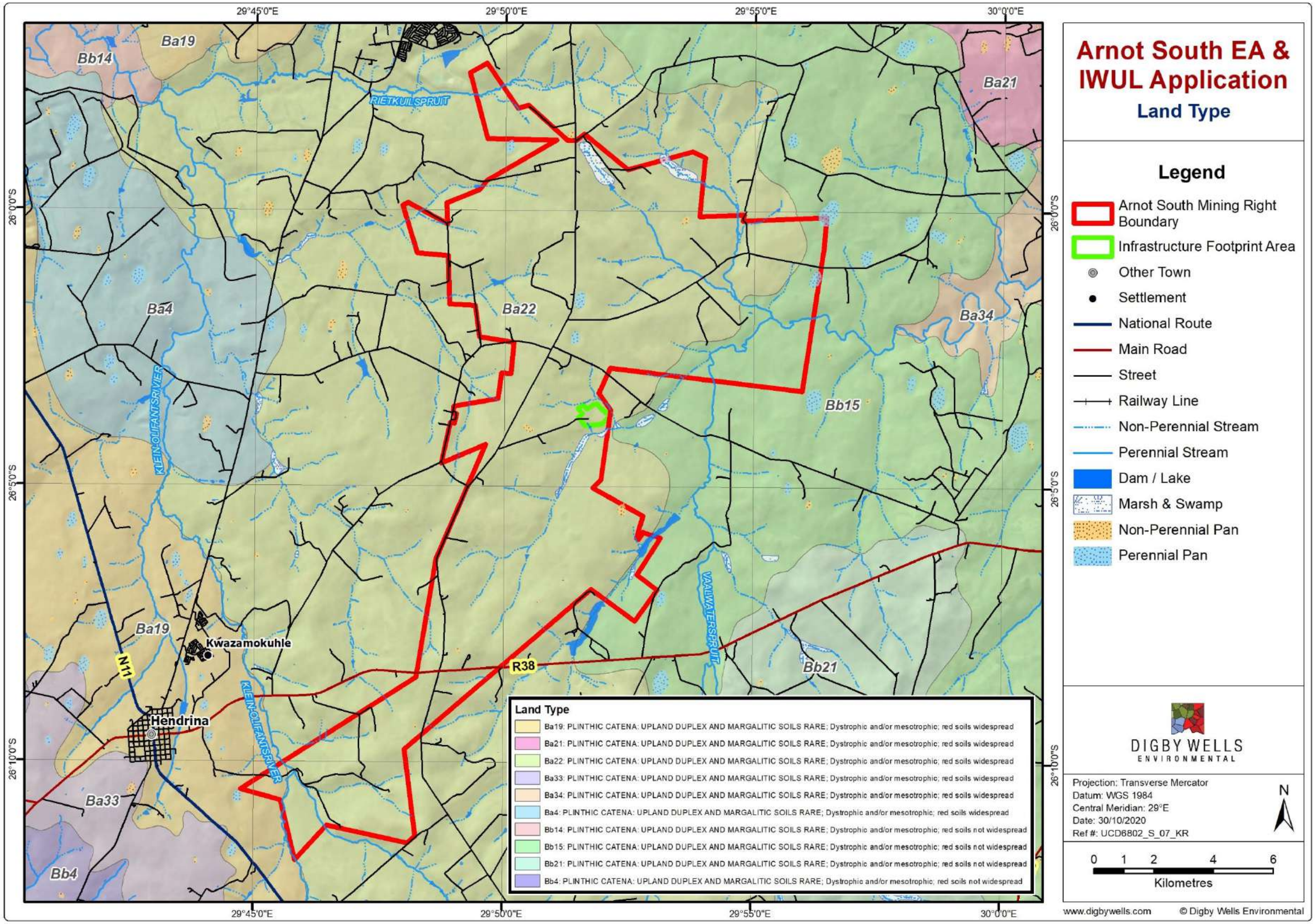


Figure 6-5: Land Types

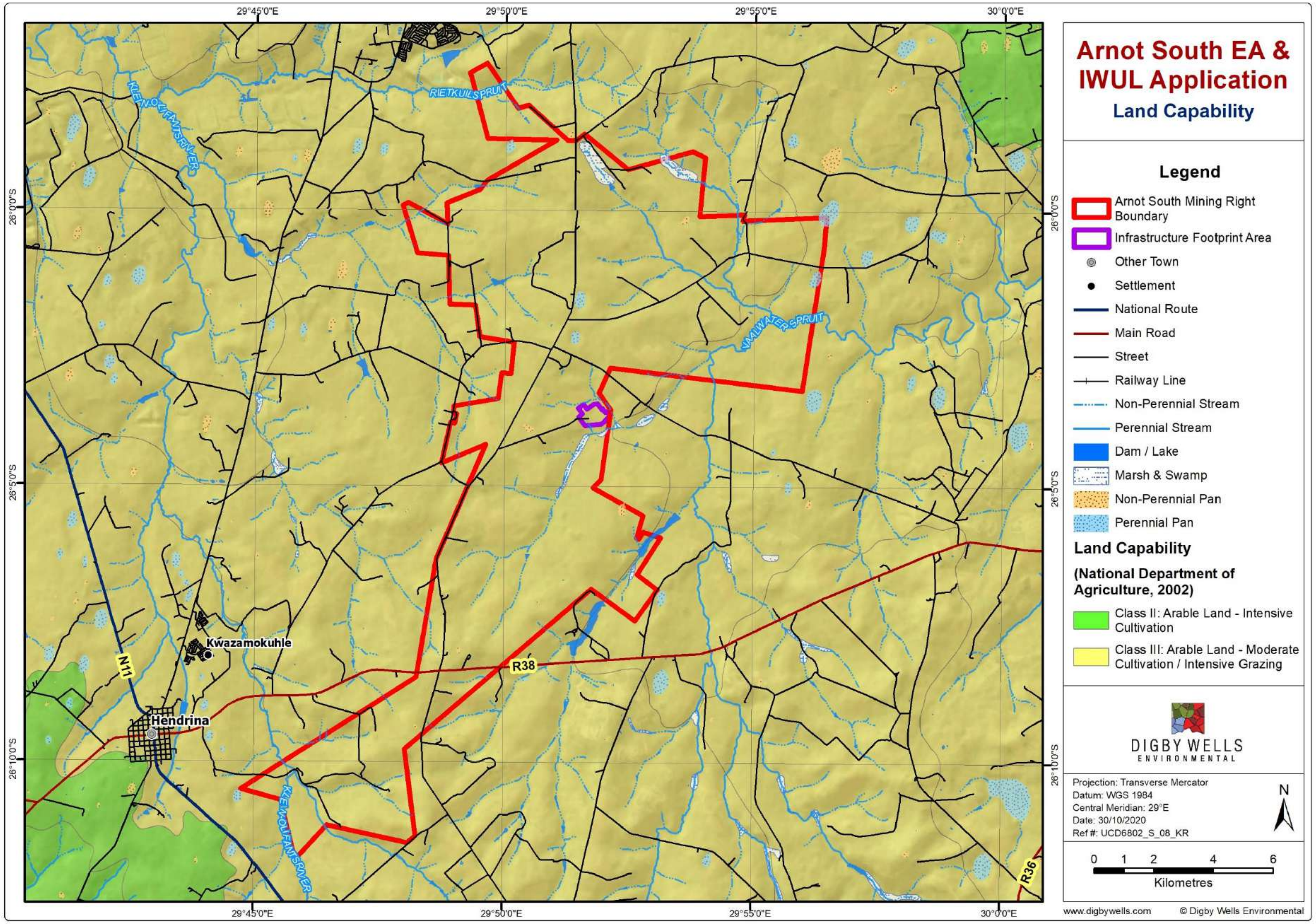


Figure 6-6: Land Capability

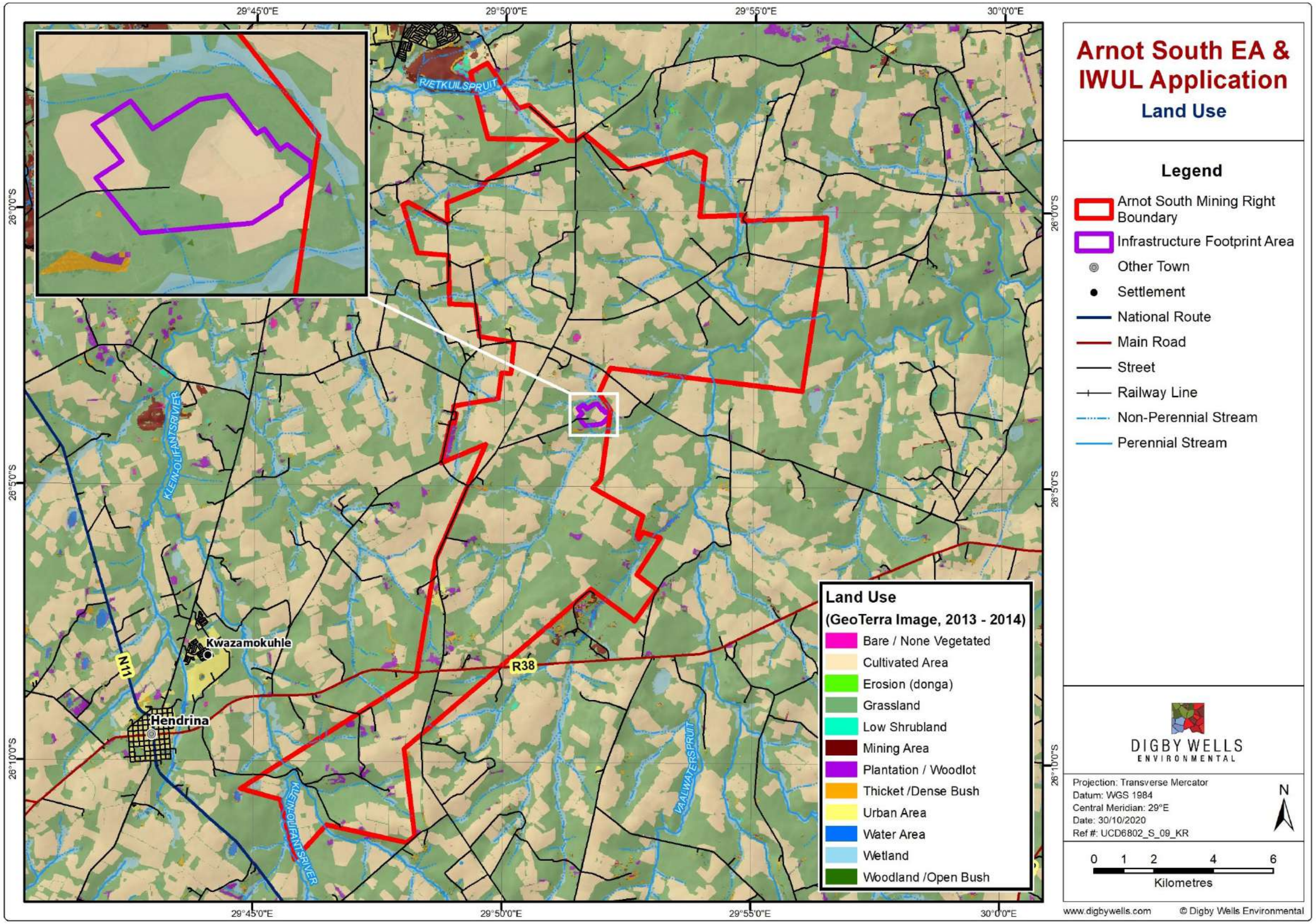


Figure 6-7: Land Use

7. Findings and Discussion

Notes

Soil forms are conceptual generalisations based on specific soil properties. Each soil form consists of soil horizons, uniquely combined and integrated. The soils were classified using the Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991).

The site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. Soils were investigated using a Bucket and Cradle auger to a maximum depth of 1.2 metre (m) or to the first restricting layer. Other features such as existing open trenches and diggings were helpful to determine soil form and depth. Mapping unit boundaries were determined by changes in topography with subsidiary indications from vegetation and parent material.

Avalon, Pinedene, Hutton, and Clovelly soils are typically deep soils, dominated by a red to Yellow-brown apedal (non-structure), sandy B-horizons with a clayey underlying material such as Soft-Plinthic. The clayey horizon increases the water holding capacity, organic material, and Cation Exchange Capacity (CEC) of the soil therefore increasing the agricultural potential.

Rensburg, Arcadia, Katspruit, Kroonstad and Longlands are often associated with low-lying areas and wetlands and are referred to as hydromorphic soils. These soils are saturated for long periods, has a fluctuating water table and very specific characteristics, including mottles, gleying and leaching.

The typical augured soil horizons were identified as: Orthic A-horizons, overlying Yellow-brown to Red Apedal B-horizons with a Plinthic B-horizon (Clovelly, Avalon, Pinedene and Glencoe). The soils were very sandy, deep fertile soils, and are generally used for commercial agropastoral activities (i.e., intensive cultivation and cattle grazing). Soils with agricultural limitations, such as soil depth, waterlogging conditions and low soil fertility were typically used for cattle grazing, whereas the deeper soils were used for cultivation and irrigation cultivation.

Scattered pans were identified within the Project Area, with typical soil horizons of Vertic-A overlying G-horizon and E-horizons overlying a G-horizon (Arcadia, Rensburg, Katspruit and Kroonstad soil forms). These areas were typically used for cattle grazing.

The dominant land use of the area is:

- **Commercial cultivation -** indicating high agricultural potential and land capability of the soils. These deep, sandy soils are generally easily manageable, preferred by farmers and excellent agricultural soils; and
- **Cattle grazing -** The low-lying and depressions within the Project Area showed increased clay content and soil wetness. These soils were identified as wetland soils and are saturated for long periods with a fluctuating water table. The land use in these areas were generally wetlands and used for cattle grazing and perennial grasslands. These soils are somewhat limited for cultivation and highly mobile (high erosion probability).

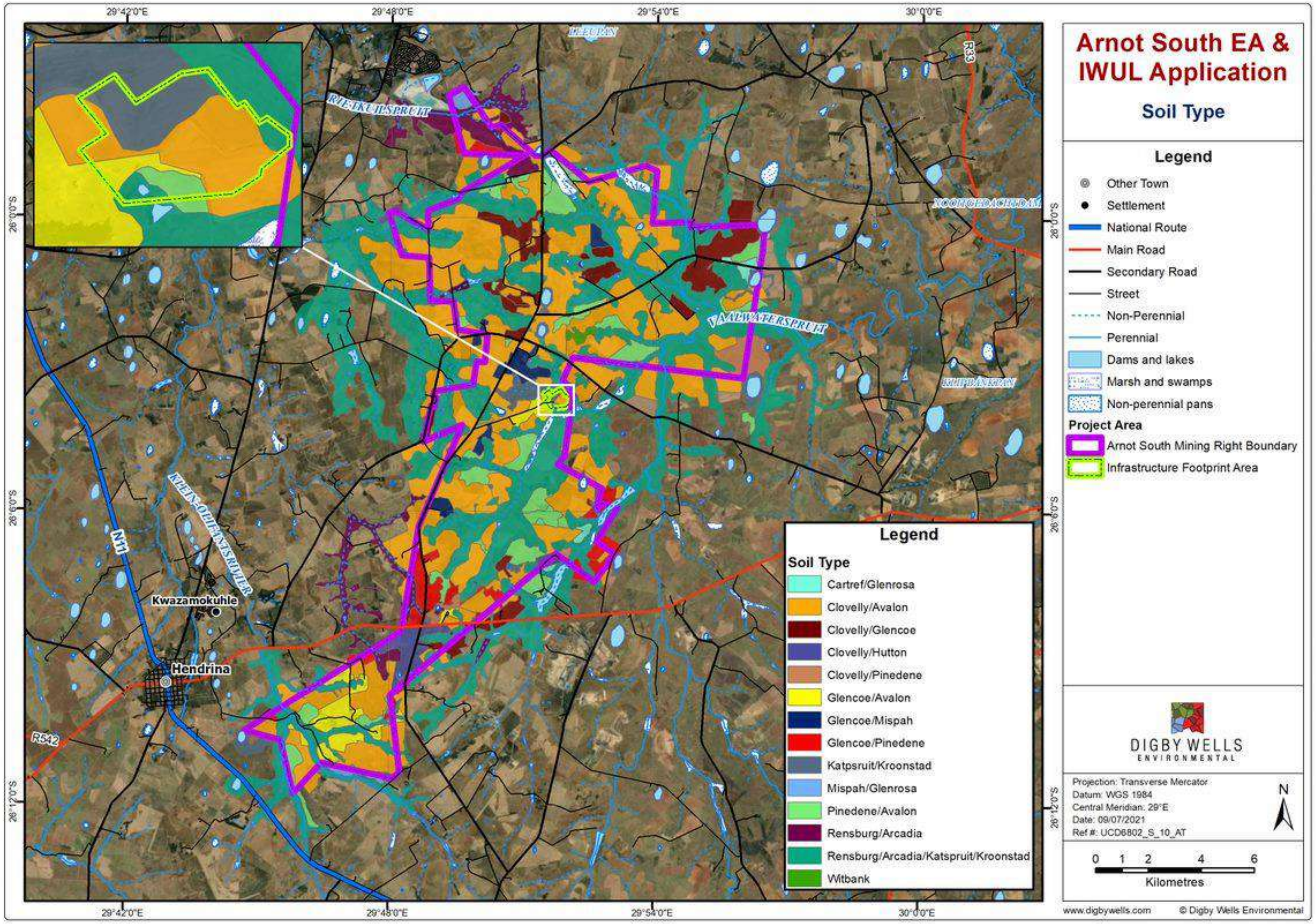


Figure 7-1: Soil Delineations

7.1. Soil Forms

The soil forms within the Project Area were delineated and are illustrated in Figure 7-1 above. Due to the extent of the Project area, limited access to the entire Project Area, time and budget constraints it was sought to group soil forms together by means of dominant soil horizon, functionality and land use (i.e., hydrogeomorphology, depth, topography and slope). The soil forms together with site photos and a short description area presented in Table 7-1 below.

The following soil groups were identified within the Project Area:

- Cartref/Glenrosa;
- Clovelly/Avalon;
- Clovelly/Hutton;
- Clovelly/Glencoe;
- Clovelly/Pinedene;
- Glencoe/Avalon;
- Glencoe/Mispah;
- Glencoe/Pinedene;
- Katspruit/Kroonstad;
- Mispah/Glenrosa;
- Pinedene/Avalon;
- Rensburg/Arcadia;
- Rensburg/Arcadia/Katspruit/Kroonstad; and
- Witbank.

Table 7-1: Soil Forms of the Arnot South Project Area

Soil Form	Dominant Land Use	**Description** (Soil Classification Working Group, 1991)	Observations in the Project Area	
Cartref/Glenrosa → Orthic A → E-horizon → Lithocutanic /→ Orthic A /→ Lithocutanic	• Cattle grazing; and • Wetlands (natural areas).	These soils are shallow and consist of leached, sandy E-horizons, overlying a weathered hard Lithocutanic layer containing cutans and signs of wetness (mottles). The soils usually overlie a hard, impermeable sandstone layer.	• Scattered sections along rivers and low-lying areas; • Shallow and leached soil overlying a hard sandstone layer; • C-horizon restrict hand auguring, water movement and root development; and • Due to the shallow depths, these soils are not cultivated and used dominantly for cattle grazing.	
Clovelly/Avalon → Orthic A → Yellow-brown Apedal → Unspecified /→ Orthic A /→ Yellow-brown Apedal /→ Soft Plinthic	• Intensive cultivation; • Irrigation cultivation; • Intensive cattle grazing; and • Planted pastures.	These soils have a Yellow-brown B-horizon overlying a soft plinthic or unspecified horizon. The soils are deep, freely drained, sandy and often used for intensive cultivation. Yellow-brown Apedal B-horizons form from leached Red Apedal B-horizons and are typically in lower-lying areas, more wet, has higher permeability potential and lower fertility than red soils. These soils have a high land capability potential, however often low in fertility. Clay, Manganese and iron oxides accumulate with depth under conditions of a fluctuating water table forming localised mottles or soft iron concretions in the soft plinthic B horizon.	• Deep, sandy, freely drained (>1200 mm); • High permeability and well suited for cultivation; • Less susceptible to erosion (when vegetated), drain easily and have a high leachability; • Low capacity to supply nutrients to plants and retain nutrients (CEC) due to the low clay content; and • These soils were dominantly cultivated and associated with crests, scarps, and mid-slopes (seep wetlands).	
Clovelly/Hutton → Orthic A → Yellow-brown Apedal → Unspecified /→ Orthic A /→ Red Apedal /→ Unspecified	• Intensive cultivation; • Irrigation cultivation; • Intensive cattle grazing; and • Planted pastures.	These soils have a Red to Yellow-brown B-horizon overlying an unspecified horizon. The soils are deep, freely drained, sandy and often used for intensive cultivation. Yellow-brown Apedal B-horizons form from leached Red Apedal B-horizons and are typically in lower-lying areas, more wet, has higher permeability potential and lower fertility than red soils. Red apedal horizons are therefore often more fertile than Yellow-brown horizons.	• Deep, sandy, freely drained (>1200 mm); • High permeability and well suited for cultivation; • Low CEC, EC and soil fertility due to the low clay content; and • Dominantly used for intensive cultivation.	
Clovelly/Glencoe → Orthic A → Yellow-brown Apedal → Unspecified /→ Orthic A /→ Yellow-brown Apedal /→ Hard Plinthic	• Moderate cultivation; • Intensive cattle grazing; • Planted pastures	These soils are generally fairly deep (500 – 1000 mm) with a loamy-sand texture in the A-horizon and a hard, restricted layer in the B-horizon. The soils are yellow-brown with drainage limitations in the sub-horizons. Drainage is limited causing waterlogging and accumulation of nutrients, increasing the soil fertility. These soils are often cultivated and used for intensive cattle grazing and has a high land capability.	• Soil depth of 500 to >1000 mm; • Sandy, well-drained A-horizon overlying a restricted B-horizon; • Auger restrictions at ~700 mm; and • Soils were dominantly used for light cultivation and intensive cattle grazing.	

Soil Form	Dominant Land Use	Description (Soil Classification Working Group, 1991)	Observations in the Project Area	
Clovelly/Pinedene → Orthic A → Yellow-brown Apedal → Unspecified /→ Orthic A /→ Yellow-brown Apedal /→ Unspecified material with signs of wetness	• Moderate cultivation; • Intensive cattle grazing; • Planted pastures; and • Wetlands (natural areas)	These soils are generally fairly deep (700 – 1200 mm) with a loamy-sand texture with up to 8% clay content. The soils are yellow-brown with minor drainage limitations in the sub-horizons, however, usually contains high clayey underlying material, limiting free drainage. Due to these high clay sub-horizons, drainage is limited causing waterlogging, potential for wetland formation and accumulation of nutrients, increasing the soil fertility. These soils are often cultivated and used for intensive cattle grazing, therefore has a high land capability.	• Soil depth of 1000 to >1200 mm; • Sandy, well-drained A-horizon overlying a high clayey B-horizon; • Clay increased with depth and often had signs of wetness (mottles) in the deeper horizons; and • Soils were dominantly used for cultivation and intensive cattle grazing.	
Glencoe/Avalon → Orthic A → Yellow-brown Apedal → Hard Plinthic /→ Orthic A /→ Yellow-brown Apedal /→ Soft Plinthic	• Limited cultivation; • Intensive cattle grazing; and • Planted pastures.	These soils comprise of a Yellow-brown Apedal B-horizon overlying a Plinthic layer containing an accumulation of iron-, and manganese oxides. These soils together with its high clay content and restricted rooting depth (usually shallow soils) prevent free drainage and lower the agricultural potential of the soils.	• Predominantly shallow soils (600 mm); • Restricted water, root and auger layer with depth; • Sections of cultivation and evidence of alterations to the natural hydrology and geomorphology; • The topsoil is sandy, freely drained and low in nutrients, overlying a restricted layer, therefore limiting intensive cultivation.	
Glencoe/Mispah → Orthic A → Yellow-brown Apedal → Hard Plinthic /→ Orthic A /→ Hard rock	• Moderate cattle grazing; • Limited planted pastures; and • Natural areas.	These soils are naturally shallow and comprise Yellow-brown Apedal B-horizon overlying a Hard Plinthic layer. The underlying material restricts root development and contain increased iron-, and manganese oxides. These soils prevent free drainage and lower the agricultural potential of the soils.	• Predominantly shallow depths (<500); • Restricting water, root, auger and cultivation; • The topsoil is sandy, freely drained and low in nutrients, overlying a restricted layer, therefore limiting cultivation; • Soils were dominantly used for cattle grazing; and • These soils are associated with crests and scarp topographies.	
Glencoe/Pinedene → Orthic A → Yellow-brown Apedal → Hard Plinthic /→ Orthic A /→ Yellow-brown Apedal /→ Unspecified material with signs of wetness	• Limited cultivation; • Intensive cattle grazing; • Planted pastures; and • Wetlands (natural areas).	Soils are generally fairly deep (700 – 1200 mm) with increased clay with depth. The soils are yellow-brown with minor drainage limitations in the upper horizons, however, usually contains very high clayey underlying material, causing water logging conditions and wetland formation. These soils are often cultivated and has a high land capability.	• Soil depth of 700 to >1200 mm; • Sandy, well-drained A-horizon overlying a high clayey B-horizon; • Clay increased with depth and often had signs of wetness (mottles); and • Soils were dominantly used for cultivation and intensive cattle grazing.	

Soil Form	Dominant Land Use	**Description** (Soil Classification Working Group, 1991)	Observations in the Project Area	
Katspruit/Kroonstad → Orthic A → G-horizon /→ Orthic A /→ E-horizon /→ G-horizon	• Moderate cattle grazing; and • Wetlands (natural areas).	Kroonstad and Katspruit soils are referred to as hydromorphic soils due to waterlogging conditions and permanent wetness. These soils consist of a sandy, leached E-horizon overlying a G-horizon with high clay content and clear signs of wetness (mottles/leaching). The soils are saturated for long periods, has a fluctuating water table and have noticeable clay accumulation in the deeper profile.	• Soils were dominantly associated with hillslope seep wetlands, pans and Unchannelled Valley Bottom wetlands (UVBs); • The soils were leached, very sandy in the A-horizon, overlying a very clayey B-horizon with Fe and Mn accumulation; • The soils contribute to subsurface water/ interflow into the wetlands; and • The soil depth varied, however often deeper than 1200 mm.	
Mispah/Glenrosa Mispah → Orthic A → Hard rock /→ Orthic A /→ Lithocutanic	• Infrastructure; • Limited cattle grazing; and • Natural areas.	These soils are dominantly shallow with a restricting water and rooting depth. The soils have a high surface runoff, shallow water table and often associated with sheetrock wetlands. The A-horizon are highly susceptible to erosion when overgrazed, disturbed and low vegetation cover. The Lithocutanic horizon merges into the underlying weathering rock (sandstone) with the same general organisation in respect to the colour, structure and consistency.	• These soils were very shallow, overlying hard rock; • The soils were delineated in the scarp, adjacent to the floodplain/CVB systems; • The soil depth did not exceed 150 mm; • The soils restrict cultivation and often had low vegetation cover; • These areas were less impacted by anthropological activities; and • Sections of the soils had some signs of temporary wetness due to springs and water accumulation due to shallow, rocky sandstone outcrops.	
Pinedene/Avalon → Orthic A → Yellow-brown Apedal → Unspecified material with signs of wetness /→ Orthic A /→ Yellow-brown Apedal /→ Soft Plinthic	• Intensive cultivation; • Irrigation cultivation; • Intensive cattle grazing; • Planted pastures; and • Wetlands.	These soils are generally deep (>1200 mm) and have a sand-clay texture. The soils are yellow-brown with minor drainage limitations in the upper horizons, however, usually contains high clay underlying material. Drainage is limited which causes waterlogging, potential for wetland formation and accumulation of nutrients, increasing the soil fertility. These soils are often cultivated and has a high land capability. The soils are free draining and chemically active soils with high permeability and leaching potential. Clay, Manganese and iron oxides accumulate with depth under conditions of a fluctuating water table forming localised mottles or soft iron concretions in the soft plinthic B horizon.	• Soil depths of >1200 mm; • The soils were sandy, well drained and often cultivated due to it high agricultural potential; • Clay increased with depth and often had signs of wetness (mottles); and • Soils were often associated with hillslope seep wetlands and intensive cultivated land.	
Rensburg/Arcadia → Vertic A → G-horizon /→ Vertic A /→ Unspecified	• Moderate cattle grazing; and • Wetlands (natural areas).	Rensburg and Arcadia soils consists of a Vertic-A horizons with very high clay, dark colour and high organic material. The soils are often deep (>1200 mm) and identified as hydromorphic soils. The G-horizon subsoil has a grey or gleyic colour pattern (leached) which at times can be hints of green due to the reduction of iron under permanent or periodic anaerobic conditions and has a firmer consistence than the overlying topsoil and is classified as a wetland soil.	• These soils were augured in pans and valley bottom wetlands within the Project Area; • The soils had a dark, black, clayey A-horizon (vertic) overlying a sandy-clay-loam, light coloured G-horizon; • Soils were often deeper that 1200 mm; • These soils were permanently saturated with water, well vegetated and dominantly used for cattle grazing; and • The soils are high in OM and soil fertility, however restrictions to cultivation due to saturation and waterlogging.	

Soil Form	Dominant Land Use	**Description** (Soil Classification Working Group, 1991)	Observations in the Project Area	
Rensburg/Arcadia/Katspruit/Kroonstad → Vertic A → G-horizon /→ Vertic A /→ Unspecified /→ Orthic A /→ G-horizon /→ Orthic A /→ E-horizon /→ G-horizon	• Moderate cattle grazing; and • Wetlands (natural areas).	Hydromorphic soils are often associated with wetlands. The soils are characterised by the reduction or localization of iron and manganese due to the temporary or permanent waterlogging conditions of the soils. Waterlogging causes a lack of oxygen over a long period. These soils are high in clay, CEC, OM, nutrients and fertility, however is restricted to cultivation due to waterlogging conditions.	• These soils are associated with wetlands and low-lying areas in the Project Area; • The soils were dominantly used for cattle grazing and cattle watering; • Some sections of these soils were eroded and gully formation (due to overgrazing) with low vegetation cover; • Surface runoff from these soils were high and usually associated with CVBs; and • Due to the cultivation restrictions, sections of these soils were left natural and not heavily impacted by anthropological activities.	
Witbank → Man-made material	• Moderate cattle grazing; and • Infrastructure (historical and current);	Witbank soils are anthropologically impacted soils. These soils are combined and mixed soils with various properties and pedogenesis. These soils are altered from its natural state and include intensive cultivated land.	• Witbank soils in the Project Area are dominantly associated with agropastoral and mining activities; • Large sections of these areas were mixed soils, compacted and contained large stands of AIPs; • The natural geomorphology of these soils is altered by excavations, compaction, dam building, stockpiling, cultivation and historical infrastructure; and • Some if these soils were associated with artificial wetness due to compaction, mixing of subsoil and topsoil causing water ponding.	

7.2. Soil Chemical and Physical Characteristics

The results of the soil analysis for the five (5) representative samples are presented in Table 7-3. As a basis for interpreting the data, SSV and local soil fertility guidelines are presented in Table 7-2, together with the pH guidelines.

The results highlighted in yellow present values below the SSV and red above the SSV. The pH colours are presented in Table 7-2 below.

Table 7-2: Soil Fertility Guidelines

Guidelines (mg per kg)			Source
Macro Nutrient	**Low**	**High**	
Aluminium (Al)	<10	>50	Australian Guidelines, (Department of Agriculture and Rural Affairs, 1986)
Boron (B)	<0.5	>1.5	USA Guidelines, (Allison, et al., 1954)
Calcium (Ca)	<200	>3000	South Africa Guidelines, (NEM:WA 2008)
Chlorides (Cl)	-	>12000	South Africa Guidelines, (NEM:WA 2008)
Copper (Cu)	<36.0	>190	Dutch Guidelines, (Dutch VROM, 2000)
F (Fluoride)	-	>200	Canadian Guidelines, (CCME, 2007)
Magnesium (Mg)	<50	>300	South Africa Guidelines, (NEM:WA 2008)
Nickel (Ni)	-	>45	Canadian Guidelines, (CCME, 2007)
Organic Carbon (OC)	< 2 %	>3 %	South Africa Guidelines, (du Preez, Mnkeni, & van Huyssteen, 2010)
Phosphorus (P)	<5	>35	South Africa Guidelines, (NEM:WA 2008)
Potassium (K)	<40	>250	South Africa Guidelines, (NEM:WA 2008)
Sodium (Na)	<50	>200	South Africa Guidelines, (NEM:WA 2008)
Zinc (Zn)	<140	>720	Dutch Guidelines, (Dutch VROM, 2000)
Electrical Conductivity (EC)	110 (mS/m)	570 (mS/m)	Australian Guidelines, (Department of Agriculture and Rural Affairs, 1986)
Cation Exchange Capacity (CEC)	5%	25%	Australian Guidelines, (Department of Agriculture and Rural Affairs, 1986)

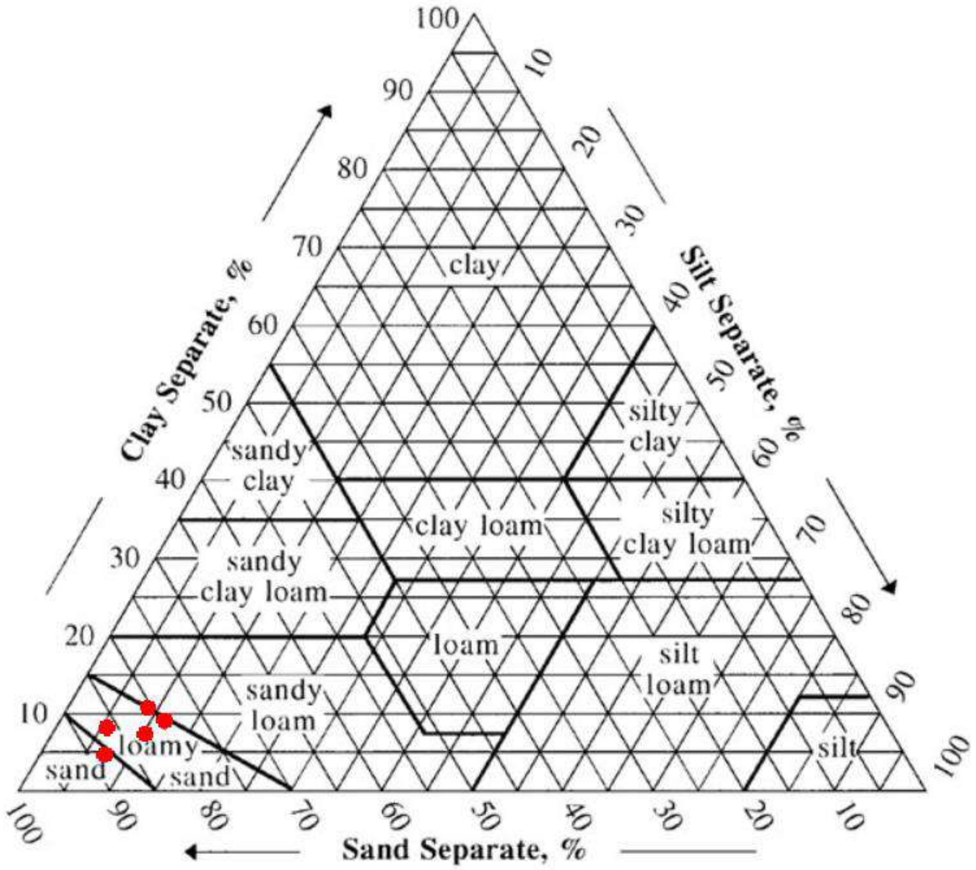
pH					
Very Acid	**Acid**	**Slightly Acid**	**Neutral**	**Slightly Alkaline**	**Alkaline**
<4	4.1-5.9	6-6.7	6.8-7.2	7.3-8	>8

Table 7-3: Soil Physico-Chemical Properties

Sample ID	pH (KCl)	EC	CEC	C	P	Ca	Mg	K	Na	Al	Fe	Mn	Cu	Zn	Ni	F	Cl	NO_3	Sand	Silt	Clay	Texture
		mS/m	cmol(+)/kg	%	mg/kg						mg/l								%			
S1	4.84	34	4.66	0.63	7.8	353.5	86.0	43.9	17.9	0	94.55	25.34	1.54	1.09	0.92	0.19	4.20	13.09	89.5	6.5	4.1	Sand
S2	4.64	63	7.29	0.73	3.8	411.4	160.6	132.0	39.6	0.14	195.50	17.71	2.85	0.76	1.05	0.07	40.75	0.36	80.7	10.8	8.5	Loamy Sand
S3	4.76	35	6.38	0.77	4.4	327.1	120.6	45.5	19.4	0	176.30	19.24	1.29	0.61	0.89	0.13	4.99	27.02	87.5	4.9	7.6	Loamy Sand
S4	4.52	25	7.99	1.27	4.5	225.1	82.3	145.6	4.2	10.95	128.40	12.75	1.98	1.18	0.61	0.15	4.78	1.45	81.7	8.1	10.2	Loamy Sand
S5	3.93	23	5.22	1.39	3.3	81.6	27.6	42.6	6.3	64.82	261.20	2.93	1.45	0.50	0.46	0.18	2.48	0.61	83.7	9.4	6.8	Loamy Sand

Table 7-4: Texture Classification

Sample Number	Texture Classification
1	Sand
2	Loamy Sand
3	Loamy Sand
4	Loamy Sand
5	Loamy Sand



7.2.1. Soil Texture

Guidance Note:

The particle size distribution of the soil sampled in the Project Area 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. The size limits for sand, silt and clay used in the determination of soil texture classes are sand: 2.0 – 0.05 mm, silt: 0.05 – 0.002 mm and clay: < 0.002 mm.

Soil water retention characteristics are strongly affected by soil texture. A higher clay content results in greater water retention. Similarly, the higher the sand fraction, the less water is retained by the soil (Gebregiorgis, 2003). Soil macropores allow a greater volume of water to drain more rapidly than would be expected from a soil that is dominated by clay fractions. Generally, the ideal pore space is between 40 – 60% (NRCS-USDA, 2013).

The bulk density of soil is dependent on the sand-clay-silt ration. The higher the clay content the higher the bulk density. Bulk density represents the mass of dry soil (mass of solids) per unit volume of soil (White, 2003). A low bulk density implies a favourable soil structure for root penetration as it is not compacted (Karuku, et al., 2012). Generally, soils with bulk densities greater than 1.6 g/cm^{-3} are considered as compacted soils (Twum & Nii-Annang, 2015).

The particle size distribution of the soil sampled in the Project Area 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.

The dominant soil textures in the Project Area were **sand** to **loamy-sand**. Soil texture are a direct attribute from the parent material (dominantly sandstone). The following characteristics are related to sand, clay and loam soils (Table 7-5):

Table 7-5 Soil Texture of the Project Area

Sandy soils	Loamy soils	Clay Soils
• High infiltration and drainage rate (low water-holding capacity);	• Moderate infiltration and drainage rate (moderate water-holding capacity);	• Low infiltration and drainage rate (high water-holding capacity);
• High leaching potential;	• Moderate leaching potential;	• Low leaching potential;
• Low soil fertility (OC, CEC, EC, pH);	• High fertility status (nutrients and OM);	• Very high fertility status (nutrients and OM);
• High lying areas; and	• Low-lying areas; and	• Low-lying areas; and
• Low erosion potential.	• High erosion potential	• High erosion potential

Due to the relatively small size of areas covered by clay rich soils, the low potential of these soils, and the fact that most of the impact will occur on the sandy soils the clayey soils were not sent for analysis. However, the high clay soils in the low-lying areas (wetlands) contribute to low infiltration, water ponding, has a high erosion potential and contain high concentration of chemicals. The higher the clay in the soil, the higher the EC, CEC, OC and pH.

7.2.2. Soil pH

Guidance Note:

The measurement of soil acidity is referred to as 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 soil chemical, physical and biological properties.

The interaction between soil particles, soil solution and dissolved ions have an important role in holding cations such as calcium (Ca^{+2}), magnesium (Mg^{+2}), potassium (K^{+}) and ammonium (NH_4^{+}) in the soil. The cations are important plant nutrients that are taken up by plants from the soil solution. When the concentration of the solution is out of proportion it will directly impact the biology of the soil as well as the growth of the vegetation. When the concentration is increased, by means of adding lime and fertilizers, the nutrient will first be absorbed by the soil particles until dissolved and released into the soil solution for plant availability. When the holding capacity of the soil particles are low (sandy soil), the nutrient will just leach out of the profile, inherently known as infertile soils whereas clayey soils have a much higher holding capacity for nutrient and thus are more fertile (Neina, 2019).

In addition to the cations in the soil is acid ions. The acid ions include hydrogen protons (H^{+}) and aluminium ions (Al^{+3} and $Al\ (OH)^{+2}$) causes an acidic reaction and therefore lower the pH of the soil solution (Farina & Channon, 1991).

The pH of the soil samples collected ranged from **3.93** to **4.84**, indicating that the soils are **very acidic** to **acidic**. The optimal pH for agricultural crops range between 5.5 and 7.5. The following can be derived from the data:

- All the samples were below the optimal pH range for agriculture;
- Due to the sandy nature of the soils (siliciclastic sedimentary rocks - conglomerates, sandstones, and mudrock parent material), intensive crop production and high rainfall in the vicinity of the Project Area, the pH tends to decrease over time and require a liming and fertilizer programme to optimize crop production;
- Soils with a low EC, cations and clay content tend to have a lower pH than soils with higher clay and EC; and
- The pH in Sample 5 were the lowest. As soil pH decreases, Al is solubilized and the proportion of Al-ions increases in the soil solution (consequently the high levels of Al in Sample 5).

7.2.3. Exchangeable Cations

Guidance Note:

The higher the CEC value (> 25) the higher the clay and/or organic material (OM) in the soil. Soils with a high clay and/ or OM content, with a high CEC will have high cation concentrations. Cations are adsorbed by the negatively charged clay and OM particles. Soils with a low CEC (< 5) is usually an indication of sandy soils with low soil fertility and OM.

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**, **Ca** being the most reactive and **Na** less reactive.

In soil, dispersion and flocculation of soil particles are a chemical phenomenon which is driven by the balance of the exchangeable cations. Excess **Na** and **K** causes dispersion (soil is broken down in very fine particles which is particularly sensitive to erosion), whereas high levels of **Ca** would rather cause flocculation (soil particles adhere to each other to form clusters/flakes or clumps). Dispersion and flocculation have several impacts on soil development and responses which in return affects root development and plant growth (Chibowski, 2011).

The CEC values ranged from **4.66** to **7.99** cmol(+)/kg. This is on average a low CEC, indicating low clay soils with high permeability and low fertility. The following can be derived from the data regarding the CEC and the exchangeable cations:

- Sample 1 had the lowest CEC as well as the highest sand fractions (most sandy);
- The lower the clay content of soil, the lower the adsorption potential of cations and therefore the lower the CEC and EC;
- Na in all five samples were below the SSV;
- P, Ca, Mg and Na were below the SSV in Sample 5, however Al exceeded the SSV;
- The EC of all five samples were below the SSV;
- The low CEC and cations in the soils can be attributed to the sandy nature of the soil (sandstone parent material), low organic material (OM), low clay content and intensive cultivation practices; and
- Soils with a low CEC and cations have a low soil fertility and require fertilization for optimal crop production.

7.2.4. Phosphorus

Guidance Note:

Phosphorus (**P**) is required in plants for root development and promote plant sugars for more efficient ripening of fruits and promote larger flowers. Soil pH and depth are just as important to note as **P** is immobile in soil and will be higher at a depth where there is a free flow of water.

Excessive levels of phosphorus in a growth medium are not particularly harmful to plant health, however, may impede the uptake of **Zn** and Iron (**Fe**) even when there are adequate amounts of these nutrients in the material. Excessive levels of **P** are not easily remedied and takes a long time to lower. It is therefore important to avoid fertilisers containing phosphorus, such as NPK and cattle manure as fertiliser.

The **P** in the samples ranged from **3.3** to **7.8** mg/kg. The following was derived from the data:

- Four of the five samples had P-levels below the SSV, these soils will require P-fertilizer for optimum crop production;
- Sample 1 had adequate P, however, is below the optimal P-level for agriculture;
- The low P indicates that the P in the soils is most likely fixed and not mobile in the soils and easily leached;
- The low P can be attributed to the sandy nature of the soils and high leaching potential; and
- P-fertilizer would be required to increase te P in the soils for optimum crop production, plant growth and vegetation cover.

7.2.5. Heavy Metals and Potential Harmful Elements

Guidance Note:

Heavy metal contamination is a serious form of inorganic pollution which has a long-term negative effect on the natural environment. These heavy metals include **Al, Hg, Cd, Pb, As, Cu, Zn, Mn, Ni, U** and **Se.** To a greater or lesser extent, these elements are toxic to living organisms. **Cd** and **As** are extremely toxic, whereas **B, Cu, Zn** and **Mn** are relatively lower in toxicity to living organisms.

The optimum level of nitrates in soil for commercial crops ranges from 5 to 10 parts per 1 million (ppm). Optimum nitrate level for soil used for corn production is more than 25 ppm.

The heavy metals and potential harmful elements in all the samples were below the SSV, except **Al** in S5. This is a good indication that there is currently no inorganic pollution in the Project Area. The following was derived from the data:

- Al, Fe, Mn, Cu, Zn, NI and F were analysed and were all within or below the SSV, excerpt for Fe in Sample 5;
- Due to the low soil pH, Al becomes soluble and the proportion of Al increases in the soil solution;

- Other potential harmful elements, including Chloride (Cl) and Nitrite (NO_2) were within the SSV in all the samples and will not cause harm to crop production; and
- The soils are not impacted by potential harmful elements, nor heavy metals. This baseline data should be used for future soil and water monitoring.

7.2.6. Organic Carbon

Guidance Note:

Soil Organic Carbon (OC) indicates organic material content in the soil, therefore soil fertility. OC releases nutrients to plants, promotes root development, soil structure, soil health and increases the buffer of the soil against harmful elements. The higher the level of OC, the higher the OM and thus the more fertile the soil. Levels above 2 - 3% OC are considered moderate to high for soils in South Africa according to du Preez et al., (2010).

The soil OC ranged from **0.63** to **1.39** % in the five soil samples. The OC in all the samples were thus below the SSV. The following was derived from the data:

- The low OC can be attributed to the sandy nature of the soils, low pH and low CEC;
- All the samples had a low OC, and organic fertilizer would be required for optimum crop production; and
- The higher the clay content of the soil, the higher the CEC, EC, pH and adsorption potential. OC also tends to be higher in clay soils due to the low leaching potential of clays.

8. Land Use and Current Impacts

The dominant land use was identified by aerial imagery during the desktop assessment and verified during the site survey as (Table 8-1 and Figure 8-1):

- Cultivation;
- Cattle grazing;
- Grazing/Wetland;
- Wetlands/natural; and
- Infrastructure.

The current impacts to the soils, land use and land capability of the Project Area are associated with agropastoral activities (i.e., cultivation, cattle grazing, infrastructure), mining (i.e., mine pits, infrastructure) and anthropological activities (roads, dams, powerlines, pipelines, culverts, bridges).

Table 8-1 Land Use Activities


Planted pastures

Historical and current infrastructure

Cattle grazing

Cultivation

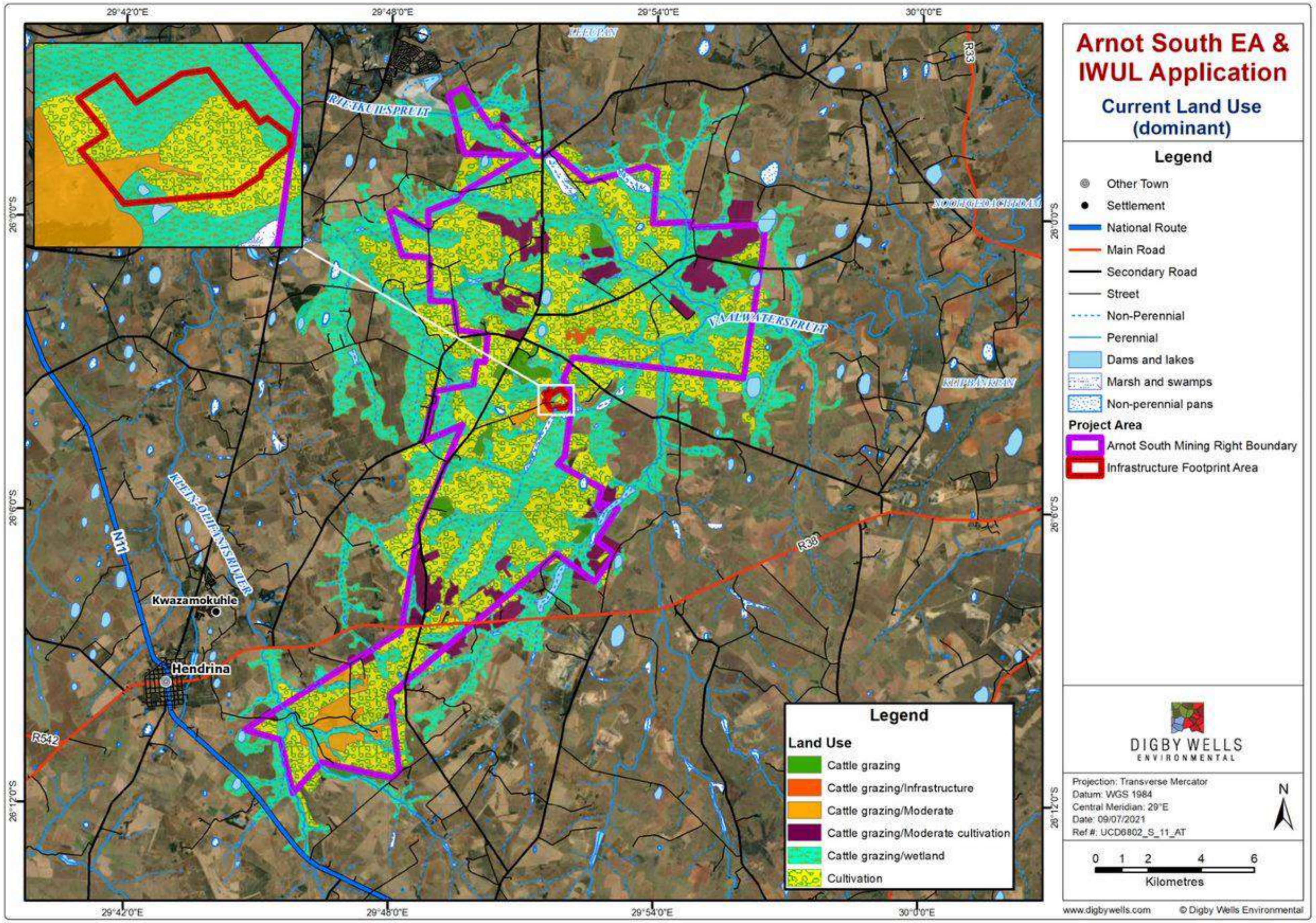


Figure 8-1 Current Land Use

9. Land Capability and Sensitivity Analysis

Guidance Note

Land capability was determined by assessing a combination of soil, terrain and climate features. Land capability is defined by the most suitable land use under rain-fed conditions. The approach by U.S. Department of Agriculture (1973) and Schoeman et al. (2000) was used to assess the land capability. The classification system is made up of land capability classes and land capability groups.

Class	Increased Intensity of Use									Land Capability Groups	Sensitivity
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable Land	High
II	W	F	LG	MG	IG	LC	MC	IC	-		
III	W	F	LG	MG	IG	LC	MC	-	-		
IV	W	F	LG	MG	IG	LC	-	-	-		
V	W	-	LG	MG	-	-	-	-	-	Grazing Land	Medium
VI	W	F	LG	MG	-	-	-	-	-		
VII	W	F	LG	-	-	-	-	-	-	Wildlife	Low
VIII	W	-	-	-	-	-	-	-	-		

W – Wildlife
F – Forestry
LG – Light Grazing
MG – Moderate Grazing
IG – Intensive Grazing
LC – Light Cultivation
MC – Moderate Cultivation
IC – Intensive Cultivation
VIC – Very Intensive Cultivation

Based on the soil delineations, land use and soil chemical and physical analysis, the following areas must be regarded as sensitive areas (areas with a high land capability and suitability) (Table 9-1):

Table 9-1: Soil Sensitivity

Soil Form	Current Land Use (dominant)	Current Land Capability (dominant) (Figure 9-1)	Land Class (Figure 9-2)	Sensitivity (Figure 9-3)
Cartref/Glenrosa	Cattle grazing	LG	VII	Low
Clovelly/Avalon	Cultivation	VIC	I	High
Clovelly/Hutton	Cultivation	VIC	I	High
Clovelly/Glencoe	Cattle grazing/Moderate cultivation	MC	III	High
Clovelly/Pinedene	Cultivation	IC	II	High
Glencoe/Avalon	Cattle grazing/Moderate cultivation	MC	III	High

Soil Form	Current Land Use (dominant)	Current Land Capability (dominant) (Figure 9-1)	Land Class (Figure 9-2)	Sensitivity (Figure 9-3)
Glencoe/Mispah	Cattle grazing	LG	VII	Low
Glencoe/Pinedene	Cattle grazing/Moderate cultivation	MG	VI	Moderate
Katspruit/Kroonstad	Cattle grazing/wetland	MG	V	Moderate
Mispah/Glenrosa	Cattle grazing	LG	VII	Low
Pinedene/Avalon	Cultivation	IC	II	High
Rensburg/Arcadia	Cattle grazing/wetland	MG	V	Moderate
Rensburg/Arcadia/ Katspruit/Kroonstad	Cattle grazing/wetland	MG	V	Moderate
Witbank	Cattle grazing/Infrastructure	LG	VII	Low

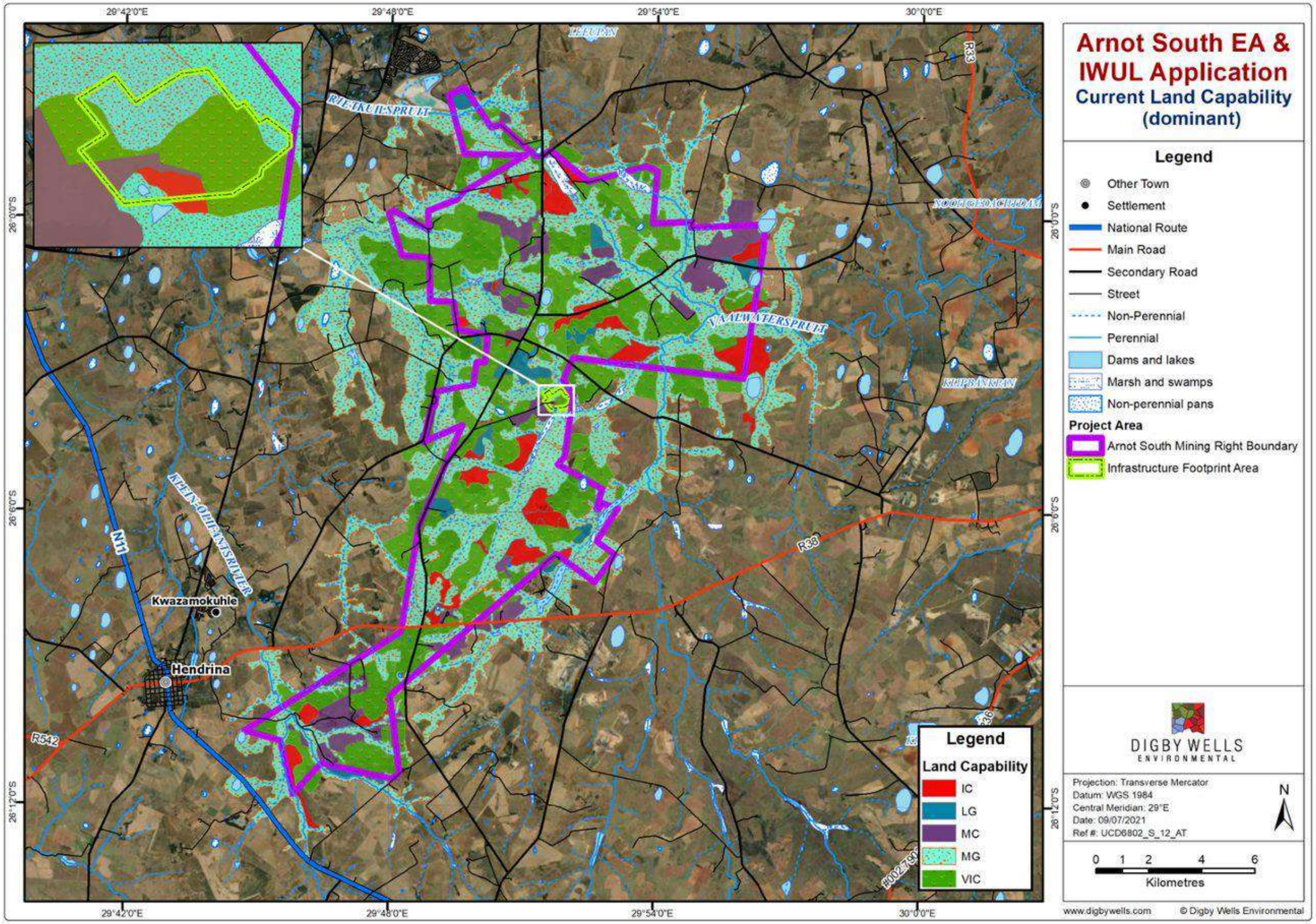


Figure 9-1 Current Land Capability

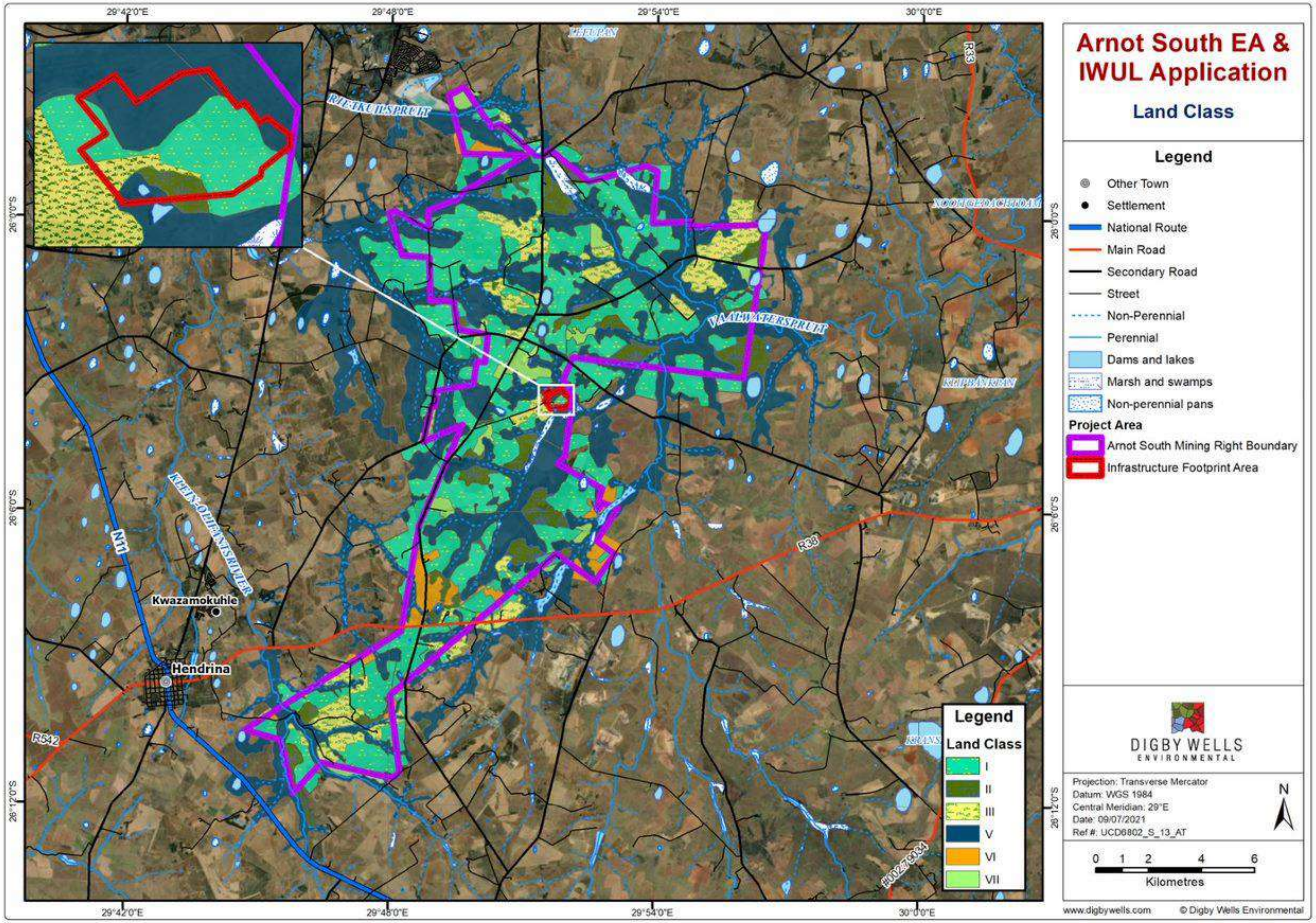


Figure 9-2 Current Land Class

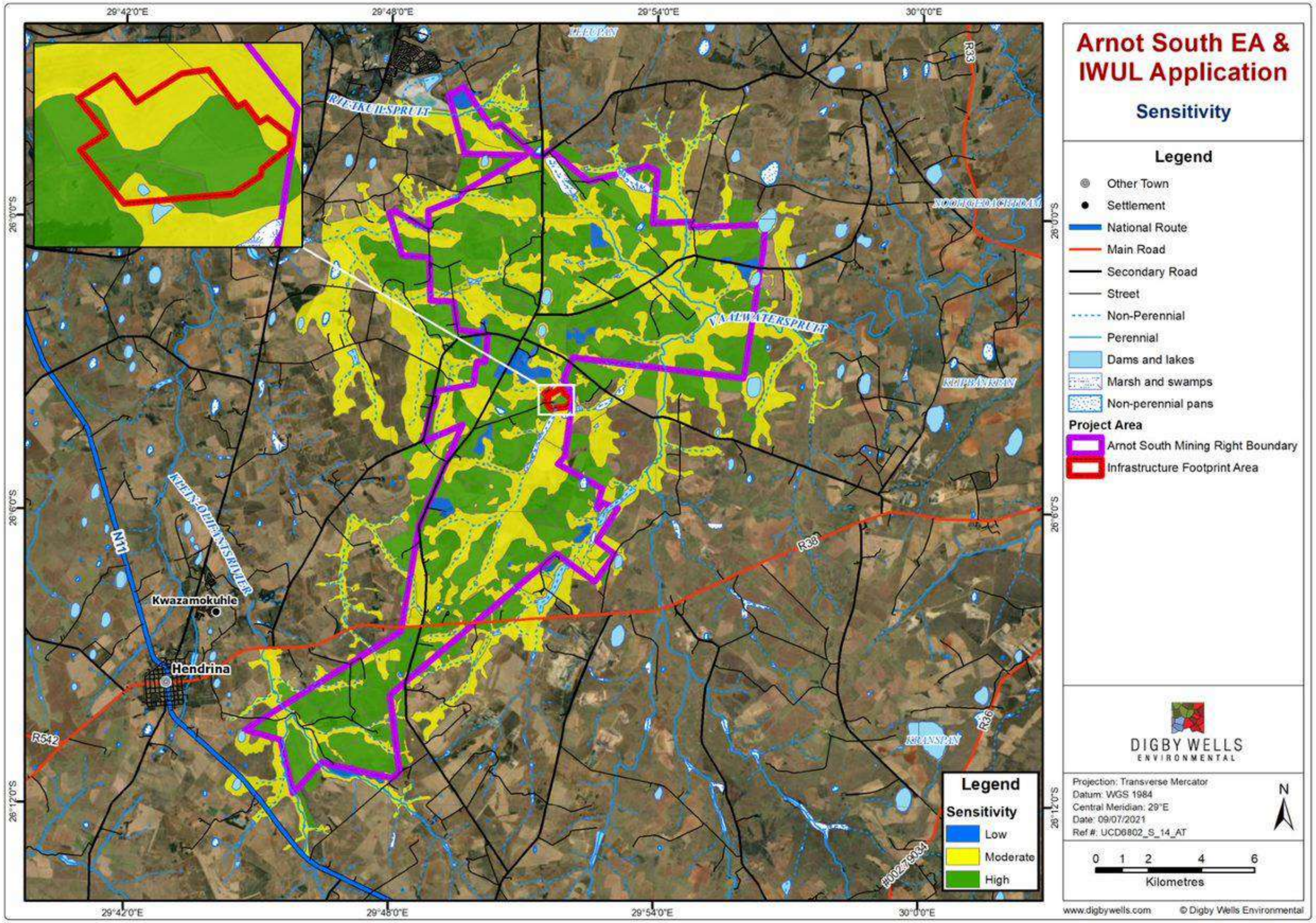


Figure 9-3 Land Sensitivity

10. Mitigation Hierarchy

Note
The aim of the Impact Assessment is to strive to avoid damage to or loss of ecosystems and services that they provide, and where they cannot be avoided, to reduce and mitigate these impacts (Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, & South African National Biodiversity Institute, 2013). Offsets to compensate for loss of habitat are regarded as a last resort, after all efforts have been made to avoid, reduce and mitigate. Land degradation is a major problem we currently have worldwide and will directly affect food security, water quality and quantity and sustainable land management. It is not always possible to avoid or prevent an impact and therefore minimization and rehabilitation should be considered. When it is not possible and feasible to avoid mining land of high capability and sensitivity, Soil/Land offset should form part of the biodiversity (wetland) offset plan. This should be implemented to compensate for residual negative effects on the soil, land use and land capability after effort have been made to minimize, avoid and rehabilitate impacts.

Based on previous studies and similar projects within the Mpumalanga province it is inevitable that the proposed activities will pose impacts on the soil, land use and land capability. Even when areas of high land capability are avoided, impacts might still arise due to erosion, sedimentation, soil degradation and soil and water pollution.

The mitigation hierarchy for the Soil, Land Use and Land Capability within the Project Area are described in Table 10-1 below.

Table 10-1: Mitigation Hierarchy

Mitigation Step	Actions
Avoid or prevent	*Consider options to avoid impacts the soils, land use and land capability (e.g., project location, siting, scale, layout, technology and project phase). This is the best option, however not always possible. Where the social and environmental impacts are too high, mining should not take place as it would be unlikely to rely on the latter steps to prove effective remedy for impacts.*
	• Avoid mining and infrastructure in **High** sensitive areas. This will require avoidance of large sections of the project area as well as considering areas of lower land capability for the surface infrastructure.
Minimise	*Consider alternatives to minimise impacts on the soils, land use and land capability (e.g., project location, scale, technology and layout).*
	• Avoid mining and infrastructure in **High** sensitive areas; • Establishment of a buffer zone to protect soils from infrastructure and mining related impacts within the Project Area;

Mitigation Step	Actions
	• Select **High** sensitive areas on-site to avoid and rehabilitate to minimize the impacts on site as well as adjacent to the Project Area; • Avoid activities in wetlands and highly erosible soils; and • Consider moving infrastructure outside areas of **High** land capability (sensitive areas). This will require to avoid large areas of the Project Area, however, it is advised to minimize activities in selected areas of **High** land suitability and in soils adjacent to sensitive wetland areas.
Rehabilitate	*Rehabilitate areas where impacts were unavoidable. Measures must be taken to return impacted areas to conditions ecologically similar to their 'pre-mining natural state' or an agreed land use after mine closure. Rehabilitation is important and necessary, however even with significant resources and effort, rehabilitation is limited and almost always falls short of replicating the biodiversity and complexity of a natural system.*
	• The land capability of the surface infrastructure should at least be rehabilitated to Arable and Grazing Land with the aim on wildlife, moderate grazing and light cultivation; • Underground mining areas should not be affecting the soils, land use and land capability at the surface; • Ensure concurrent monitoring and rehabilitation with special attention to reshaping areas and re-vegetation in surface infrastructure areas as well as if impacts such as subsidence occur; • Landscape and reshape impacted areas (if any) to near natural topographies with at least 500 mm of topsoil; and • Contaminated soils must be disposed of at a registered landfill site prior rehabilitation to prevent further soil and water contamination and increase the rehabilitation success. The land capability of the infrastructure areas will likely not be rehabilitated back to Intensive Cultivation; however, the aim should be to get the land back to a high land capability as far as possible and to have as little impacts to the rest of the MRA as possible.
Offset	*Compensating for remaining and residual (unavoidable) negative impacts on the soils, land use and land capability. Offset should be implemented when every effort has been made to minimise and rehabilitate impacts with 'like-for-like' targets.*
	• Soil/Land Offset should form part of a biodiversity (wetland) Offset plan that will have to be developed and implemented after the residual impacts have been determined; and • Monitor and mitigate subsidence, dewatering, decanting and contamination of soils and groundwater that will impact the land use and land capability.

Mitigation Step	Actions
	This is a costly activity and require selecting land/wetlands outside the impacted area to mitigate and rehabilitate. This could lead to cost implications.

11. Soil Impact Assessment

Guidance Note:

This section aims to rate the significance of the identified potential impacts pre-mitigation and post-mitigation. The potential impacts identified in this section are a result of both the environment in which the proposed project activities take place, as well as the actual activities. The potential impacts are discussed per aspect and per each phase of the Project, i.e., the Construction Phase, Operational and Rehabilitation/Closure Phases where applicable.

Mitigation measures in this section are provided to avoid, minimise, and rehabilitate soils within the Study Area (500 m buffer around the Protect Area). However, due to the permanent impact the proposed activities will have on the soil and land, it is recommended to include soils as part of the biodiversity (wetland) offset strategy to compensate for the land lost.

The mitigation hierarchy includes firstly the avoidance of an impact. When it is not possible to avoid an impact, such as in the case of during the Construction and Operational Phases, the next step is or to minimise the impact and thereafter rectify or reduced the impact. When it is not possible to rectify or reduce the impact, offsets need to be implemented.

Activities during the Construction, Operational and Rehabilitation Phases that may have potential impacts on the soil, land use and land capability are described below. Soils directly impacted by the proposed surface infrastructure, needs to be avoided and minimised as far as possible, when it is not possible to avoid impacts, the impacted areas need to be rehabilitated and or offset implemented.

Land impacted by underground mining activities, such as subsidence, soil and groundwater contamination, dewatering and decanting must be rehabilitated. An offset calculation must be done to determine the residual impacts to the land. Offsetting must be implemented to compensate for the hectare equivalent lost (“like-for-like”).

The following are discussed below:

- Table 11-1: Interactions and Impacts of Activity;
- Table 11-2: Pre-Mitigation Impacts of Activity;
- Table 11-3: Mitigation Measures; and
- Table 11-4: Post-Mitigation Impact Ratings.

Table 11-1: Interactions and Impacts of Activity

<table>
<tr><th>Project Phase</th><th>Project Activity</th><th>Impact</th><th>Description</th></tr>
<tr><td rowspan="6">Construction Phase</td><td>Site/vegetation clearance (52.28 ha)</td><td rowspan="6">Loss of usable soil (high land capability soils);
Soil erosion and sedimentation;
Erosion and sedimentation from stockpiles, rock dump and discard dump;
Soil contamination and deterioration; and
Increased runoff from hardened surfaces (soil compaction).</td><td rowspan="6">The site clearance, removal of vegetation, soil stripping and stockpiling will result in the complete loss of useable soils for agropastoral activities within the vicinity of the proposed infrastructure. When soils are stripped, the physical and chemical properties are changed, and the soils will degrade and changed from high land capability (IC) to low land capability/ industrial. When the organic material is removed, either by the clearing of an area for development of infrastructure or by erosion from stockpiles, the soil fertility status is reduced and may result in soil acidification.
Vehicles and machinery will lead to soil compaction, increased surface runoff, erosion and loss of vegetation (OM). This reduces infiltration rates, and the ability for plant roots and water to penetrate the soil. Once the soil is eroded it reduces the overall soil depth, soil fertility rate, and as a result the land capability.
During the topsoil and subsoil excavation and stockpiling, the topsoil's seed bank and natural fertility balance is diluted. This will affect the regrowth of vegetation using the stockpiled topsoil. Soils should be handled with care from the construction phase through to the decommissioning phase. When usable soil is disturbed, compacted, or eroded, the soil profile is compromised and its ability to function as a growth medium is restricted. The sandy soils in the Project Area will be particularly vulnerable to wind and water erosion when exposed during site clearance and stockpiling. An intact vegetation cover is needed to reduce impact from raindrops, slows down surface run-off, filter sediment and binds the soil together for more stability.
The potential for chemical pollution and soil contamination exists during site preparation and construction when spills or leaks of fuels, oils and lubricants from construction or operational vehicles or machinery occur. Fluids used for vehicles and machinery may spill during filling or direct leakage. During construction, spills from machinery, STP, PCD and wastewater may occur which will in effect contaminate the soils and deteriorate the land capability.</td></tr>
<tr><td>Diesel storage and explosives magazine</td></tr>
<tr><td>Establishment of infrastructure (Infrastructure footprint - 13.28 ha; linear infrastructure - 51 501 m)
Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office</td></tr>
<tr><td>Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long</td></tr>
<tr><td>Construction of Pollution control dam (PCD) (1.61 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)</td></tr>
<tr><td>Stockpiling of soils, rock dump and discard dump establishment.</td></tr>
<tr><td rowspan="5">Operational Phase</td><td>Operating STP (18.31 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant</td><td rowspan="5">Infrastructure area:
Soil quality contamination and deterioration;
Loss of usable soil for agriculture;
Soil erosions and sedimentation; and
Increased runoff and flow from hardened surfaces (soil compaction).
Underground mined areas:
Subsidence;
Decanting;
Dewatering; and
Groundwater and soil contamination; and
Decreased land capability and agricultural potential.</td><td rowspan="5">Various unplanned and residual impacts to the soils might occur due to the surface infrastructure such as soil pollution/contamination, erosion and compaction. Underground mining activities may lead to unforeseen impacts such as subsidence, dewatering, contamination and decanting, leading to changes to the current land capability.
Probable impacts due to the surface infrastructure activities include changes to the natural soil physical, chemical and biological activities which changes the land use and capability. Drilling, blasting, dumping of waste rock and crushing of RoM, contamination and sedimentation might occur and impact the soils and land. When stockpiles and the surface infrastructure are not well maintained, soil contamination might occur. Erosion might transpire and result in sedimentation, hydromorphic changes and loss of vegetation cover. Chemical contamination dependent on the size of the spill and the permeability/infiltration rate into the soils. Contaminants transported by water into the soils would rapidly infiltrate into sandy soils which are dominant across the Project Area.
If heavy vehicles and machinery are not confined to the permanent roads, widespread erosion may take place. Land capability and productivity will be lost within the Project Area. The operation, maintenance and potential spills from the PCD, STP, raw water, processed water and washing plant could potentially lead to soil and water contamination, leading to decreased land capability.
Furthermore, the underground mining activities may lead to unforeseen impacts such as subsidence, dewatering, contamination and decanting. Areas of high extraction and shallow resources should be monitored and mitigated as soon as impacts are observed to prevent secondary impacts leading from the aforementioned.</td></tr>
<tr><td>Mining of coal by underground mining (underground) (5 050.83 ha)
Removal of rock (blasting), rock/discard dumps, soils, ROM, discard dump (discard dump 2946 ha and Overburden stockpile 13716 ha)</td></tr>
<tr><td>Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste</td></tr>
<tr><td>Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.</td></tr>
<tr><td>Continue with exploration activities</td></tr>
<tr><td>Re ha bili</td><td>Demolition and removal of infrastructure.</td><td>Soil erosion and sedimentation;</td><td></td></tr>
</table>

Project Phase	Project Activity	Impact	Description
	Post-closure monitoring and rehabilitation.	• Decreased soil fertility and increased AIPs; • Soil contamination due to decanting and the groundwater contamination plume; • Subsidence; • Dewatering; • Decreased land capability; and agricultural potential.	During the decommissioning and rehabilitation of the surface infrastructure and underground mining activities, soils might get compacted and eroded, loosing effective rooting depth, water and root penetration, water holding capacity and soil fertility. The movement of heavy machinery on the soil surface causes compaction, which reduces the vegetation's ability to grow and as a result erosion. Soils might be lost due to erosion from unprotected surfaces. Rehabilitation activities will cover the extent of the infrastructure footprint areas and will include ripping, spreading of overburden and topsoil and establishment of vegetation. The first phase of the rehabilitation plan (demolishing of infrastructure) will have a negative effect on the soil, land use and land capability, however when rehabilitation of these areas commence, the land capability status will increase. It would be the optimal to rehabilitate the Project Area back to Agricultural land. Demolishing of the infrastructure, PCD, STP, raw water, processed water and washing plant could potentially lead to soil and water contamination, resulting in land capability degradation. Removal of linear infrastructure may lead to erosion, soil compaction, contamination. It is not clear if dewatering, decanting and subsidence are expected in the area, however, could lead to various impacts to the land capability of the Project Are.
	Closure of the underground mine.		

11.1. Impact Ratings

Table 11-2 and Table 11-4 presents the impact ratings associated the Project for all the phases prior and post mitigation, whereas Table 11-3 presents the mitigation measures to be implemented to avoid, reduce, and rehabilitate impacts to the soil, land use and land capability.

Table 11-2: Pre-Mitigation Impacts of Activity

Pre-Mitigation Rating								
Project Phase	**Project Activity**	**Impact**	**Duration/ Reversibility**	**Extent**	**Intensity/ Replicability**	**Probability**	**Nature**	**Significance**
Construction Phase	Site/vegetation clearance (52.28 ha)	• Loss of usable soil (high land capability soils); • Soil erosion and sedimentation; • Erosion and sedimentation from stockpiles, rock dump and discard dump; • Soil contamination and deterioration; and • Increased runoff from hardened surfaces (soil compaction).	Beyond Project Life (6)	Limited (2)	Irreplaceable Loss (7)	Definite (7)	Negative	Moderate - 105
	Construction of diesel storage and explosives magazine		Beyond Project Life (6)	Local (3)	Irreplaceable Loss (6)	Almost Certain (6)	Negative	Moderate - 90
	Establishment of infrastructure (Infrastructure footprint - 13.2849 ha; linear infrastructure - 51 501 m) Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office		Beyond Project Life (6)	Local (3)	Irreplaceable Loss (6)	Definite (7)	Negative	Moderate - 105
	Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long		Permanent (7)	Region (5)	Irreplaceable Loss (6)	Almost Certain (6)	Negative	Moderate - 108
	Construction of Pollution control dam (PCD) (1.61 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)		Permanent (7)	Municipal Area (4)	Irreplaceable Loss (7)	Definite (7)	Negative	Major - 126
	Stockpiling of soils, rock dump and discard dump establishment.		Project Life (5)	Local (3)	Irreplaceable Loss (7)	Definite (7)	Negative	Moderate - 105
Operational Phase	Operating STP (18.31 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant	Infrastructure area: • Soil quality contamination and deterioration; • Loss of usable soil for agriculture; • Soil erosions and sedimentation; and • Increased runoff and flow from hardened surfaces (soil compaction). Underground mined areas: • Subsidence; • Dewatering; • Groundwater and soil contamination; and • Decreased land capability and agricultural potential.	Permanent (7)	Municipal Area (4)	Irreplaceable Loss (7)	Almost Certain (6)	Negative	Moderate - 108
	Mining of coal by underground mining (underground) (5 050.83 ha) Removal of rock (blasting). Rock/discard dumps, soils, ROM, discard dump (discard dump 2946 ha and Overburden stockpile 13716 ha)		Permanent (7)	Municipal Area (4)	Irreplaceable Loss (7)	Definite (7)	Negative	Major - 126
	Storage, handling, and treatment of hazardous products (including fuel, explosives and oil) and waste		Beyond Project Life (6)	Municipal Area (4)	Irreplaceable Loss (7)	Almost Certain (6)	Negative	Moderate - 102
	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.		Project Life (5)	Local (3)	Serious loss (5)	Almost Certain (6)	Negative	Moderate - 78
	Continue with exploration activities		Project Life (5)	Local (3)	Serious loss (5)	Almost Certain (6)	Negative	Moderate - 78
Rehabilitation Phase	Demolition and removal of infrastructure.	• Soil erosion and sedimentation; • Decreased soil fertility and increased AIPs; • Soil contamination due to decanting and the groundwater contamination plume; • Subsidence; • Dewatering; and • Decreased land capability and agricultural potential.	Beyond Project Life (6)	Local (3)	Serious loss (5)	Almost Certain (6)	Negative	Moderate - 84
	Post-closure monitoring and rehabilitation.		Project Life (5)	Local (3)	Serious loss (5)	Likely (5)	Negative	Minor -65
	Closure of the underground mine.		Permanent (7)	Municipal Area (4)	Irreplaceable Loss (7)	Definite (7)	Negative	Major - 126

Table 11-3: Mitigation Measures

Phase	Mitigation Measures
Construction Phase	• If the destruction of soils with a High land capability is unavoidable, disturbance must be minimised and appropriately rehabilitated; • Environmental Practitioner to be present during soil stripping to prevent mixing of soils and ensure correct stockpiling methods (i.e., stockpile height, separate stockpiling for topsoil, subsoil and waste rock); • Stockpiles must be vegetated and allocated to specific areas and stockpiled on hardened surfaces to prevent leaching of contaminants into the soil and groundwater; • Bare land surfaces must be vegetated to limit erosion from surface runoff associated with infrastructure areas. Revegetate disturbed areas immediately after construction, • Monitor infrastructure, stockpiles and dumps to ensure no runoff, erosion and sedimentation and decreased land capability; • Monitor PCD, STP, raw water, processed water and washing plant, if spills have occurred, clean up immediately and implement a monitoring program for at least three months after the spill has occurred; • If any erosion occurs on site and adjacent of the Project Area, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; • Restrict extent of disturbance within the Project Area and minimise activity within designated areas of disturbance; • Minimise the period of exposure of soil surfaces through dedicated planning; • Ensure proper storm water management designs are in place; and • Spill containment and clean up kits should be available onsite and clean-up from any spill must be in place and executed at the time of a spillage with appropriate disposal as necessary.
Operational Phase	• All vehicle maintenance and refuelling must occur within designated areas and inspected regularly for leaks; • All spills must be cleaned up immediately to prevent contaminants to enter the soils and groundwater. Monitoring must take place at least for three months after the spill have occurred to determine any contamination; • Culverts, roads, conveyors, powerlines and river crossings must be maintained, cleared and monitored; • All vehicles must remain on demarcated roads and within the operational footprint; • Stockpiles should be monitored and vegetated to ensure no runoff, erosion, sedimentation and loss of soil fertility; • Stockpiles must be allocated to specific areas and stockpiled on hardened surfaces to prevent leaching of contaminants into the soil and groundwater; • A Storm Water Management Plan (SWMP) should already be implemented. This should consider all wetlands and other watercourses adjacent and downstream of the new developments/infrastructure which should divert stormwater and wastewater away from the surface infrastructure and back into natural watercourses. The SWMP should also convey contaminated water to silt traps to limit erosion and subsequent contaminants into soils and groundwater; • Monitoring of subsidence, dewatering and contamination must take place regularly to access possible impacts to soils; • Care must be taken to ensure that contamination of the receiving environment as a result of mining activities is minimised as far as possible; • Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions; • Re-vegetate cleared areas and stockpiles to avoid wind and water erosion; • Preserve looseness of stockpiled soil by executing fertilisation and seeding operations by hand; • If any erosion occurs, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; • A Topsoil Management Plan (TMP) must be prepared to demonstrate how topsoil will be preserved in a condition as near as possible to its pre-mining condition to allow successful mine rehabilitation (Statham, 2014); • Long term stockpiles should be revegetated to minimise loss of soil quality. This will minimise AIPs, maintain soil organic matter levels, maintain soil structure, and microbial activity; and • Compacted areas are to be ripped to loosen the soil structure.
Rehabilitation Phase	• Rehabilitation and decommissioning should occur in the dry season to avoid high rainfall events that could lead to increased runoff, erosion, contamination and sedimentation; • Actively landscape and re-vegetate disturbed areas as soon as possible to avoid loss of soil, organic material, and sedimentation; • Implement and maintain a AIPs Management Plan for the duration of the rehabilitation phase and into closure; • Rehabilitation must be done as soon as any impacts are observed (decanting, subsidence and contamination); • Monitor subsidence and possible decant of Acid Mine Drainage (AMD) and implement management measures which include for example an abstraction borehole placed down gradient of the decant point and in-situ passive treatment or neutralisation and electrolytic treatment using a WTP to get purified water for discharge to the natural environment or other beneficial uses (refer to Groundwater Impact Assessment, 2021); • Newly shaped and topsoiled areas must be revegetated as soon as possible to prevent sedimentation and erosion; • Ensure proper storm water management designs are in place and should be kept in place until all infrastructure is removed. Where infrastructure will remain, stormwater and culverts should be maintained and monitored for erosion and AIPs; • Continue with Concurrent Rehabilitation, and implement land rehabilitation measures; • Address compacted areas by deep ripping to loosen the soil, and revegetate the area; and • The backfilled, reprofiled landscape should be top soiled and revegetated to allow free drainage close to the pre-mining conditions.

Table 11-4: Post-Mitigation Impact Ratings

Pre-Mitigation Rating								
Project Phase	**Project Activity**	**Impact**	**Duration/ Reversibility**	**Extent**	**Intensity/ Replicability**	**Probability**	**Nature**	**Significance**
Construction Phase	Site/vegetation clearance (52.28 ha)	After avoidance, minimisation, mitigation and rehabilitation of the site, impacts should be Moderate to Minor, however impacts might still arise over time due to the construction phase (infrastructure area): • Erosion; • Sedimentation; • Compaction and increased runoff; • Mixing of subsoil and topsoil; and • AIPs proliferation.	Beyond Project Life (6)	Limited (2)	Irreplaceable Loss (6)	Definite (7)	Negative	Moderate - 98
	Construction of diesel storage and explosives magazine		Project Life (5)	Limited (2)	Serious loss (4)	Probable (4)	Negative	Minor - 44
	Establishment of infrastructure (Infrastructure footprint - 13.2849 ha; linear infrastructure - 51 501 m) Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office		Project Life (5)	Local (3)	Serious loss (4)	Likely (5)	Negative	Minor - 60
	Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long		Project Life (5)	Local (3)	Serious loss (4)	Likely (5)	Negative	Minor - 60
	Construction of Pollution control dam (PCD) (1.6078 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)		Beyond Project Life (6)	Local (3)	Serious loss (5)	Almost Certain (6)	Negative	Moderate - 84
	Stockpiling of soils, rock dump and discard dump establishment.		Project Life (5)	Limited (2)	Serious loss (5)	Likely (5)	Negative	Minor - 60
Operational Phase	Operating STP (18.31 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant	• 52.28 ha of land will completely/partially be removed due to surface infrastructure; • Subsidence, decanting, dewatering and groundwater contamination will possibly still take place even tough various mitigation measures are followed; • Soil contamination from the STP, PCD and washing plant is still possible even if mitigation measures are followed; and • When rehabilitaiton, mitigation and monitoring is done correctly, impacts from infrastructure and monitoring should be moderate to minor.	Beyond Project Life (6)	Local (3)	Irreplaceable Loss (6)	Likely (5)	Negative	Moderate - 75
	Mining of coal by underground mining (underground) (5 050.83 ha) Removal of rock (blasting). Rock/discard dumps, soils, ROM, discard dump (discard dump 2946 ha and Overburden stockpile 13716 ha)		Permanent (7)	Local (3)	Irreplaceable Loss (6)	Almost Certain (6)	Negative	Moderate - 96
	Storage, handling, and treatment of hazardous products (including fuel, explosives and oil) and waste		Project Life (5)	Limited (2)	Serious loss (5)	Likely (5)	Negative	Minor - 60
	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.		Project Life (5)	Limited (2)	Serious loss (4)	Likely (5)	Negative	Minor - 55
	Continue with exploration activities		Long Term (4)	Limited (2)	Moderate loss (3)	Probable (4)	Negative	Minor - 36
Rehabilitation Phase	Demolition and removal of infrastructure.	Impacts from rehabilitation and monitoring is rare/negligible. However, there is a possibility for subsidence, dewatering and decanting that will most probably impact soils and the current land capability after mine closure. Even after the proposed mitigation measures, some impacts might still occur, including: • Erosion when areas are not revegetated instantly; • Compaction; • Spreading of AIPs; • Subsidence; • Soil and groundwater contamination; and • Decanting causing soil contamination.	Project Life (5)	Limited (2)	Moderate loss (3)	Probable (4)	Negative	Minor -40
	Post-closure monitoring and rehabilitation.		Long Term (4)	Limited (2)	Moderate loss (3)	Unlikely (3)	Negative	Negligible -27
	Closure of the underground mine.		Permanent (7)	Local (3)	Irreplaceable Loss (6)	Almost Certain (6)	Negative	Moderate - 96

11.2. Cumulative Impacts

The land uses within and adjacent of the Project Area have contributed to losses of soil, land use and land capabilities. Historical and current land uses (i.e., agropastoral activities, infrastructure and mining) has led to major geomorphological and hydrological changes, vegetation loss, erosion, overgrazing, the contamination of soil and water resources and increased surface inflows.

The land uses have led to land degradation, changing the land capability in large areas. The alteration of vegetation and surface flow has led to the onset of erosion and may be perpetuated further by the proposed activities. In addition to mining and agropastoral activities were linear infrastructures such as roads, dams, powerlines, and fences. The impacts include the creation of preferential flow paths, erosion, sedimentation and compaction of soils.

- Activities impacting the soil resources include changes to the physico-chemical properties of the soil. Impacts include:
- Geomorphological changes to the natural soils and landscape;
- Loss of habitat, vegetation and growth medium;
- Erosion, destruction of agricultural land, loss of topsoil and organic material;
- Sedimentation and pollution of water courses (wetlands); and
- Soil contamination through agricultural fertilizers, pesticides, mine impacted water and heavy metals from adjacent mining activities.

The cumulative impacts have a significant effect on the soil resources and therefore impacting the land use and land capability of the Project Area. Contaminated soil directly impacts the water quality and quantity as well as vegetation and soil fertility.

11.3. Unplanned and Low Risk Events

Only a small portion of the MRA is planned to be impacted by surface infrastructure. However, there is a risk that subsidence, dewatering, contamination and decanting might occur due to underground mining activities. Table 11-5 outlines mitigation measures that must be adopted in the event of unplanned impacts throughout the life of the proposed Project.

Table 11-5: Unplanned Events and Associated Mitigation Measures

Unplanned Risk	Mitigation Measures
• Dewatering	• Reinstate the pumped-out water from the underground mining activities back into the catchment and freshwater systems after treatment; and • Freshwater resource monitoring must be carried out during the operational phase to ensure no unnecessary impact, and if so that a remedy is put in place as soon as possible.
• Decanting	• Prevent decanting by keeping the groundwater levels low post-closure; • Abstraction boreholes placed down gradient of the decant point to reduce decant generation and will lower the impact; • Treat decant water before it is put back into the natural systems; • Fence off decant areas to prevent human and animal consumption; • Rehabilitate and mitigate areas where decanting has taken place; and • Monitor decant of AMD and implement management measures which include in-situ passive treatment or neutralisation and electrolytic treatment using a WTP to get purified water for discharge to the natural environment or other beneficial uses.
• Subsidence	• Evaluate the subsidence/sinkholes to determine the rehabilitation method and impacts to the soils and land use (i.e., depth, cause, ingress of water, groundwater drawdown, geology, blanket layer and thickness, • If the subsidence is determined to be unstable, fence off and prevent animal and human entry; • If subsidence is stable, the land can be rehabilitated back to pre-mining land use; • Compact the surface material (blanket layer) to stabilize the area; and • Backfill and revegetate.
• Erosion from the proposed infrastructure	• Ensure proper stormwater management, including culverts and road design; • Monitor and rehabilitate erosion as soon as it has occurred; • Maintain infrastructure; and • Install silt traps, re-vegetate area after construction and ensure proper slopes (avoid water ponding and steep slopes).
• Coal spillage from moving machinery	• Machines and trucks must be checked and maintained regularly; • Access roads and conveyors must be maintained; • Ensure emergency response plans are in place; • Contractors must ensure that all employees are aware of the procedure for dealing with spills and undergo training on site; and • Contaminated soils must be disposed in a registered and licensed Waste Land Facility.
• Hazardous substance spillage from pipelines or waste storage.	• Ensure correct storage of all chemicals at operations as per each chemical's specific storage requirements (e.g., sealed containers for hydrocarbons); • Ensure staff involved at the proposed Project have been trained to correctly work with chemicals at the sites; • If spills have occurred, clean up immediately to prevent contamination of the soils; • Ensure spill kits (e.g., Drizit) are readily available at areas where chemicals are known to be used; • Conduct monitoring after construction and during operation with continuous rehabilitation if and where necessary to prevent secondary impacts to the adjacent and downstream soils and land; and • Staff must also receive appropriate training in the event of a spill.

12. Environmental Management Plan

The EMP is described in **Error! Not a valid bookmark self-reference.** below.

Table 12-1: Environmental Management Plan

Phase	Project Activity	Potential Impacts	Mitigation Measures	Mitigation Type	Period for Implementation
Construction Phase	Site/vegetation clearance (52.28 ha) Diesel storage and explosives magazine Establishment of infrastructure (Infrastructure footprint - 13.28 ha; linear infrastructure - 51 501 m) Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long Construction of Pollution control dam (PCD) (1.61 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)	• Loss of usable soil (high land capability soils); • Soil erosion and sedimentation; • Erosion and sedimentation from stockpiles, rock dump and discard dump; • Soil contamination and deterioration; and • Increased runoff from hardened surfaces (soil compaction).	• **Control and Remedy.** If the destruction of soils with a High land capability is unavoidable, disturbance must be minimised and appropriately rehabilitated; • **Control and Remedy.** Environmental Practitioner to be present during soil stripping to prevent mixing of soils and ensure correct stockpiling methods (i.e., stockpile height, separate stockpiling for topsoil, subsoil and waste rock); • **Control and Remedy.** Stockpiles must be vegetated and allocated to specific areas and stockpiled on hardened surfaces to prevent leaching of contaminants into the soil and groundwater; • **Control and Remedy.** Bare land surfaces must be vegetated to limit erosion from surface runoff associated with infrastructure areas. Revegetate disturbed areas immediately after construction, • **Control and Remedy.** Monitor infrastructure, stockpiles and dumps to ensure no runoff, erosion and sedimentation and decreased land capability; • **Control and Remedy.** Monitor PCD, STP, raw water, processed water and washing plant, if spills have occurred, clean up immediately and implement a monitoring program for at least three months after the spill has occurred; • **Control and Remedy.** If any erosion occurs on site and adjacent of the Project Area, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; • **Control and Remedy.** Restrict extent of disturbance within the Project Area and minimise activity within designated areas of disturbance; • **Control and Remedy.** Minimise the period of exposure of soil surfaces through dedicated planning; • **Control and Remedy.** Ensure proper storm water management designs are in place; and • **Control and Remedy.** Spill containment and clean up kits should be available onsite and clean-up from any spill must be in place and executed at the time of a spillage with appropriate disposal as necessary.	Concurrent rehabilitation through the life of mine	Life of Construction Phase
Operational Phase	Operating STP (18.32 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant Mining of coal by underground mining (underground) (5 050.83 ha)	• Infrastructure area: • Soil quality contamination and deterioration; • Loss of usable soil for agriculture; • Soil erosions and sedimentation; and • Increased runoff and flow from hardened surfaces (soil compaction). • Underground mined areas:	• **Control.** All vehicle maintenance and re-fueling must occur within designated areas and inspected regularly for leaks; • **Control and Remedy.** All spills must be cleaned up immediately to prevent contaminants to enter the soils and groundwater. Monitoring must take place at least for three months after the spill have occurred to determine any contamination; • **Control and Remedy.** Culverts, roads, conveyors, powerlines and river crossings must be maintained, cleared and monitored; • **Control.** All vehicles must remain on demarcated roads and within the operational footprint; • **Control.** Stockpiles should be monitored and vegetated to ensure no runoff, erosion, sedimentation and loss of soil fertility; • **Control.** Stockpiles must be allocated to specific areas and stockpiled on hardened surfaces to prevent leaching of contaminants into the soil and groundwater; • **Control.** A Storm Water Management Plan (SWMP) should already be implemented. This should consider all wetlands and other watercourses adjacent and downstream of the new developments/infrastructure which should divert stormwater and wastewater away from	Concurrent rehabilitation through the life of mine	Life of Operational Phase

Phase	Project Activity	Potential Impacts	Mitigation Measures	Mitigation Type	Period for Implementation
	Removal of rock (blasting). Rock/discard dumps, soils, ROM, discard dump (discard dump Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.	• Subsidence; • Dewatering; • Groundwater and soil contamination; and • Decreased land capability and agricultural potential.	the surface infrastructure and back into natural watercourses. The SWMP should also convey contaminated water to silt traps to limit erosion and subsequent contaminants into soils and groundwater; • **Control and Remedy.** Monitoring of subsidence, dewatering and contamination must take place regularly to access possible impacts to soils; • **Control.** Care must be taken to ensure that contamination of the receiving environment as a result of mining activities is minimised as far as possible; • **Control.** Chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions; • **Control and Remedy.** Re-vegetate cleared areas and stockpiles to avoid wind and water erosion; • **Control and Remedy.** Preserve looseness of stockpiled soil by executing fertilisation and seeding operations by hand; • **Control and Remedy.** If any erosion occurs, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; • **Control.** A Topsoil Management Plan (TMP) must be prepared to demonstrate how topsoil will be preserved in a condition as near as possible to its pre-mining condition to allow successful mine rehabilitation (Statham, 2014); • **Control.** Long term stockpiles should be revegetated to minimise loss of soil quality. This will minimise AIPs, maintain soil organic matter levels, maintain soil structure, and microbial activity; and • **Control and Remedy.** Compacted areas are to be ripped to loosen the soil structure.		
Rehabilitation Phase	Demolition and removal of infrastructure. Post-closure monitoring and rehabilitation. Closure of the underground mine.	• Soil erosion and sedimentation; • Decreased soil fertility and increased AIPs; • Soil contamination due to decanting and the groundwater contamination plume; • Subsidence; • Dewatering; and • Decreased land capability and agricultural potential.	• **Control and Remedy.** Rehabilitation and decommissioning should occur in the dry season to avoid high rainfall events that could lead to increased runoff, erosion, contamination and sedimentation; • **Control and Remedy.** Actively landscape and re-vegetate disturbed areas as soon as possible to avoid loss of soil, organic material, and sedimentation; • **Control and Remedy.** Implement and maintain a AIPs Management Plan for the duration of the rehabilitation phase and into closure; • **Control and Remedy.** Rehabilitation must be done as soon as any impacts are observed (decanting, subsidence and contamination); • **Control and Remedy.** Monitor subsidence and possible decant of Acid Mine Drainage (AMD) and implement management measures which include for example an abstraction borehole placed down gradient of the decant point and in-situ passive treatment or neutralisation and electrolytic treatment using a WTP to get purified water for discharge to the natural environment or other beneficial uses (refer to Groundwater Impact Assessment, 2021); • **Control and Remedy.** Newly shaped and topsoiled areas must be revegetated as soon as possible to prevent sedimentation and erosion; • **Control and Remedy.** Ensure proper storm water management designs are in place and should be kept in place until all infrastructure is removed. Where infrastructure will remain, stormwater and culverts should be maintained and monitored for erosion and AIPs; • **Control and Remedy.** Continue with Concurrent Rehabilitation, and implement land rehabilitation measures; • **Control and Remedy.** Address compacted areas by deep ripping to loosen the soil, and revegetate the area; and • **Control and Remedy.** The backfilled, reprofiled landscape should be top soiled and revegetated to allow free drainage close to the pre-mining conditions.	Concurrent rehabilitation through the life of mine and after mine	Life of Rehabilitation Phase

13. Monitoring Programme

Note

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.

Soil monitoring should be done in terms of:

- EIA Regulations, 2014 (GN R 982 of 4 December 2014 as amended by GN R326 of 7 April 2017) promulgated under the NEMA;
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA); and
- The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA).

Results of chemical analyses of soils obtained must be measured against the SSV and reference samples and clearly demonstrate that the selection of guideline values is consistent with the principles of the Framework. The Mine Manager (MM) and the EP are responsible to report on results of the monitoring program.

Internal monitoring reports should be required, reporting on the progress of the state of the monitoring and rehabilitation programme. This should be completed after each external monitoring report.

Table 13-1 describes the monitoring plan which should be followed from the Construction Phase through to the Rehabilitation and Monitoring phase. The table includes each element of monitoring together with the frequency of monitoring and person responsible thereof.

Table 13-1: Monitoring Plan

Monitoring Element	Comment	Requirement	Frequency	Phase	Responsibility	Duration
Stockpiles (Height, erosion, compaction, low vegetation cover)	Report any irregularities to the Environmental Officer for assessment and mitigation measures.	Stockpile update report and recommendations for impact mitigation, if any.	Quarterly	Construction	Environmental Officer	Up to Rehabilitation
				Operational		
			N/A	Rehabilitation		
Soil health and fertility	Implementation of intervention/mitigation measures.	Soil update report and recommendations for impact mitigation, if any.	Bi-annually	Construction	Environmental Officer	3 years after Rehabilitation
			Annually	Operational		
				Rehabilitation		
Soil physical attributes (vegetation, erosion, sedimentation)	Report any irregularities to the Environmental Officer for assessment and mitigation measures.	Take photos of impacted areas and record any impacts seen.	Bi-annually and after storm events	Construction	Mine Environmental Manager.	3 years after Rehabilitation
				Operational		
			Annually	Rehabilitation		
Soil contamination assessment (incl. decant points)	Report any irregularities to the Environmental Officer for assessment and mitigation measures.	Take soil samples for laboratory analysis, measuring heavy metals and potential harmful elements. Measure against the baseline data and SSV.	Only after a spill has occurred	Construction	Environmental Officer	3 months after (monthly) the spill has occurred
				Operational		
				Rehabilitation		
Subsidence, decanting and dewatering	Report any irregularities to the Environmental Officer for assessment and mitigation measures. Implementation of intervention measures.	Soil update report and recommendations for impact mitigation, if any. Take photos of impacted areas and record any impacts seen.	Only when impacts are observed	Construction	Environmental Officer	Bi-annually (twice a year) for three years or subsidence are stable and land use are remediated
				Operational		
				Rehabilitation		

14. Stakeholder Engagement Comments Received

Notes

The consultation process affords Interested and Affected Parties (I&APs) opportunities to engage in the EIA process. The objectives of the Stakeholder Engagement Process (SEP) include the following:

- To ensure that I&APs are informed about the Project;
- To provide I&APs with an opportunity to engage and provide comment on the Project;
- To draw on local knowledge by identifying environmental and social concerns associated with the Project;
- To involve I&APs in identifying methods in which concerns can be addressed;
- To verify that stakeholder comments have been accurately recorded; and
- To comply with the legal requirements.

The Public Participation Process (PPP) has been completed in part, as a process separate to the Soil, Land Use and Land Capability Impact Assessment. No formal consultation was undertaken as part of this assessment. Should any I&AP comments be submitted in relevance to soil resources during the SEP, these will be considered in the final EIA report.

15. Recommendations

The following actions are recommended to reduce adverse effects on the soil resources of the Project Area (Table 15-1):

Table 15-1: Possible Impacts and Recommendations

Possible Impacts	Recommendations
Surface infrastructure areas Soil erosion and loss of biodiversity/vegetation cover resulting in increased sedimentation, loss of topsoil and decreased land capability.	• Reduce the risk of erosion, compaction, and the creation of preferential flow paths by re-vegetating exposed areas, maintaining linear infrastructure and culverts and installing sediment traps and erosion berms; • Rehabilitated areas must be fenced, and animals should be kept off the area until the vegetation is self-sustaining. Follow a grazing plan to prevent overgrazing, trampling and erosion. This will lead to improved soil fertility land capability; and • Runoff must be controlled and managed using proper stormwater management measures.
Surface infrastructure areas Change in soil characteristics (i.e., soil structure, depth, fertility) due to compaction of areas and associated infrastructure.	• Restriction of vehicle movement over sensitive areas to reduce compaction; • Only the designated access routes are to be used to reduce any unnecessary compaction; and • Deep rip compacted areas, cover with at least 500 mm of topsoil and revegetate.
Surface and underground operations Contamination of the soil resource due to hydrocarbons spillages and decanting.	• If soil is polluted, treat the soil using in-situ bioremediation; • 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; • All vehicles and machines must be parked within hard park areas, and must be checked daily for fluid leaks; • Refuelling must take place on a sealed surface area away from soils to prevent seepage of hydrocarbons into the soil; • Place drip trays where vehicles or machinery leaks are occurring; • Fuel, grease, and oil spills should be remediated using a commercially available emergency clean up kits; • Any contractors on site must ensure that all employees are aware of the procedure for dealing with spills, and leaks, and undergo training on-site; and • Soil pollution monitoring after spills should be conducted at selected locations on the project site to detect any extreme levels of pollutants.
Underground operations Soil contamination from decanting.	• Monitor the decant of AMD, contamination and dewatering and implement management measures which include for example, an abstraction borehole placed down gradient of the decant point and in-situ passive treatment or neutralisation and electrolytic treatment using a WTP to get purified water for discharge to the natural environment or other beneficial uses (refer to Groundwater Impact Assessment, 2021).
Surface and underground operations Complete loss of soils with high land capability due to infrastructure and potential subsidence	• Soil/Land Offset should form part of a biodiversity (wetland) Offset plan that will have to be developed and implemented after the residual impacts have been determined.
Underground operations Decanting, dewatering, subsidence and contamination	• Monitor the area for related impacts and report to authorities as soon as possible. If areas are unstable and hold a risk to animals and humans, the area should be fenced off.

16. Reasoned Opinion Whether Project Should Proceed

The overall impacts of the Project were determined to be **Major** to **Minor** prior-mitigation and will lead to irreversible impacts to the soils, land use and land capability. However, post-mitigation, the impacts should me **Moderate** to **Negligible**. The Project could potentially lead to impacts to the soils, land use and land capability as the proposed surface infrastructure may result in loss of land of **High** land capability and sensitivity. The land capability will decrease from intensive cultivation to grazing and wildlife in the infrastructure area. Underground mining contains the risk of subsidence, dewatering, decanting and contamination which might impact the soils, land use and land capability significantly. However, if the project is to proceed, it is in the opinion of the specialist that that protection, mitigation and implementation of an offset strategy will help improve and protect the soils, land use and land capability. Wetlands tend to be well vegetated (protecting the soils from erosion and loss of soil fertility), improve the water and soil quality, increase organic material and soil fertility and therefore increased land capability.

It is recommended to follow the mitigation hierarchy which includes firstly the avoidance of an impact. When it is not possible to avoid an impact, such as in the case of during the Construction and Operational Phases, the next step is or to minimise the impact and thereafter rectify or reduced the impact. When it is not possible to rectify or reduce the impact, offsets need to be implemented.

The soil, land use and land capability management and monitoring requirements as set out in Sections 12 and 13 and the recommendations in Section 15 should form part of the conditions for the EA. A offset strategy should be implemented to compensate for residual impacts due to possible subsidence.

17. Conclusion

Digby Wells has been appointed to undertake an EA Application Process for the underground mining of Arnot South. This report therefore includes inputs to the EMPr for the application of an IWUL supported by an IWWMP. This report focussed on the **Soil, Land Use and Land Capability Impact Assessment** and was undertaken in compliance with the following relevant legislation:

- EIA Regulations, 2014 (GN R982 of 04 December 2014, as amended) (the "EIA Regulations, 2014) promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA); and
- Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

The soils and land uses are typical of Red to Yellow-brown Apedal soils with plinthic subsoils. The Land Capability was measured as Class III, defined as arable land used for moderate cultivation and intensive grazing. Due to the extent of the Project area, it was sought to group soil forms together by means of dominant soil horizon, functionality and land use. The soil forms included Cartref, Glenrosa, Clovelly, Avalon, Hutton, Pinedene, Glencoe, Mispah, Katspruit, Kroonstad, Rensburg, Arcadia and Witbank. The dominant land use was identified as cultivation, cattle grazing, grazing/wetland, wetlands/natural and infrastructure.

Due to the sandy nature of the soils, intensive crop production and high rainfall in the vicinity of the Project Area, the soil fertility tends to decrease over time and require a liming and fertilizer programme to optimize crop production. However, despite the average low soil fertility, the soils are deep, sandy and has a high land capability and therefore sensitive to impacts. Large areas of the Project Area consist of **High** sensitive areas and should be avoided, and impacts minimised as far as possible.

In conclusion, the overall impacts of the Project were **Major** to **Minor** prior-mitigation and will lead to irreversible impacts to the soils, land use and land capability. However, post-mitigation, the impacts should me **Moderate** to **Negligible**. Underground mining contains the risk of subsidence, dewatering, decanting and contamination which might impact the soils, land use and land capability significantly. However, if the project is to proceed, it is in the opinion of the specialist that that protection, mitigation and implementation of an offset strategy will help improve and protect the soils, land use and land capability. Wetlands tend to be well vegetated (protecting the soils from erosion and loss of soil fertility), improve the water and soil quality, increase organic material and soil fertility and therefore increased land capability.

It is recommended to follow the mitigation hierarchy which includes firstly the avoidance of an impact. When it is not possible to avoid an impact, such as in the case of during the Construction and Operational Phases, the next step is or to minimise the impact and thereafter rectify or reduced the impact. When it is not possible to rectify or reduce the impact, offsets need to be implemented.

The soil, land use and land capability management and monitoring requirements as set out in Sections 12 and 13 and the recommendations in Section 15 should form part of the conditions for the EA. A offset strategy should be implemented to compensate for residual impacts due to possible subsidence.

18. References

Allison, L., Brown, J., Hayward, H., Richards, L., Bernstein, L., Fireman, M., . . . Hatcher, J. (1954). *Diagnosis and Improvement of Saline and Alkali Soils: Agriculture Handbook 60.* Washington DC: United States Department of Agriculture.

ARC. (2006). *Land Types of South Africa.* Pretoria: Agricultural Research Council of South Africa.

CCME. (2007). *Canadian Soil Quality Guidelines for Protection of Environmental and Human Health, Canadian Council of Ministers of the Environment (CCME).*

Department of Agriculture and Rural Affairs. (1986). *Trace Elements for Pastures and Animals in Victoria.* Melbourne.

Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, & South African National Biodiversity Institute. (2013). *Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector.* Pretoria.

Digby Wells, E. (2021). *Hydrogeomorphology Impact Assessment.*

du Preez, C., Mnkeni, P., & van Huyssteen, C. (2010). *Knowledge review on land use and soil organic matter in South Africa.* 19th World Congress of Soil Science, Soil Solution for a Changing World.

Dutch VROM. (2000). *The Circular on Target Values and Intervention Values for Soil Remediation.* Ministry of Housing, Spatial Planning and the Environment, the Netherlands.

Kleynhans, C., Thirion, C., & Moolman, J. (2005). *A Level 1 River Ecoregion classification System for South Africa, Lesotho and Swaziland.* Water.

Land Type Survey Staff. (1972 - 2006). *Land Types of South Africa: Digital Map (1:250 000) and Soil Inventory Databases. .* Pretoria: Agricultural Research Council - Institue for Soil, Climate and Water.

Mucina, L., & Rutherford, M. C. (2012). *The Vegetation of South Africa, Lesotho and Swaziland.* Pretoria: South African National Biodiversity Institute.

Schoeman, J., van der Walt, M., Monnik, K., Thackrah, A., Malherbe, J., & Le Roux, R. (2000). *The Development and Application of Land Capability Classification System for South Africa. .* Pretoria: ARC - ISCW Report No. GW/A/2000/57: ARC - Institute for Soil, Climate and Water .

Soil Classification Working Group. (1991). *Soil Classification: A Taxonomic System for South Africa.* Pretoria: Soil and Irrigation Research Institute, Department of Agricultural Development.

Soil Conservation Service: U.S. Department of Agriculture. (1973). *Land-Capability Classification.* Agriculture Handbook No. 210.

Soil Science Society of South Africa. (1990). *Handbook of standard soil testing methods for advisory purposes.* Pretoria.

South African Sugar Association. (1999). *Identification and management of the soils of the South African Sugar Industry.*

Appendix A: Methodology

Methodology

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

Desktop Assessment and Literature Review

Digby Wells conducted a desktop review of the baseline data and findings related to the soil surveys and other relevant existing documentation:

- 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) (ARC, 2006). 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;
- Aerial imagery was analysed to determine areas that are most likely to be suitable for agriculture. The aerial imagery analysis focused on lower lying areas where suitable soils for agriculture are more likely to occur; and
- Land use and land capability were described with specific reference to the interaction between water and land use through a review of existing studies conducted in the area as well as publicly available information.

Soil Classification

A soil assessment on the Arnot South Project Area was conducted during a field visit in April 2021.

The site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. Soils were investigated using a Bucket and Cradle auger to a maximum depth of 1.2 metres (m) or to the first restricting layer. Survey positions were recorded as waypoints using a handheld Global Positioning System (GPS). Other features such as existing open trenches and diggings were helpful to determine soil form and depth. Mapping unit boundaries were determined by changes in topography with subsidiary indications from vegetation and parent material.

The soils were classified using the Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991). The following attributes were included at each observation:

- Topography, aspect and slope;
- Soil form and family;
- Soil depth;

- Estimated soil texture;
- Soil structure, coarse fragments, calcareousness;
- Underlying material; and
- Vegetation.

Soil Physical and Chemical Analysis

Five (5) representative soil samples (0 to 0.6 m) were collected from the proposed areas for soil chemical and physical analysis. The soil samples were stored in plastic bags and sent for analysis at a South African National Accreditation System (SANAS) accredited laboratory. In accordance with the methodology given in the Handbook of Standard Soil Testing Methods for Advisory Purposes (Soil Science Society of South Africa, 1990), the soil samples were tested for the following parameters:

- Cation Exchangeable Capacity (CEC);
- Electrical Conductivity (EC);
- pH (KCl);
- Exchangeable cations (Ca, Mg, K and Na);
- Phosphorus (Bray 1 extractant);
- Metals (Fe, Mn, Cu, Zn and Ni);
- Macro-elements (F and Cl);
- Nitrogen (NO_3); and
- Soil texture (Sand, Silt and Clay fractions).

Fertility analysis was used to provide recommendations for fertilisation and liming that is mostly used for soil management and remediation.

Soil texture is defined as the relative proportion of sand, silt and clay particles found in the soil. The relative proportions of these 3 fractions (clay, sand and silt) as illustrated in Figure 1, determines 1 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.

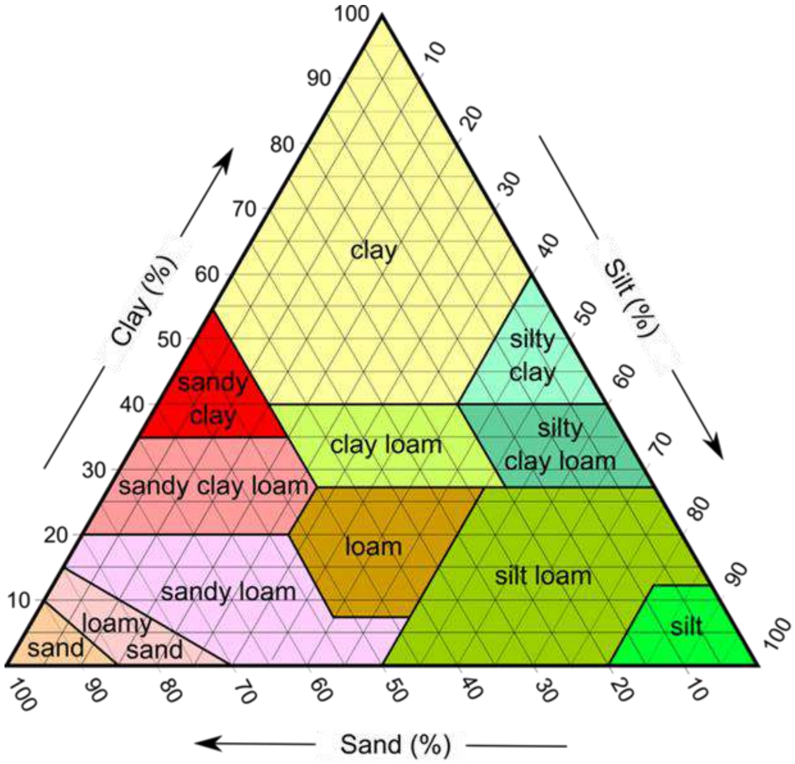


Figure 1: Soil Textural Diagram

(Source: (South African Sugar Association, 1999)

Land Use

The current land use was identified by aerial imagery during the desktop assessment and by on-site inspection during the EIA phase. The maps indicate delineated areas of similar land use (Land Type Survey Staff, 1972 - 2006). Land use categories are split into:

- Plantations;
- Natural;
- Waterbodies;
- Mines;
- Urban built-up; and
- Agriculture.

Land Capability

Land capability was determined by assessing a combination of soil, terrain and climate features. Land capability is defined by the most suitable land use under rain-fed conditions. The approach by U.S. Department of Agriculture (1973) and Schoeman et al. (2000) was used to assess the land capability. The classification system is made up of land capability classes and land capability groups (Table 1). The land will be rated into eight classes which include group of capability units or subgroups that have the same relative degree of limitation or potential. These classes range from I to VIII in order of decreasing agricultural potential based on limiting factors that include erosion hazard (e), excess water (w), soil root zone (s) and climatic (c) limitations. Classes I-IV represent arable land and Classes V-VIII represent non-arable land according to the guidelines (Soil Conservation Service: U.S. Department of Agriculture, 1973; Schoeman, et al., 2000).

Table 1: Land Capability Classes

<table>
<tr><th>Class</th><th colspan="9">Increased Intensity of Use</th><th>Land Capability Groups</th><th>Sensitivity</th><td rowspan="9">W – Wildlife
F – Forestry
LG – Light Grazing
MG – Moderate Grazing
IG – Intensive Grazing
LC – Light Cultivation
MC – Moderate Cultivation
IC – Intensive Cultivation
VIC – Very Intensive Cultivation</td></tr>
<tr><td>I</td><td>W</td><td>F</td><td>LG</td><td>MG</td><td>IG</td><td>LC</td><td>MC</td><td>IC</td><td>VIC</td><td rowspan="4">Arable Land</td><td rowspan="4">High</td></tr>
<tr><td>II</td><td>W</td><td>F</td><td>LG</td><td>MG</td><td>IG</td><td>LC</td><td>MC</td><td>IC</td><td>-</td></tr>
<tr><td>III</td><td>W</td><td>F</td><td>LG</td><td>MG</td><td>IG</td><td>LC</td><td>MC</td><td>-</td><td>-</td></tr>
<tr><td>IV</td><td>W</td><td>F</td><td>LG</td><td>MG</td><td>IG</td><td>LC</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>V</td><td>W</td><td>-</td><td>LG</td><td>MG</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Grazing Land</td><td rowspan="2">Medium</td></tr>
<tr><td>VI</td><td>W</td><td>F</td><td>LG</td><td>MG</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>VII</td><td>W</td><td>F</td><td>LG</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Wildlife</td><td rowspan="2">Low</td></tr>
<tr><td>VIII</td><td>W</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Land Suitability (Agricultural Potential)

The process of land suitability classification is the grouping of specific areas of land in terms of their suitability for a defined land use. Soil agricultural potential or suitability mapping was determined by considering the soil forms, land capability classes, soil analysis results, the hydrology of the site and the current land use. The process involved allocating terrain factors (topography and slope) and soil factors (depth, texture, internal drainage and mechanical limitations) which define soil forms, to an area of land. The soil chemical analysis, which includes pH, cations and phosphorus compositions, was considered in determining the final suitability of the soil. The suitability guidelines according to Schoeman et al., (2000) were used.

Soil chemical, physical and biological processes depends on five soil forming factors, including time, topography, organic material, climate and parent material. These soil forming factors changes the soil characteristics and therefore are considered when soils are grouped into land capability and suitability. Depending on which of these are limiting, the soils fall under one of the following suitability classes (Table 2):

Table 2: Land Classes – Descriptions and Suitability

Class	Definition	Conservation Need	Use-Suitability
I	• No or few limitations. • Very high arable potential. • Very low erosion hazard.	Good agronomic practice.	Annual cropping.
II	• Slight limitations. • High arable potential. • Low erosion hazard.	Adequate run-off control.	Annual cropping with special tillage or ley (25%).
III	• Moderate limitations. • Some erosion hazards.	Special conservation practice and tillage methods.	Rotation of crops and ley (50%).
IV	• Severe limitations. • Low arable potential. • High erosion hazard.	Intensive conservation practice.	Long term leys (75%).
V	• Watercourse and land with wetness limitations.	Protection and control of water table.	Improved pastures or Wildlife.
VI	• Limitations preclude cultivation. • Suitable for perennial vegetation.	Protection measures for establishment e.g. Sod-seeding.	Veld and/or afforestation.
VII	• Very severe limitations. • Suitable only for natural vegetation.	Adequate management for natural vegetation.	Natural veld grazing and afforestation.
VIII	• Extremely severe limitations. • Not suitable for grazing or afforestation.	Total protection from agriculture.	Wildlife.

Impact Assessment

The soil impacts were assessed based on the impact's magnitude as well as the receiving environment's sensitivity, resulting in an impact significance rating which identified the most important impacts that require management. Based on national guidelines and legislation, the following criteria were taken into consideration when potentially significant impacts were examined relating to soils:

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

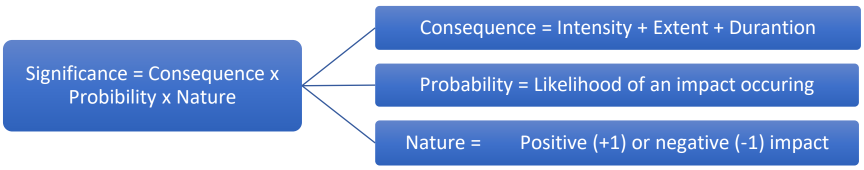
- Measures to mitigate avoid or offset significant adverse impacts.

Significance Rating

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

The severity of an impact was determined by taking the spatial extent, the duration and the severity of the impacts into consideration. The probability of an impact was 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 were incorporated into the EMP. 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:



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 calculated the rating out of 147, whereby intensity, extent, duration and probability were each rated out of seven as indicated in Table 4. The weight assigned to the various parameters was then multiplied by +1 for positive and -1 for negative impacts.

Parameter Rating

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 3, which is extracted from Table 4. The description of the significance ratings is discussed in Table 5.

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.

Mitigation Hierarchy

The aim of the Impact Assessment is to strive to avoid damage to or loss of ecosystems and services that they provide, and where they cannot be avoided, to reduce and mitigate these impacts (Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, & South African National Biodiversity Institute, 2013). Offsets to compensate for loss of habitat are regarded as a last resort, after all efforts have been made to avoid, reduce and mitigate. The mitigation hierarchy is represented in Table 3.

Table 3: Mitigation Hierarchy

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

Table 4: Impact Assessment Parameter Ratings

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
7	**Irreplaceable loss** or damage to biological or physical resources or **highly sensitive** environments. Irreplaceable damage to **highly sensitive** cultural/social resources.	Noticeable, on-going natural and/or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the Project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	**Irreplaceable loss** or damage to biological or physical resources or **moderate to highly** sensitive environments. Irreplaceable damage to cultural/social resources of **moderate to highly** sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond Project Life: The impact will remain for some time after the life of the Project and is potentially irreversible even with management.	Almost Certain/Highly Probable: It is most likely that the impact will occur. >65 but <80% probability.
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.
3	**Moderate loss** and/or damage to biological or physical resources of **low to moderately sensitive** environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local including the site and its immediate 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. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited extending only as far as the development site area.	Short Term: Less than 1 year and is reversible.	Rare/Improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
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 5: Probability/Consequence Matrix

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

Table 6: 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) (-)