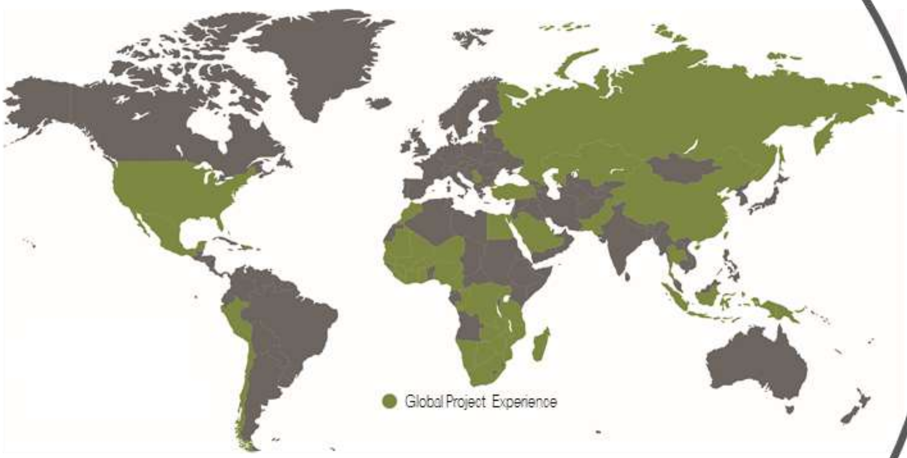

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Proposed Arnot South Coal Mining Project, Situated near Hendrina, Mpumalanga Province

Hydropedological Impact Assessment

Prepared for:
Universal Coal PLC

Project Number:
UCD6802

August 2021

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This document has been prepared by Digby Wells Environmental.

Report Type:	Hydropedological Impact Assessment
Project Name:	Proposed Arnot South Coal Mining Project, Situated near Hendrina, Mpumalanga Province
Project Code:	UCD6802

Name	Responsibility	Signature	Date
Daniel Fundisi	Report Writer		August 2021
Mashudu Rafundisani	Report Reviewer		August 2021

EXECUTIVE SUMMARY

Digby Wells Environmental (hereinafter Digby Wells) was appointed to conduct an Environmental Authorisation (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. The EA application process is for underground mining of various farm portions within the existing Arnot South Mining Right Area (MRA). This report should be read in conjunction with other specialist reports required for the EA and it constitutes the Hydropedology Impact Assessment which supports the EIA process and compilation of the EMPr, IWULA and IWWMP for the Project.

The MRA of the Arnot South Project stretches across three different quaternary catchments, namely B12A, B12B and X11A within the Olifants Water Management Areas (WMA 2) and Inkomati-Usuthu (WMA 3). The proposed development footprint is in Quaternary Catchment X11A which is drained by the Vaalwaterspruit in a South Westerly direction into the Komati River. Quaternary Catchments B12A and B12B are drained by the Klein- Olifants River, which is a tributary of the Olifants River. On average, the project site receives a Mean Annual Precipitation (MAP) of 685 mm. The project area has wet summers and dry winters as moderate to high volumes of rainfall are recorded from November to February. The Mean Annual Runoff (MAR) was calculated to be 55.02 mm which is approximately 8% of MAP. The region has a Mean Annual Evaporation (MAE) of 1358 mm which is much greater than the average MAP.

Identified soil forms within the Arnot South MRA include the Rensburg (Rg), Arcadia (Ar), Katspruit (Ka), Cartref (Cf), Witbank (Wb), Kroonstad (Kd), Avalon (Av), Mispah (Ms), Pinedene (Pn), Glencoe (Gc), Glenrosa (Gs), Clovelly (Cv) and Hutton (Hu). Hillslope crest positions are dominated by Hu and Cv soil forms which are classified as deep recharge soils. Soils within the midslope such as Av, Pd and Gc were classified as interflow soils in which lateral movement of water is dominant feeding the Vaalwaterspruit further down at footslope positions. Witbank soils were also encountered which represent a shallow recharge hydrological soil type. The riparian areas of the Vaalwaterspruit variably have shallow responsive Mispah and Glenrosa soils which are characterised by overland flow due to saturation from above and Rensburg, Katspruit, and Arcadia soils which are characterised by saturation excess overland flow.

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Detailed hydropedological surveys should be conducted to assess subsurface hydraulic heads and hydraulic gradients to get insight into flow directions and establish whether there is any significant interaction between groundwater and surface water including wetlands within the study area. Since the proposed Arnot South Project is based on underground mining, no significant or extensive disruption of flow paths is envisaged.

Recommendations

The following is recommended based on findings of the hydropedological impact assessment:

- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments and hazardous substances from construction vehicles used during site clearing;
- Dust suppression with water on the haul roads and cleared areas must be undertaken to limit dust mobilisation which contribute to sedimentation of watercourses
- Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors.
- Implementation of the proposed stormwater management plan to reduce sedimentation and siltation of nearby watercourses. The recommended perimeter berms around the discard dump, lay down areas, box cut, overburden dump and stockpiles will ensure that clean water is diverted from the dirty areas;
- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Vaalwaterspruit.
- In the event of decanting, passive treatment (through application of calcium compounds) should be implemented to neutralise and treat the AMD before being discharged back into freshwater resources;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD;
- Alternatively, when passive treatment fails to correct the situation active Water Treatment (e.g. Reverse Osmosis) should be considered;
- Post closure monitoring should be conducted for at least 5 years after decommissioning to help with the early detection of decant and prevent or reduce contamination of water resources; and
- Placement of infrastructure should be outside of all hydrologically sensitive areas such as the wetland zone of regulation, pans and watercourses

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS, ABBREVIATIONS AND DEFINITION

AMD	Acid Mine Drainage
ARC	Agricultural Research Council
CEC	Cation Exchange Capacity
DMRE	Department of Mineral Resources
EA	Environmental Authorisation
EMP	Environmental Management Plan
ET	Evapotranspiration
LoM	Life of Mine
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMWA	National Environmental Management: Waste Act (Act 59 of 2008)
MRA	Mining Rights Area
MREA	Mining Rights Extension Area
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
WMA	Water Management Area
WRC	Water Research Commission
WUL	Water Use Licence

1 Introduction

Digby Wells Environmental (hereinafter Digby Wells) was appointed to conduct an Environmental Authorisation (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.

2 Terms of Reference

The EA application process is for underground mining of various farm portions within the existing Arnot Mining Right Area (MRA). This report should be read in conjunction with other specialist reports required for the EA and it constitutes the Hydropedology Impact Assessment which supports 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).

The relevant legal and administrative framework specific to the Hydropedological assessment is described in Section 5.

3 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.

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 4-1; Figure 4-1).

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 4-1: 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

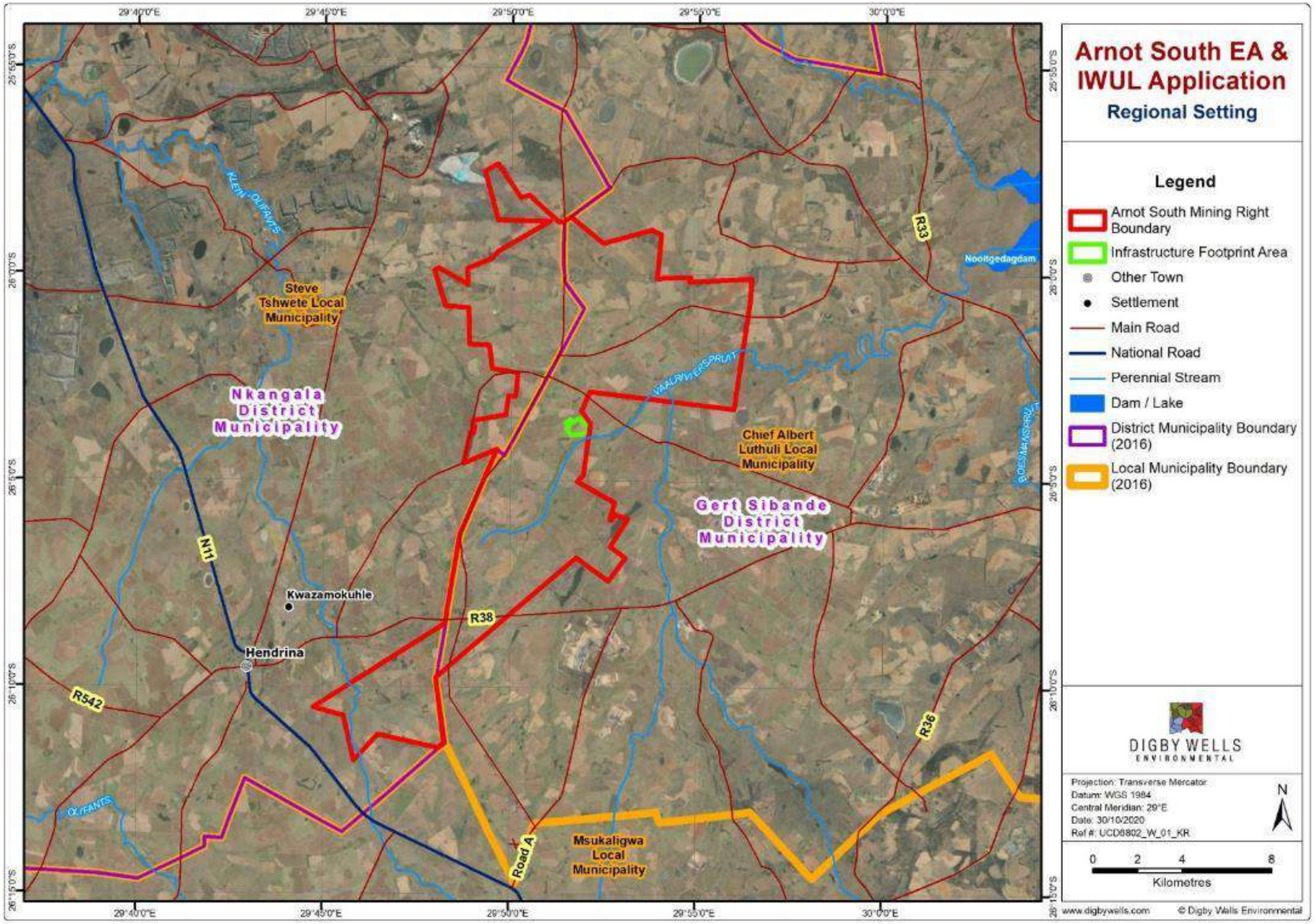

Figure 4-1: Locality map of the Arnot South Project

4.1 Proposed Infrastructure and Activities

As indicated in Table 4-2 and illustrated in Figure 4-2, 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 4-2 details the Project activities for the duration of the Construction, Operational and Rehabilitation Phases.

Table 4-2: 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.

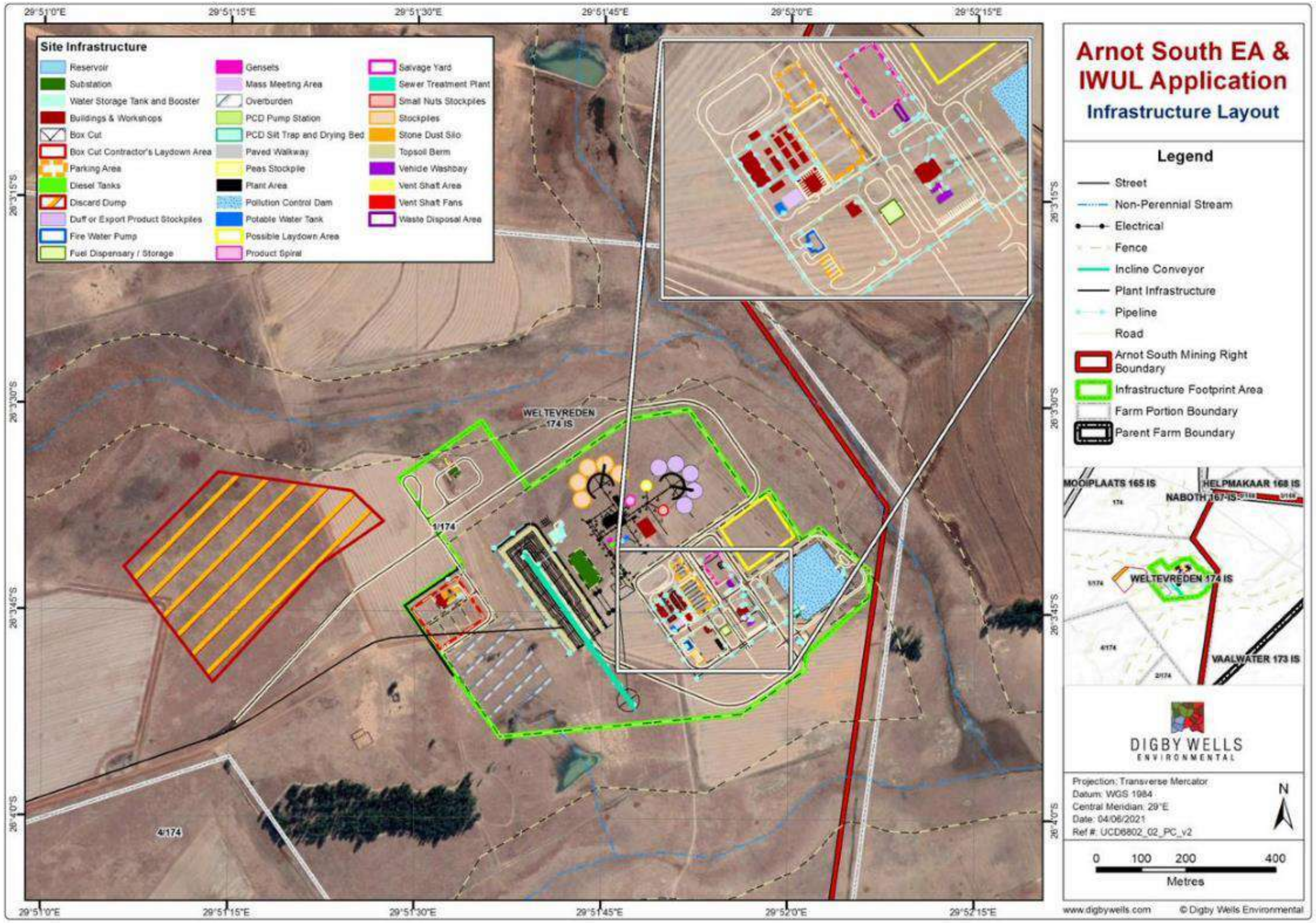

Figure 4-2: Infrastructure layout plan

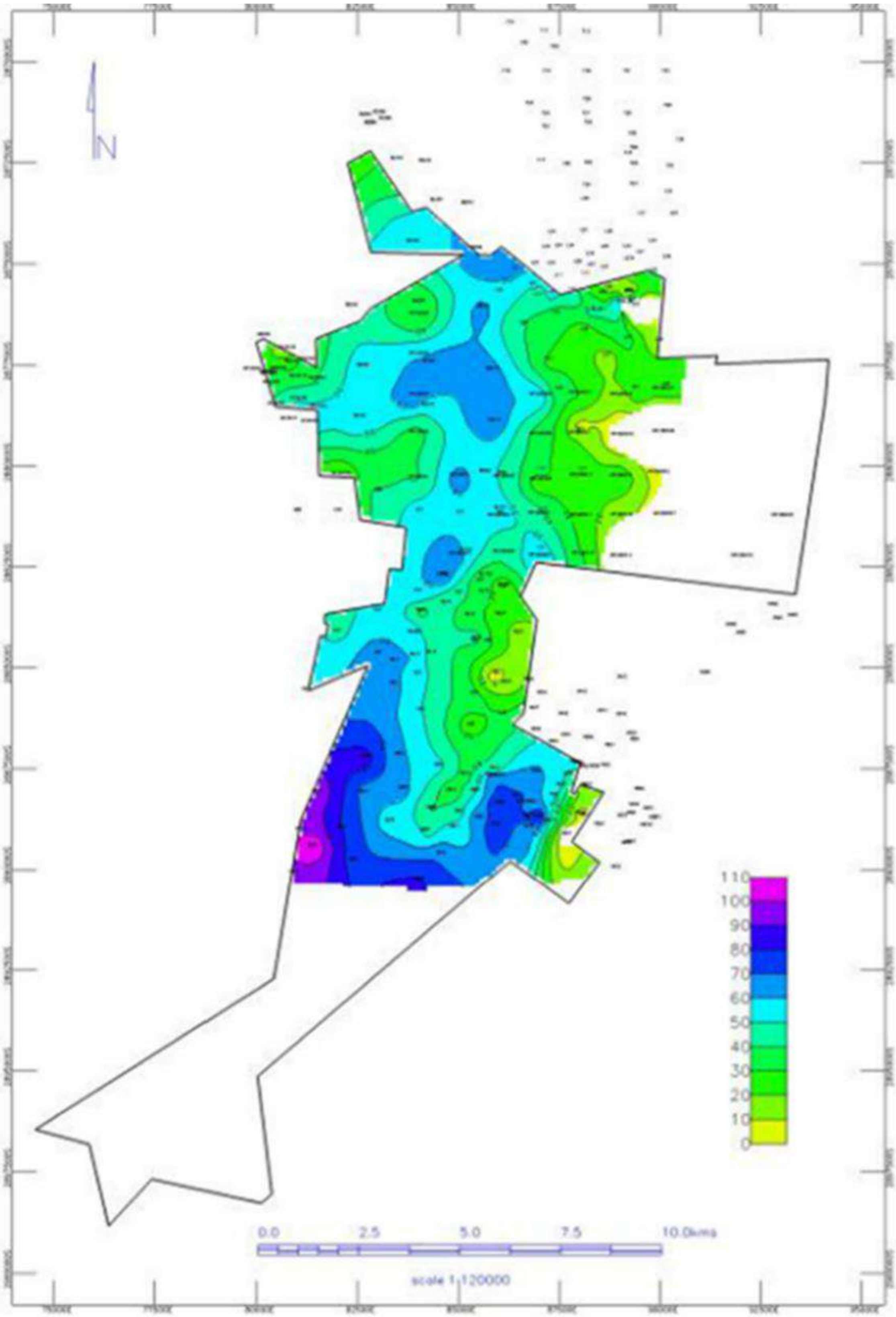

Figure 4-3: No. 2 Coal Seam Elevation (Source: Arnot South Mining Works Programme, 2020)

5 Relevant Legal and Administrative Framework

The table below summarizes the legal framework applicable to this Hydropedology Impact Assessment. The assessment includes the proposed mining and associated activities as detailed in Section 2.

Table 5-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Water Act, 1998 (Act No. 36 of 1998) (NWA) NWA makes provision for water resource management, protection of the quality of water resources and recognising the need for the integrated management of all aspects of water resources to achieve sustainable use of water. **Section 21 of the National Water Act, 1998 (Act No. 36 of 1998)** All water uses listed in terms of Section 21 of the NWA need to be licenced, unless it is a permissible water use in terms of Section 22 of the NWA.	The NWA is applicable for the protection and prevention of pollution of water resources that may arise as a result of the proposed activities within the Middeldrift Resources project site. The hydropedology study will form part of the impact assessment to minimize and remedy the pollution and degradation of the water resources within the project area. The water to be used within the mine does not constitute as a permissible water use in terms of Section 22 of the NWA.
Environmental Impact Assessment Regulations, 2014 Government, Gazette No 40772 including GNR 327 and GNR 328 dated 7 April 2017 The purpose of this Notice is to identify activities that would require environmental authorisations prior to commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.	The proposed mining activities trigger a licence and may result in the release of effluent or pollution of receiving waterbodies.
Section 2 (4) (a) (ii) of the National Environmental Management Act (Act 107 of 1998) (NEMA) Requires that the Environmental Management Plan (EMP) to include a rehabilitation plan, decommissioning plan and mine closure strategy. It must demonstrate pollution control measures and management of mining waste.	The hydropedology study will form part of the impact assessment to minimize and remedy the pollution and degradation of the water resources in the project area.
National Environmental Management: Waste Act (Act 59 of 2008) (NEMWA) Requires that waste generators classify waste material and appropriate handling of waste based on the classification must be adhered to based on the regulations that have been set out within the Act, unless the waste has been listed under the waste activities that do not require a waste management licence.	The proposed mining will result in waste that needs to be classified and handled appropriately.

Legislation, Regulation, Guideline or By-Law	Applicability

6 Methodology

This Section details the methodology that was undertaken in this hydropedological impact assessment investigation.

6.1 Desktop Assessment and Literature Review

The following literature was reviewed for better understanding of hydropedological processes within the study area:

6.1.1 Agricultural Research Council (ARC) Land type inventories

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the proposed project site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of relatively uniform terrain, soil pattern and climate (Land Type Survey Staff, 1972 - 2006).

The South African land types map represents a marked uniformity of terrain form, soil pattern and climate. Land type data indicates what soils can be expected and where they can be found in the landscape. Furthermore, land type data presents the dominant hillslope within a specific land type. The hillslope is therefore a fundamental landscape unit for understanding hydrological processes (Le Roux, et al., 2011). Dominant streams are preferably used for delineation of the lower side boundary of the identified hillslopes (Le Roux, et al., 2011). The typical terrain units that were used in the land type classification are presented in Figure 6-1.

Land type data and its associated uniformity are limited by scale and the methodology that was available at the time of the survey (Land Type Survey Staff, 1972-2006). Terrain analysis, including slope and elevation parameters was undertaken for improved accuracy of soil form and land type determination.

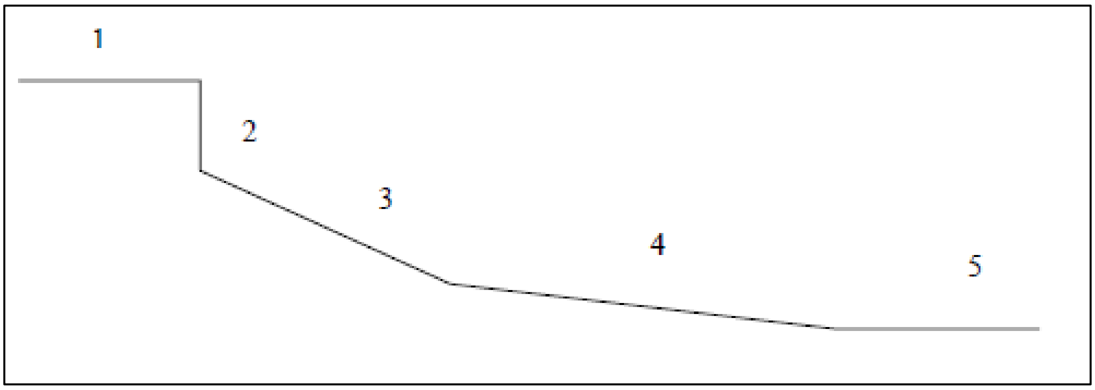

Figure 6-1: Terrain morphological units where 1= crest, 2= scarp, 3= midslope, 4= footslope, 5= valley bottom (Soil Classification Working Group, 1991)

6.1.2 Site Visit

The site assessment was undertaken on the 9th of April 2021 to understand and verify hillslope hydrology which determines the dominant water flow paths within the demarcated landscape units. Soil characteristics which indicate water residence times and leaching effects were assessed during the site visit. Physical and chemical soil characteristics which indicate water residence times (for example, signs of wetness include, grey, low chroma colours, leaching and mottles) were noted during the site visit. Any signs which indicate groundwater-surface water interaction were identified such as hillslope seeps, springs and wetlands.

6.2 Hydropedological Classification

Hillslopes were delineated according to methods described by (Le Roux, et al., 2011) and the conceptual hillslope hydrological behaviour determined. The hydrological behaviour was based on identified hydrological soil types as described in the Table 6-1 below.

Table 6-1: Hydrological Soil Types of the hillslopes (Adapted from (Le Roux, et al., 2011))

Hydrological Soil Type	Description	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out of the profile into the underlying bedrock is the dominant flow direction. These soils can either be shallow on fractured rock with limited contribution to evapotranspiration or deep freely drained soils with significant contribution to evapotranspiration (ET).	
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates build-up of water in the topsoil. The duration of drainable water depends on rate of ET, position in the hillslope (lateral addition/release) and slope (discharge in a predominantly lateral direction).	
Interflow (Soil/Bedrock)	Soils overlying relatively impermeable bedrock. Hydromorphic properties signify temporal build of water on the soil/bedrock interface and slow discharge in a predominantly lateral direction.	
Responsive (Shallow)	Shallow soils overlying relatively impermeable bedrock. Limited storage capacity results in the generation of overland flow after rain events.	
Responsive (Saturated)	Soils with morphological evidence of long periods of saturation. These soils are close to saturation during rainy seasons and promote the generation of overland flow due to saturation excess.	

6.3 Impact Assessment

The methodology adopted for the hydropedology impact assessment is detailed in Appendix A.

7 Findings

This Section details the findings of the hydropedology survey and impact assessment.

7.1 Baseline Environment

This section describes the baseline environment within and around the project area and this includes the climate, surface water hydrology, topography, land types and land use.

7.1.1 Hydrology and Topography

The Mining Right Boundary of the Arnot South Project Area stretches across three different quaternary catchments, namely B12A, B12B and X11A within the Olifants Water Management Areas (WMA 2) and Inkomati-Usuthu (WMA 3) (Figure 7-1). The proposed development footprint is in Quaternary Catchment X11A which is drained by the Vaalwaterspruit in a South Westerly direction into the Komati River. Quaternary Catchments B12A and B12B are drained by the Klein- Olifants River, which is a tributary of the Olifants River.

The elevation of the Project Area ranges from 1 565 - 1 745 metres above mean sea level (mamsl) which equates to a range of 180 m between the lowest and highest points of elevation within the Project Area (Figure 7-2). The average slope for the entire Project Area is approximately 2.8 degrees (Figure 7-3).

On average, the project site receives a Mean Annual Precipitation (MAP) of 685 mm. The project area has wet summers and dry winters as moderate to high volumes of rainfall are recorded from November to February. The Mean Annual Runoff (MAR) was calculated to be 55.02 mm which is approximately 8% of MAP. The region has a Mean Annual Evaporation (MAE) of 1358 mm which is much greater than the average MAP.

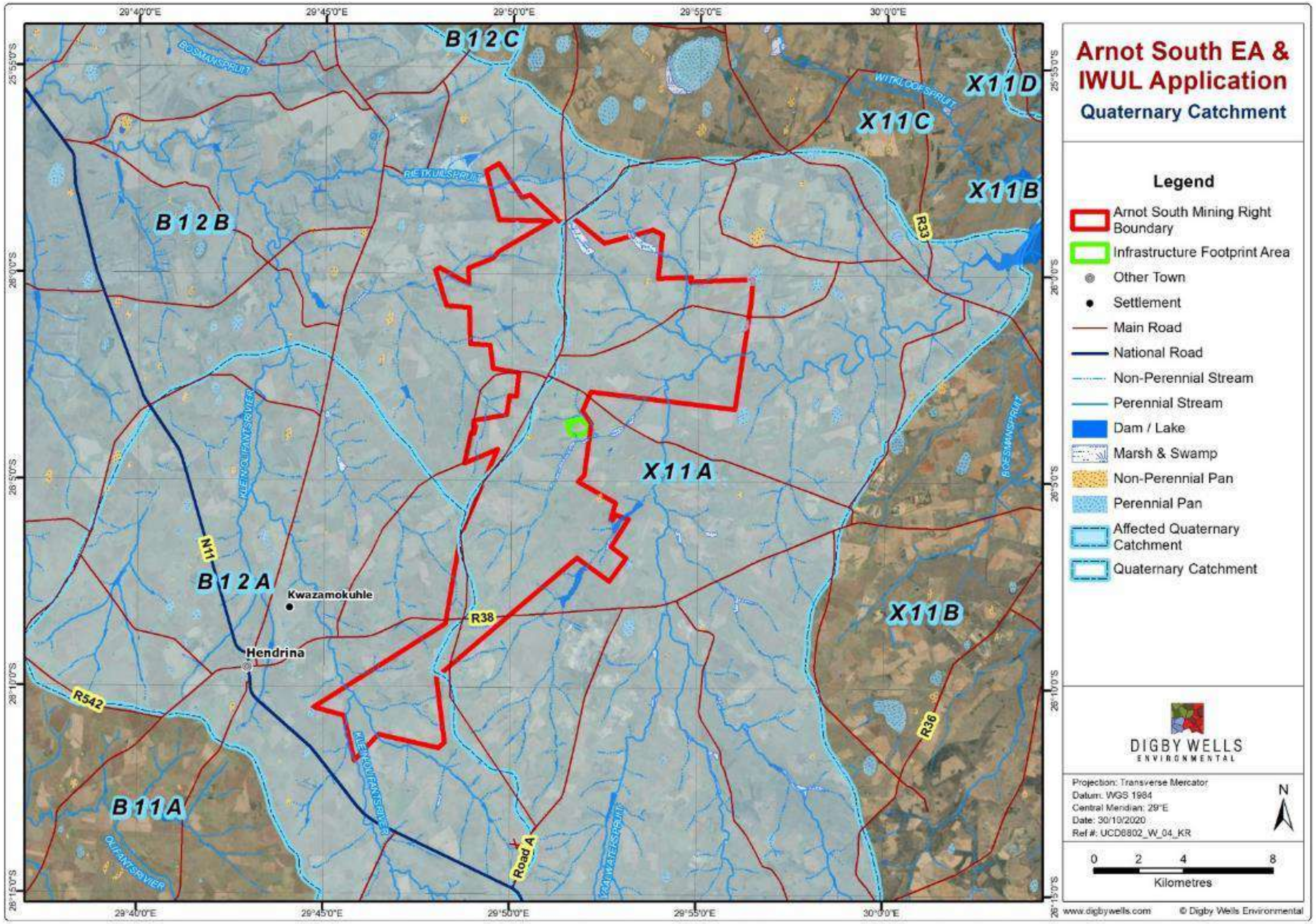

Figure 7-1: Hydrological Setting of the Arnot South MRA

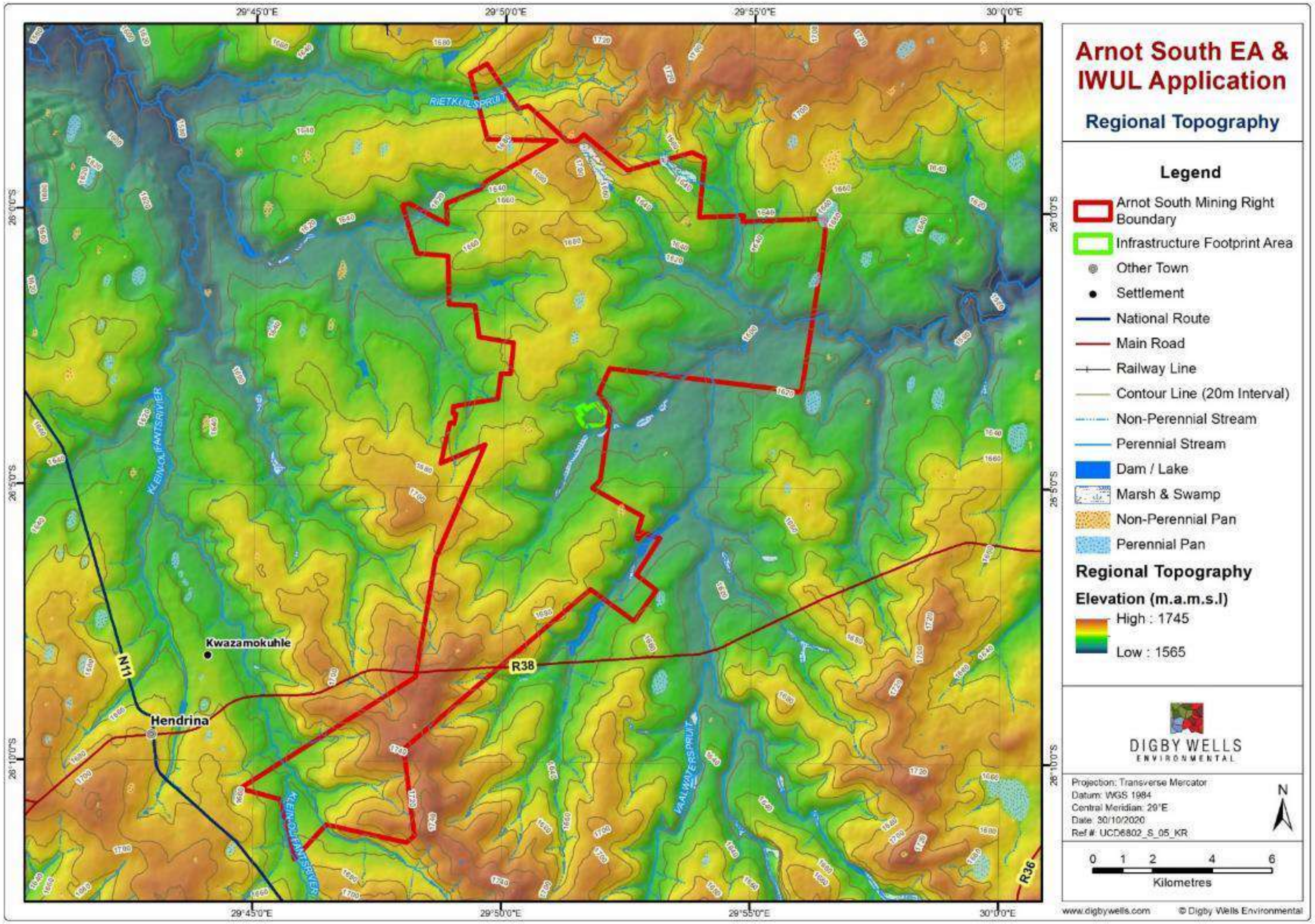

Figure 7-2: Topography of the Arnot South MRA

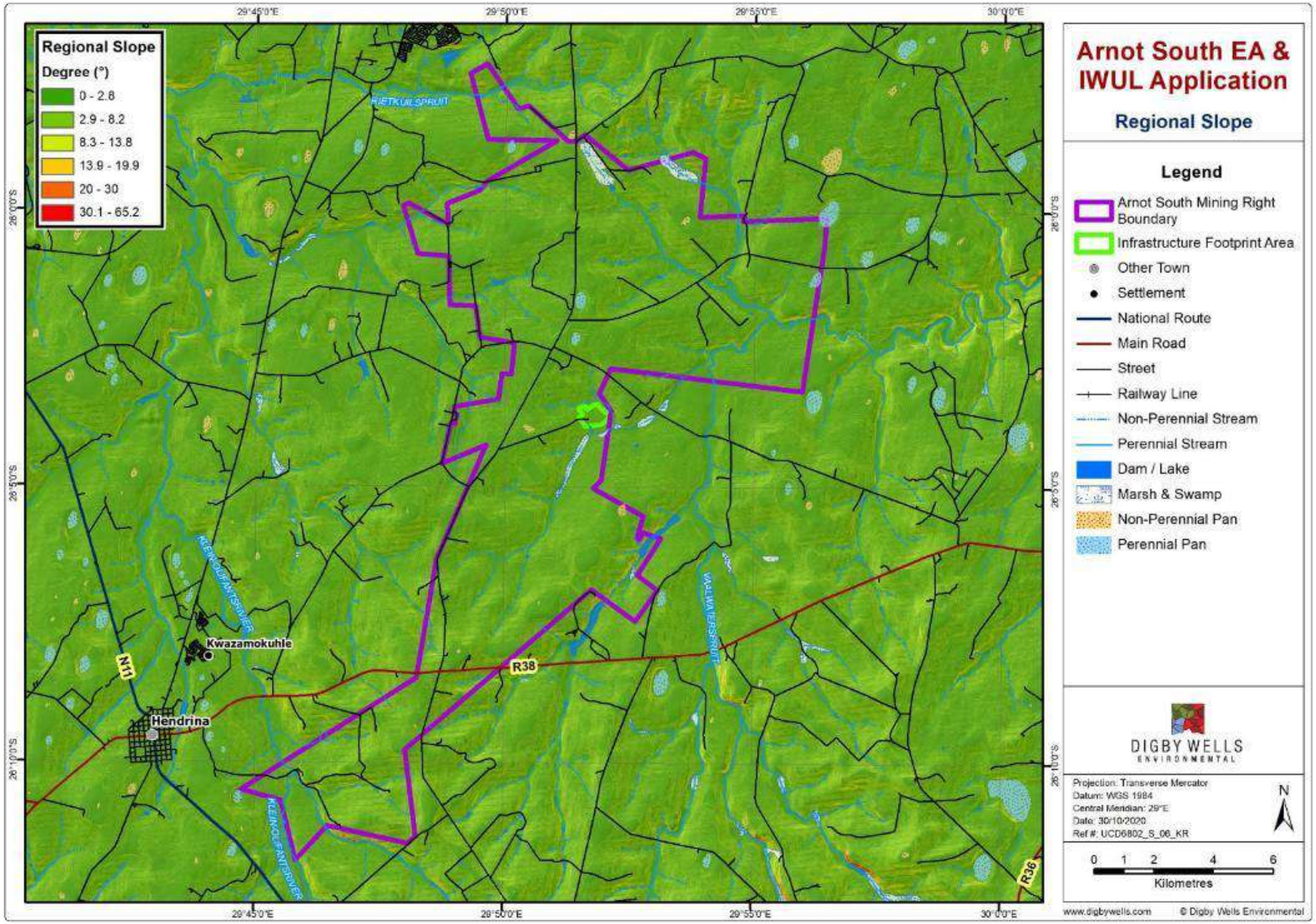

Figure 7-3: Slope of the Arnot South MRA

7.1.2 Land Types

The land types that occur within the Arnot South Mining Rights Boundary and the extent they cover are summarized in Table 7-1. The proposed mine infrastructure is solely within the dominant Land Type Ba22 (Figure 7-5). Based on the Land Types Inventory, the area is dominated by red-apedal, well-drained Hutton soil form and the Glencoe and Avalon soil forms. The Glencoe soil form consists of an orthic A horizon overlying a yellow brown apedal B and hard plinthic B horizon. The Avalon soil form consists of an orthic A horizon overlying a yellow brown apedal B and a soft plinthic B horizon.

The general terrain type within the Ba22 land type is presented in Figure 7-4. The Ba22 land type is dominated by terrain unit Type 3, which is characterised by a slope of 2 to 8% (Land Type Survey Staff, 1972-2006). Terrain unit 1 represents the crests while unit 5 represents the lowest point in the topography of the land type, which are the streams. These terrain units are correlated to the Land Type Inventory from which the distribution of the expected soil type within each terrain unit is given. The soils are described as dystrophic and mesotrophic, which defines the leaching class. Dystrophic soils are highly leached, while mesotrophic soils are moderately leached (Land Type Survey Staff, 1972-2006). The plinthic subsoil is characterized by an accumulation of iron (and frequently Manganese) oxides and hydroxides, with the localization of high chroma mottles and concretions. In a hard plinthic B horizon, an indurated zone of accumulation of iron and manganese oxides forms which is relatively impermeable.

Table 7-1: Distribution of Land Types at the Arnot South Project Area

Land Type	Area (km^2)	Area (%)	Description of broad soil pattern code
Ba19	1.1	0.71	Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise >33% of land type)
Ba22	142.7	91.47	
Bb15	12.2	7.82	Red and yellow, dystrophic/mesotrophic, apedal soils with plinthic subsoils (plinthic soils comprise >10% of land type, red soils comprise <33% of land type)

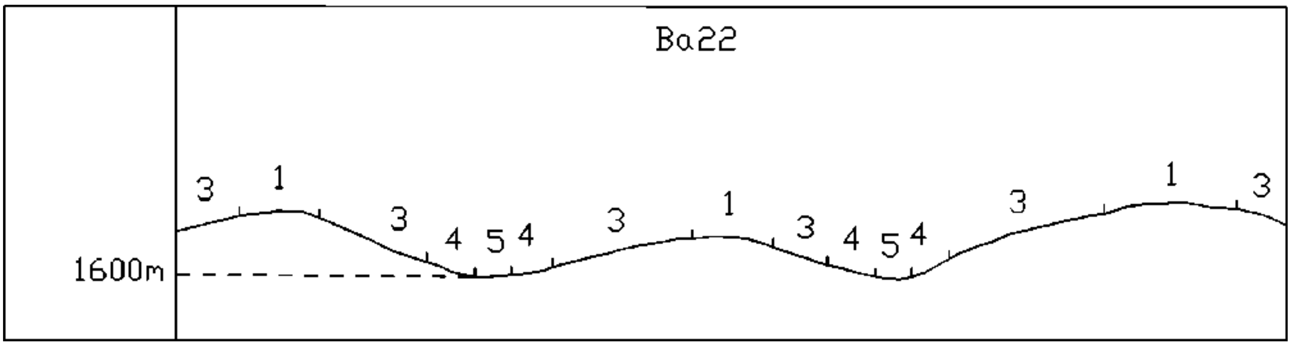

Figure 7-4: General Terrain Type for the Dominant Land Type Ba22 (Adapted from (Land Type Survey Staff, 1972-2006))

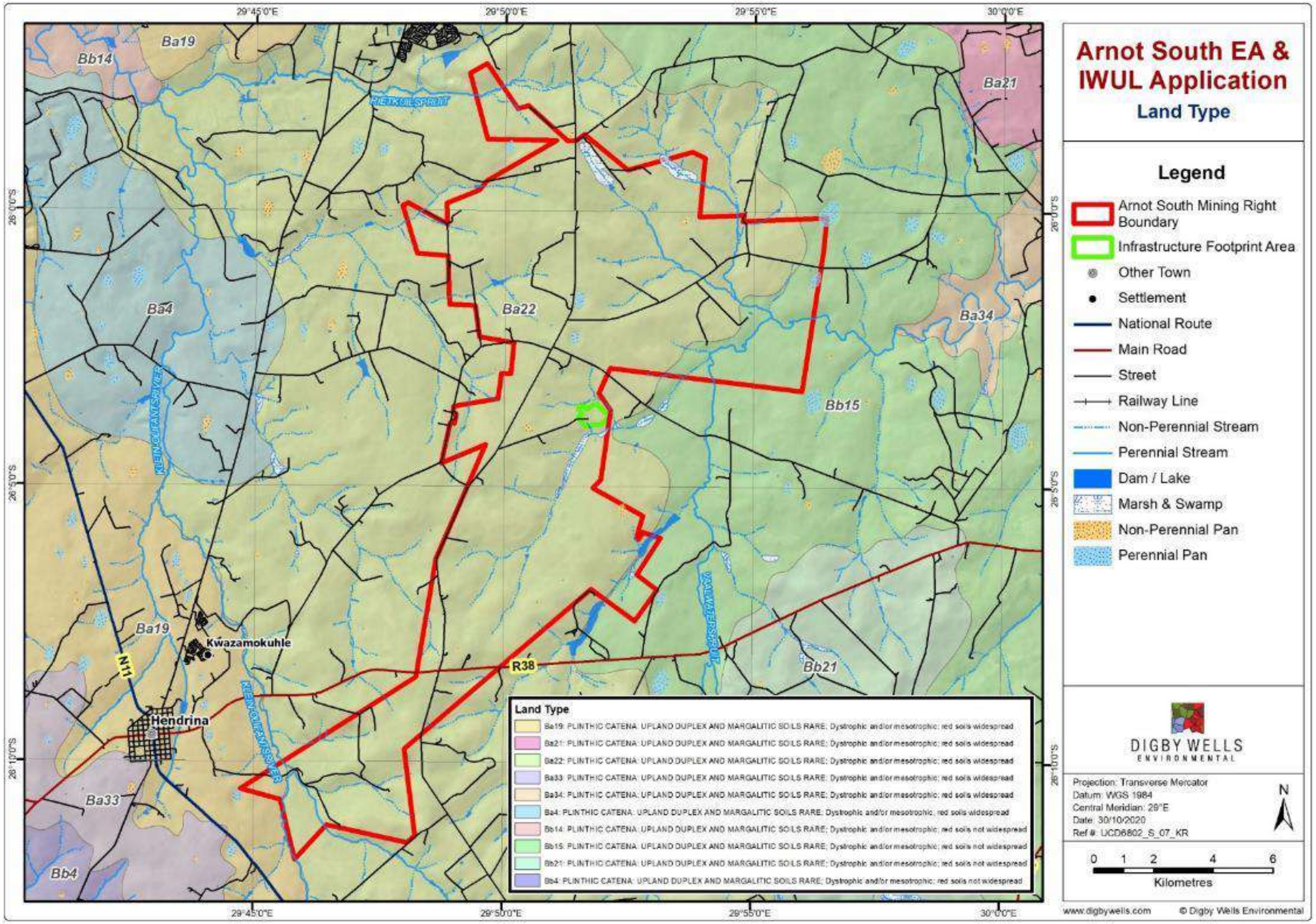

Figure 7-5: Land Types Within the Arnot South MRA

7.1.3 Land Use

The current land use of the Arnot South Project Area was identified by aerial imagery as part of the desktop assessment (Figure 7-6). The land use can be described as predominantly grassland and cultivated area. Minor areas with wetland, plantation/woodlot, thicket/dense bush, urban area and bare/non-vegetated land also exist within and around the Arnot Project Area.

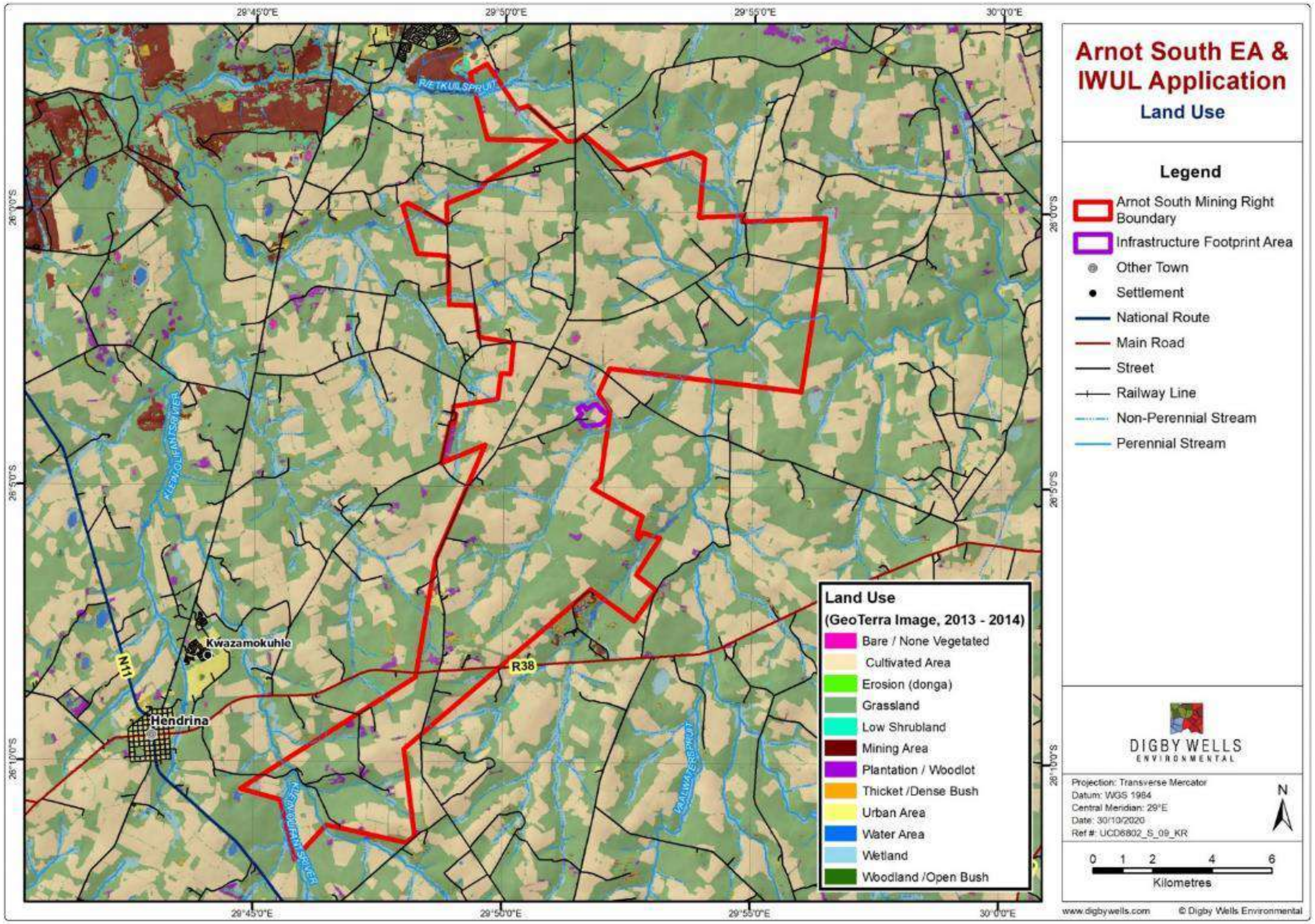

Figure 7-6: Land Use Map Within and Around the Arnot South Project Area

7.2 Soil Forms and Hydropedological Soil Types

Due to the wide extent of the project area, limited access to some areas, time and budget constraints dominant soil forms were determined based on field surveys, physiography, observed and perceived functionality and hillslope catena position and land use. Brief descriptions of soil forms coupled with photographs and associated hydropedological soil types are presented in Table 7-2 below.

The following soil forms were identified within the project area:

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

Delineated soil forms within the Arnot South MRA are illustrated in Figure 7-7, while associated hydropedological soil types are presented in Figure 7-8.

Table 7-2: Soil Forms and Hydropedological Soil Types within the Arnot South MRA

Soil Form	Hydropedological Soil Type	Dominant Land Use	Description (Soil Classification Working Group, 1991)	Observations in the Project Area	
Cartref → Orthic A → E-horizon → Lithocutanic	Interflow (A/B)	• 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; • 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.	
Glenrosa →Orthic A → Lithocutanic B	Recharge (Shallow)	• Cattle grazing; and • Wetlands (natural areas).	Shallow soils overlying a weathered rock	Shallow and leached soil overlying a hard weathered sandstone layer;	
Avalon → Orthic A → Yellow-brown Apedal B → Soft Plinthic	Interflow (Soil/bedrock)	• Intensive cultivation; • Irrigation cultivation; • Intensive cattle grazing • .	These soils have a Yellow-brown B-horizon overlying a soft plinthic horizon. 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).	

Soil Form	Hydropedological Soil Type	Dominant Land Use	**Description** (Soil Classification Working Group, 1991)	Observations in the Project Area	
Clovelly → Orthic A → Yellow-brown Apedal → Unspecified	Recharge (Deep)	• Intensive cultivation; • Irrigation cultivation; • Intensive cattle grazing	These soils have a 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. These soils have a high land capability potential, however often low in fertility.	• 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	
Hutton → Orthic A → Red Apedal → Unspecified	Recharge (Deep)	• 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.	
Glencoe → Orthic A → Yellow-brown Apedal → Hard Plinthic	Interflow (Soil/Bedrock)	• 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	Hydropedological Soil Type	Dominant Land Use	Description (Soil Classification Working Group, 1991)	Observations in the Project Area	
Pinedene → Orthic A → Yellow-brown Apedal → Unspecified material with signs of wetness	Interflow (Soil/Bedrock)	• 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.	
Mispah → Orthic A → Hard rock	Responsive (Shallow)	• 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.	
Katspruit → Orthic A → G-horizon	Responsive (Saturated)	• Moderate cattle grazing; and • Wetlands (natural areas).	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.	

Soil Form	Hydropedological Soil Type	Dominant Land Use	Description (Soil Classification Working Group, 1991)	Observations in the Project Area	
Kroonstad → Orthic A → E-horizon → G-horizon	Interflow (A/E)	• Moderate cattle grazing; and • Wetlands (natural areas).	Kroonstad 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.	
Rensburg → Vertic A → G-horizon	Responsive (Saturated)	• Moderate cattle grazing; and • Wetlands (natural areas).	Rensburg soils consist 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.	
Arcadia → Vertic A → Unspecified	(Responsive (Shallow)	• 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;	

Soil Form	Hydropedological Soil Type	Dominant Land Use	**Description** (Soil Classification Working Group, 1991)	Observations in the Project Area	
				• 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	Recharge (Shallow)	• 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.	

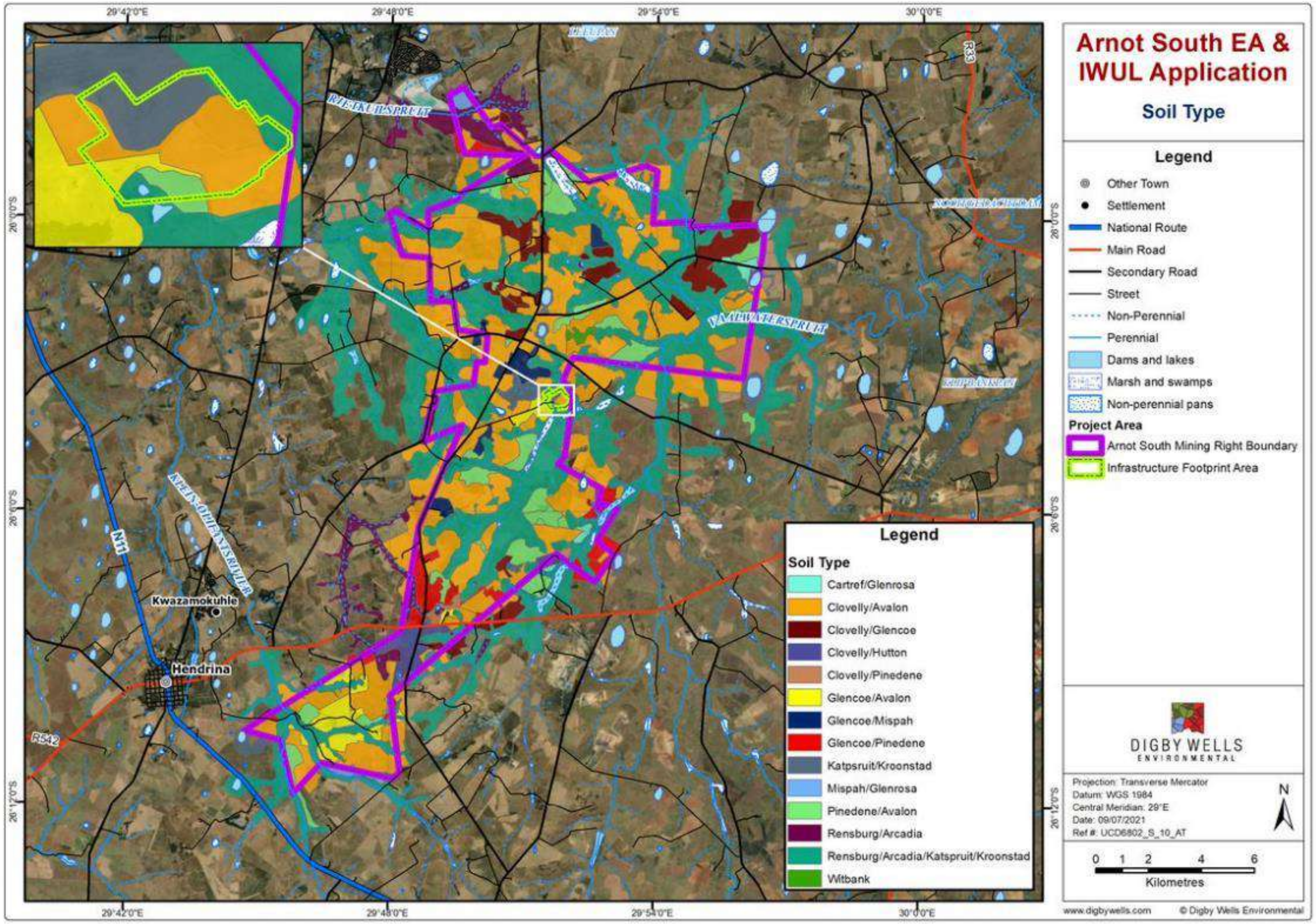

Figure 7-7: Soil Form Distribution Within the Arnot South MRA

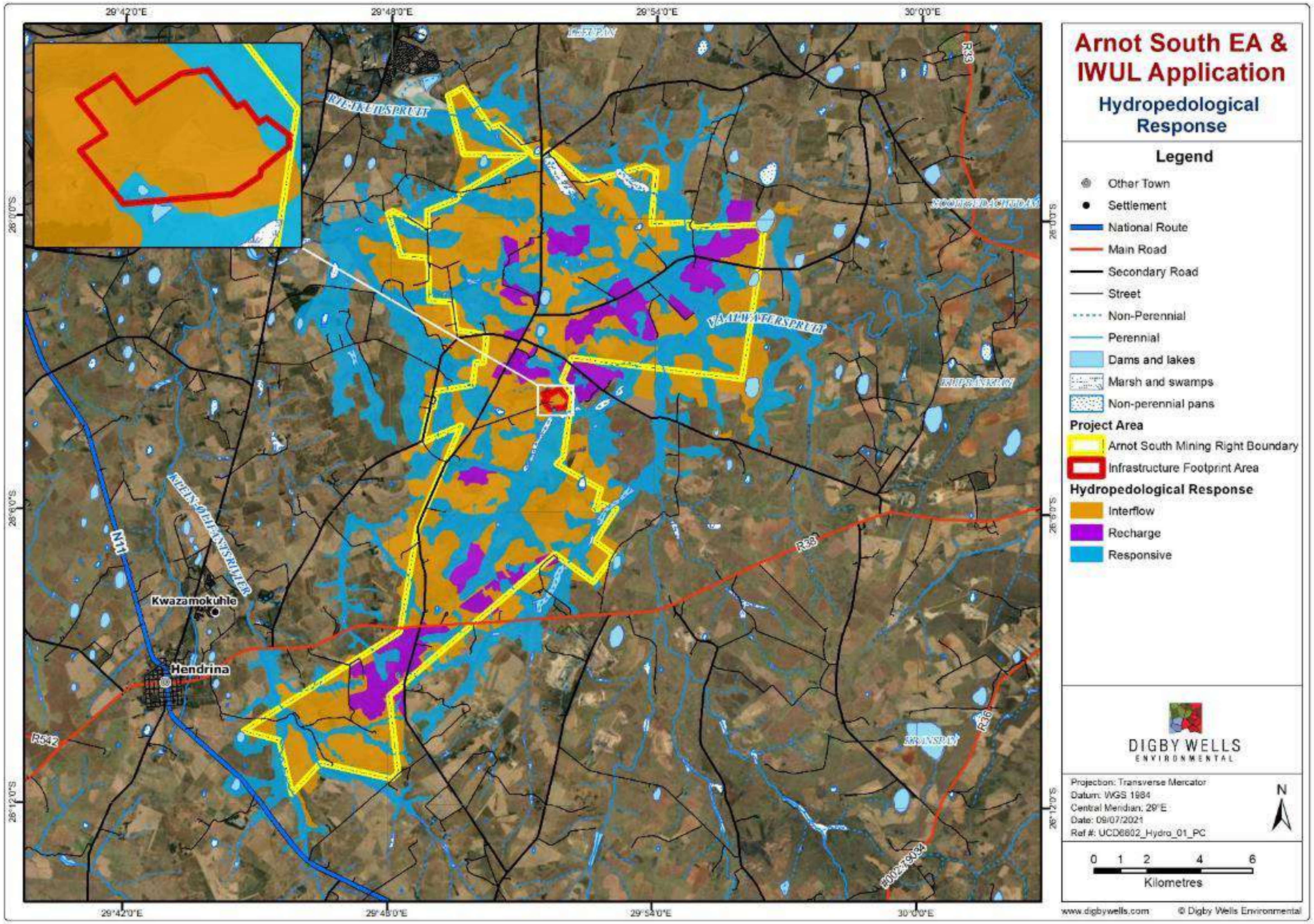

Figure 7-8: Hydrological Soil Types within the Arnot South MRA

7.3 Hydropedological Responses and Implications

Hydropedological responses were at the Arnot South Infrastructure Area were closely assessed. Dominant flow paths within the infrastructure area are Interflow (A/B) and Interflow (Soil/Bedrock). The interflow (A/B) is a lateral flow path resulting from differences in soil permeability which cause temporary build-up of water on a less permeable underlying soil layer. The interflow (soil/bedrock) occurs when water encounters an impermeable hardrock after passing through a permeable soil horizon(s). Prolonged saturation with evidence of mottles, concretions and illuviation were observed at the footslope of hillslopes and within valley bottoms. These hillslope positions are dominated by responsive soils where saturation overland flow occurs (Figure 7-8).

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Disruption of flow paths will occur where the Box cut will be constructed and the underground mine shaft sunk with potential reduction of water that reports to the Vaalwaterspruit. This disruption will likely not be significant due to a relatively small area (approximately 0.03 km^2) that will be occupied by the Box cut on Hillslope Number 2 within interflow soils at the midslope (Figure 7-9). The Discard Dump and Stockpiles will slow down or reduce infiltration into the vadose zone by increasing the depth of seepage. However, eventually the water will likely follow original flow paths as it gets to less permeable soil layers in the subsurface. Overland flow will likely increase on hard park areas which include the car park area due to compaction of soils.

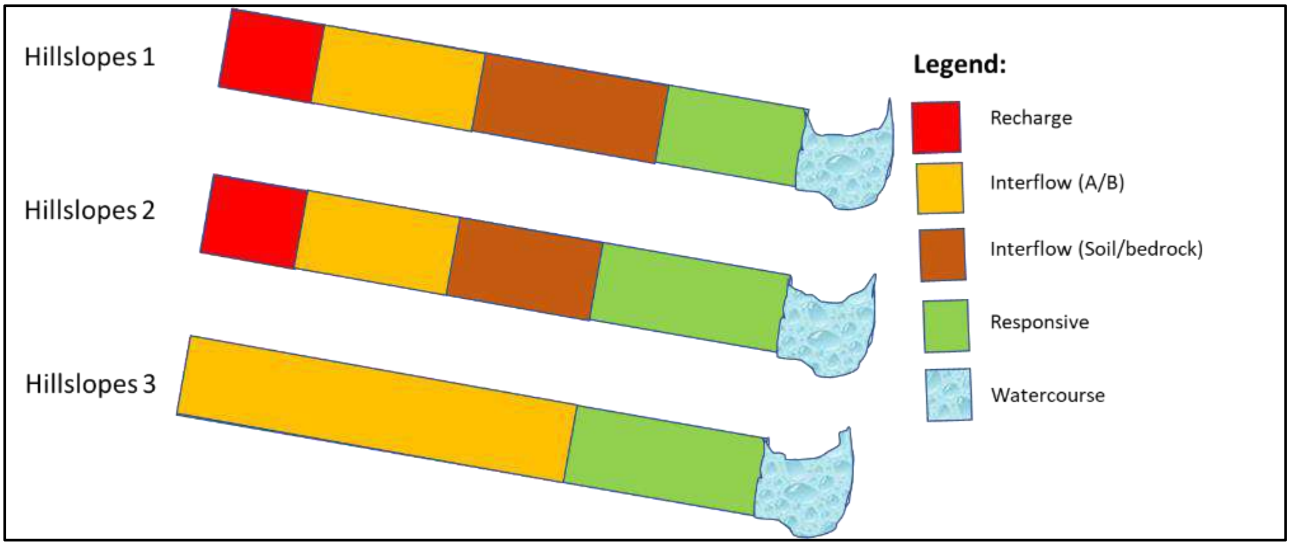

Figure 7-9: Conceptual hydropedological responses at the Arnot South Infrastructure Area

7.4 Impact Assessment

This Section details the impact assessment on the hydropedology in the project area as a result of the proposed mining and associated activities during the construction, operational and decommissioning phases.

7.4.1 Construction Phase

Activities with potential impacts on surface water resources and their mitigation or management measures are listed and described on the table provided below (Table 7-3) and the impact significance rating is given in Table 7-4.

Table 7-3: Interactions and the impacts of activities in the Construction phase

Interaction	Impacts
Removal of vegetation / topsoil for establishment of mining infrastructure such as the haul roads, discard dump, offices, workshop and change houses, PCD, silt traps and lay down areas.	Sedimentation and siltation of watercourses through overland flow leading to reduced water quality
Moving vehicles and machinery during construction of infrastructure including haul roads, discard dump, offices, workshop and change houses, PCD, silt traps and lay down areas. Handling of hydrocarbon residues and spills during construction operations.	Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas

7.4.1.1 *Impact Description: Sedimentation and siltation of watercourses through overland flow leading to reduced water quality*

Vegetation serves as land cover which protects the soil from being eroded during rainfall events. Vegetation cover allows water to seep into vegetation, allowing water to flow at a slow speed and preventing soil from being washed off. Clearing vegetation exposes the soil to the possibility of erosion during a rainfall event or when water flows on that area, therefore increasing the volume of suspended solids in adjacent water resources. Furthermore, the movement of vehicles during construction increases the amount of dust particles which also reduce the quality of nearby surface water resources.

7.4.1.2 *Impact Description: Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas*

Moving vehicles and machinery during construction of infrastructure including haul roads, discard dump, offices, workshop and change houses, PCD, silt traps and lay down areas. Handling of hydrocarbon residues and spills during construction operations. Hydrocarbon waste such as oils, fuels and grease potentially contaminate nearby water resources when washed off into rivers, streams and pans.

7.4.1.3 Management/Mitigation Measures

The recommended management/mitigation measures are as follows:

- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments and hazardous substances from construction vehicles used during site clearing;
- Dust suppression with water on the haul roads and cleared areas must be undertaken to limit dust mobilisation which contribute to sedimentation of watercourses
- Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath; and
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors.

Table 7-4: Impact Significance Rating for the Construction Phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of watercourses through overland flow leading to reduced water quality			
Duration	5	The impact will likely occur during construction and decommissioning phases.	-90 Moderate (Negative)
Intensity	5	The impact will have serious, long-term impact on the ecosystem.	
Spatial scale	5	The impacts will go beyond the specified project area.	
Probability	6	It highly possible that it will occur.	
Post-mitigation			
Duration	5	The impact will likely occur throughout the project's life.	18-Negligible (negative)
Intensity	2	The impacts will have minor effects on water resources.	

Spatial scale	2	The impacts will be limited to the project site.	
Probability	2	The possibility of the impact occurring will be reduced due to the implemented mitigation measures.	

Dimension	Rating	Motivation	Significance
Impact: Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas			
Duration	5	The impact will likely occur for the life of the project	60- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localised extending across the site and to nearby downstream.	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will have low intensity	
Spatial scale	2	With proper management, the impact will be localised to sites where incidents occur	
Probability	2	The possibility of the impact occurring is very low as a result of implementation of adequate mitigation measures	

7.4.2 Operational Phase

Activities that might have potential impacts on surface water resources during the operational phase are indicated in Table 7-5. Table 7-6 further indicates the impact significance rating. This Section also describes the recommended mitigation/managements measures to limit the effects of potential identified impacts.

Table 7-5: Interactions and impacts of activities in the operational phase

Interaction	Impact
Operation of the Box Cut as a means for secure and safe entrance and access to the decline of the underground mine	Disruption of water flow paths will likely reduce the quantity of water reporting to the Vaalwaterspruit thereby affecting the availability of water for downstream water users
Overland flow and interflow from the dirty areas or catchments (coal stockpile areas, mine processing plant, workshops, lay down areas etc.). Hydrocarbon residues including oil, grease and fuel spillages from equipment, moving haulage trucks and machinery transported to watercourses.	Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas

7.4.2.1 Impact Description: Disruption of water flow paths will likely reduce the quantity of water reporting to the Vaalwaterspruit thereby affecting the availability of water for downstream water users

Operation of the Box Cut as a means for secure and safe entrance and access to the decline of the underground mine. The Box cut and mine shaft traverse through subsurface and vadose zone profiles where soil (A/B) and soil/bedrock interflow pathways are disrupted.

7.4.2.2 Impact Description: Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas

Overland flow and interflow from the dirty areas or catchments (coal stockpile areas, mine processing plant, workshops, lay down areas etc.). Hydrocarbon residues including oil, grease and fuel spillages from equipment, moving haulage trucks and machinery will likely be transported over the land and through interflow pathways towards the Vaalwaterspruit and its tributaries.

7.4.2.3 Management/Mitigation Measures

Recommended management/mitigation measures are as follows:

- Implementation of the proposed stormwater management plan to reduce sedimentation and siltation of nearby watercourses. The recommended perimeter berms around the discard dump, lay down areas, box cut, overburden dump and stockpiles will ensure that clean water is diverted from the dirty areas;

Similar to the construction phase the following should be conducted to mitigate contamination of water resources during the operation phase:

- Hydrocarbon waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;

- Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath; and
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors.

Table 7-6: Impact Significance Rating for Operational Phase

Dimension	Rating	Motivation	Significance
Impact: Disruption of water flow paths will likely reduce the quantity of water reporting to the Vaalwaterspruit thereby affecting the availability of water for downstream water users			
Duration	4	The impact will occur during the operation phase.	-49 Minor (negative)
Intensity	2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated with help of external consultants.	
Spatial scale	1	Limited to the box cut and mine shaft area	
Probability	7	The impact will occur.	
Post Mitigation			
There are no mitigation measures to prevent this impact from occurring, but the area to be affected by the box cut and mine shaft is relatively small making this impact of minor negative significance.			

Dimension	Rating	Motivation	Significance
Impact: Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas			
Duration	5	The impact will likely occur for the life of the project	60- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	

Dimension	Rating	Motivation	Significance
Spatial scale	3	The impacts will be localised extending across the site and to nearby downstream.	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will have low intensity	
Spatial scale	2	With proper management, the impact will be localised to sites where incidents occur	
Probability	2	The possibility of the impact occurring is very low as a result of implementation of adequate mitigation measures	

7.4.3 Decommissioning and Closure Phase

Table 7-7 indicates activities with potential impacts on soil-water resources during the decommissioning and closure phase. In addition, this section also details the ways in which these impacts can be mitigated or managed. Table 7-8 indicates the impact significance rating for the decommissioning phase.

Table 7-7: Interactions and Impact Activity

Interaction	Impacts
Demolition and removal of infrastructure	Sedimentation and siltation of nearby watercourses leading to reduced water quality
After decommissioning, dewatering ceases and water accumulates within the mine shaft and the water reacts with the pyrite in the backfilled material, thereby becoming acidified and starts decanting at low lying positions, including the adjacent Vaalwaterspruit.	Contamination of soil and water resources from potential decant of Acid Mine Drainage (AMD) and movement of contamination plume due to re-watering of the mine shaft

7.4.3.1 Impact Description: Sedimentation and siltation of water sources therefore affecting water quality and flow of streams

Infrastructure demolition and removal will result in debris and exposure of the soil, which may be transported to the nearest surface water resources through runoff. Thus, sedimentation and siltation of watercourses might result from such activities and consequently affecting streamflow and quality of receiving water resources.

7.4.3.2 Impact Description: Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the mine shaft

AMD occurs when water reacts with pyrites or sulphide compounds which are abundant in the coal layers (McCarthy, 2011)). After decommissioning, dewatering ceases and water accumulates within the shaft and the water reacts with the pyrite, becomes acidified and decants at low lying positions, including the Vaalwaterspruit.

7.4.3.3 Management/Mitigation Measures

The following mitigation/management measures are recommended:

- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Vaalwaterspruit.
- In the event of decanting, passive treatment (through application of calcium compounds) should be implemented to neutralise and treat the AMD before being discharged back into freshwater resources;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD;
- Alternatively, when passive treatment fails to correct the situation active Water Treatment (e.g. Reverse Osmosis) should be considered; and
- Post closure monitoring should be conducted for at least 5 years after decommissioning to help with the early detection of decant and prevent or reduce contamination of water resources.

Table 7-8: Impact Significance Rating for the Decommissioning Phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality			
Duration	5	The impact will likely occur during construction and decommissioning phases.	-90 Moderate (Negative)

Intensity	5	The impact will have serious, long-term impact on the ecosystem.	
Spatial scale	5	The impacts will go beyond the specified project area.	
Probability	6	It highly possible that it will occur.	
Post-mitigation			
Duration	5	The impact will likely occur throughout the project's life.	18-Negligible (negative)
Intensity	2	The impacts will have minor effects on water resources.	
Spatial scale	2	The impacts will be limited to the project site.	
Probability	2	The possibility of the impact occurring will be reduced due to the implemented mitigation measures.	

Dimensions	Rating	Motivation	Significance
Impact: Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the mine shaft			
Duration	7	The impact will potentially persist long after the project ceases.	-119 Major (Negative)
Intensity	6	The impact will have significant impacts on water resources and the environment.	
Spatial scale	4	The impacts will be felt around the mining area and immediate downstream of the project site.	
Probability	7	There is a high probability that this impact will take place.	
Post-Mitigation			
Duration	4	The impact has long-term duration	-63 Minor (Negative)
Intensity	3	Impact has the potential for serious effects on the environment, however, with proper management the adverse effects will be relatively low.	
Spatial scale	2	Limited to decant sites as decant will be intercepted for treatment before reaching wider extents	

Dimensions	Rating	Motivation	Significance
Probability	7	The impact will occur.	

7.5 Cumulative Impacts

Activities within and adjacent of the Arnot South MRA contribute to the interruption of hydropedological processes within hillslopes thereby influencing flow regimes in rivers and streams as well as affecting wetland and aquatic ecosystems. Historical and current land uses (i.e., agropastoral activities, infrastructure development and mining) has led to major geomorphological and hydropedological changes, vegetation loss, overgrazing, the contamination of soil and water resources and increased runoff and associated erosion processes.

The cumulative impacts have a significant effect on the soil-water resources and therefore impacting on hillslope processes which are essential to ensure sustainable river flow regimes and water storage in natural reservoirs including wetlands and pans. The proposed Arnot South Project will also add to these impacts when viewed at a regional scale.

8 Environmental Management Plan

This Section summarises proposed activities, potential impacts of the proposed activities, affected environmental aspects and associated mitigation measures. Table 8-1 details and summarises the frequency of mitigation, timing of implementation, the roles, and the responsible persons in ensuring the implementation of the EMP.

Table 8-1: Environmental Mangement Plan during the Life of Mine at the Proposed Arnot South Operations

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
Removal of vegetation / topsoil for establishment of mining infrastructure such as the haul roads, discard dump, offices, workshop and change houses, PCD, silt traps and lay down areas.	Sedimentation and siltation of watercourses due to increased soil erosion leading to reduced water quality	Water quantity and Quality	Construction	• Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones; • If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments and hazardous substances from construction vehicles used during site clearing; • Dust suppression with water on the haul roads and cleared areas must be undertaken to limit dust mobilisation which contribute to sedimentation of watercourses • Installation of the proposed stormwater management measures (e.g. perimeter berms around discard dump, overburden and stockpiles) to reduce sedimentation and siltation of nearby watercourses.	Control through restricting clearance or disturbance to the project footprint	During the construction phase
Moving vehicles and machinery during construction of infrastructure including haul roads, discard dump, offices, workshop and change houses, PCD, silt traps and lay down areas. Handling of hydrocarbon residues and spills during construction operations.	Contamination of water resources from hydrocarbon residues and spills	Water Quality	Construction	• Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills; • Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath; and • Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors.	Control through training personnel in proper waste handling measures, and through monthly water quality monitoring for the life of mine	During the construction phase
Operation of the Box Cut as a means for secure and safe entrance and	Disruption of water flow paths will likely reduce the quantity of water reporting to the Vaalwaterspruit	Water quantity	Operation	No mitigation	N/A	Operation phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
access to the decline of the underground mine	thereby affecting the availability of water for downstream water users					
Overland flow and interflow from the dirty areas or catchments (coal stockpile areas, mine processing plant, workshops, lay down areas etc.). Hydrocarbon residues including oil, grease and fuel spillages from equipment, moving haulage trucks and machinery transported to watercourses.	Pollution of water resources by pollutants conveyed through overland flow and interflow from contaminated areas	Water quality	Operation	Implementation of the proposed stormwater management plan to reduce sedimentation and siltation of nearby watercourses. The recommended perimeter berms around the discard dump, lay down areas, box cut, overburden dump and stockpiles will ensure that clean water is diverted from the dirty areas.	Control through implementation of the stormwater management plan and through monthly water quality monitoring for the life of mine.	During the operation phase
Demolition and removal of infrastructure After decommissioning, dewatering ceases and water accumulates within the mine shaft and the water reacts with the pyrite in the backfilled material, thereby becoming acidified and starts decanting at low lying positions, including the adjacent Vaalwaterspruit.	• Sedimentation and siltation of nearby watercourses leading to reduced water quality • Contamination of soil and water resources from potential decant of AMD and movement of contamination plume due to the re-watering of the backfilled pit	Water Quality and Water quantity	Decommissioning and closure	• Soil disturbances during demolition should be restricted to the relevant footprint area; • All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Vaalwaterspruit; • In the event of decanting, passive treatment (through application of calcium compounds) should be applied to neutralise and treat the AMD before being discharged back into freshwater resources; • Use of constructed wetlands can also be considered as a mitigation measure against AMD; • Alternatively, when passive treatment fails to correct the situation, active Water Treatment (e.g. Reverse Osmosis) should be considered; and • Post closure monitoring should be conducted for at least 5 years after decommissioning to help with the early detection of decant and prevent or reduce contamination of water resources.	Control through water quality monitoring; Remedy through passive treatment of AMD; and	During decommissioning and closure phase

9 Monitoring Programme

The monitoring program assists with the early detection of water contamination therefore, allowing mitigation or management strategies to be implemented at an early stage, thus minimising the potential impacts on water resources. Table 9-1 presents the proposed surface water monitoring plan to ensure sustainability of the mining activities within the proposed Arnot South Project and surrounds.

Table 9-1: Monitoring Plan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Ensure regular water quality monitoring in the proposed monitoring sites/locations. This includes water within the mining sites in cases of potential overflow and water discharges into the surface water. Examples of parameters to be monitored include Total Dissolved Solids, Total Suspended solids, pH, Electrical Conductivity; Sulphate; major cations (K, Ca, Mg & Na).	Monitoring should be done on monthly bases during construction, operation, and decommissioning. After that monitoring should be done at least five years after closure or until rehabilitation becomes sustainable.	Environmental Officer
Sedimentation and Siltation	Investigate the site after a rainfall event, during construction and demolishing to ensure that there is no erosion of soil which may lead to siltation and sedimentation of surface water resources. Rehabilitated sites should be inspected for any signs of erosion. Install filtration material or temporary silt fences and soil stabilizing blankets until vegetation has been established.	After rainfall events	Environmental Officer
Physical structures and Storm Water Management Plan (SWMP) performance	Facilities around the mine should be physically inspected and checked regularly for any anomalies/malfunctions and leakages.	It should be done frequently and continuously	Environmental Officer

Monitoring Element	Comment	Frequency	Responsibility
	Ensure that there is no blockage of inflows in stormwater channels, dams and pipelines in order to maintain good hydraulic conditions. The overall SWMP performance should be monitored to ensure its' effectiveness.		
Surface inspection during rehabilitation	Surface inspection should be done during rehabilitation until the vegetation cover is established to prevent erosion and sedimentation which will subsequently lead to topsoil loss, sedimentation and siltation of nearby watercourse.	It should be done frequently and continuously	Environmental Officer

10 Recommendations

The following is recommended based on findings of the hydropedological impact assessment:

- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments and hazardous substances from construction vehicles used during site clearing;
- Dust suppression with water on the haul roads and cleared areas must be undertaken to limit dust mobilisation which contribute to sedimentation of watercourses
- Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors.
- Implementation of the proposed stormwater management plan to reduce sedimentation and siltation of nearby watercourses. The recommended perimeter berms around the discard dump, lay down areas, box cut, overburden dump and stockpiles will ensure that clean water is diverted from the dirty areas;

- Soil disturbances during demolition should be restricted to the relevant footprint area;
- All decommissioning activities should be undertaken in a way to minimise disturbance of soils which will lead to erosion, sedimentation and siltation of the Vaalwaterspruit.
- In the event of decanting, passive treatment (through application of calcium compounds) should be implemented to neutralise and treat the AMD before being discharged back into freshwater resources;
- Use of constructed wetlands can also be considered as a mitigation measure against AMD;
- Alternatively, when passive treatment fails to correct the situation active Water Treatment (e.g. Reverse Osmosis) should be considered;
- Post closure monitoring should be conducted for at least 5 years after decommissioning to help with the early detection of decant and prevent or reduce contamination of water resources; and
- Placement of infrastructure should be outside of all hydrologically sensitive areas such as the wetland zone of regulation, pans and watercourses.

11 Reasoned Opinion of Whether the Project Should Proceed

Based on findings of the hydropedological assessment, there is no reason why the proposed Arnot South Project should not be undertaken, provided all recommended management and mitigation measures are implemented.

12 Conclusions

The Mining Right Boundary of the Arnot South Project stretches across three different quaternary catchments, namely B12A, B12B and X11A within the Olifants Water Management Areas (WMA 2) and Inkomati-Usuthu (WMA 3). The proposed development footprint is in Quaternary Catchment X11A which is drained by the Vaalwaterspruit in a South Westerly direction into the Komati River. Quaternary Catchments B12A and B12B are drained by the Klein- Olifants River, which is a tributary of the Olifants River. On average, the project site receives a Mean Annual Precipitation (MAP) of 685 mm. The project area has wet summers and dry winters as moderate to high volumes of rainfall are recorded from November to February. The Mean Annual Runoff (MAR) was calculated to be 55.02 mm which is approximately 8% of MAP. The region has a Mean Annual Evaporation (MAE) of 1358 mm which is much greater than the average MAP.

Identified soil forms within the Arnot South MRA include the Rensburg (Rg), Arcadia (Ar), Katspruit (Ka), Cartref (Cf), Witbank (Wb), Kroonstad (Kd), Avalon (Av), Mispah (Ms), Pinedene (Pn), Glencoe (Gc), Glenrosa (Gs), Clovelly (Cv) and Hutton (Hu). Hillslope crest positions are dominated by Hu and Cv soil forms which are classified as deep recharge soils. Soils within the midslope such as Av, Pd and Gc were classified as interflow soils in which lateral movement of water is dominant feeding the Vaalwaterspruit further down at footslope positions. Witbank soils were also encountered which represent a shallow recharge hydrological soil type. The riparian areas of the Vaalwaterspruit variably have shallow responsive Mispah and Glenrosa soils which are characterised by overland flow due to saturation from above and Rensburg, Katspruit, and Arcadia soils which are characterised by saturation excess overland flow.

Contribution of groundwater to surface water resources including wetlands was conceptually implied but not quantified during this phase of the study. Detailed hydropedological surveys should be conducted to assess subsurface hydraulic heads and hydraulic gradients to get insight into flow directions and establish whether there is any significant interaction between groundwater and surface water including wetlands within the study area. Since the proposed Arnot South Project is based on underground mining, no significant or extensive disruption of flow paths is envisaged.

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Appendix A: Impact Assessment Methodology

Impact Rating Methodology

The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

***Type of Impact** = **+1** (Positive Impact) or **-1** (Negative Impact)*

The weighting assigned to the various parameters for positive and negative impacts is provided for in the formula and is presented in Table 13-1. The probability consequence matrix for impacts is displayed in Table 13-2, with the impact significance rating described in Table 13-3.

Table 13-1: Surface water Impact Assessment Parameter ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
7	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project.	Certain/ Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate.	On-going and widespread positive benefits to local communities which improves livelihoods, as	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational	Likely The impact may occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
	Very serious widespread social impacts. Irreparable damage to highly valued items.	well as a positive improvement to the receiving environment.		life span of the Project.	
4	Serious medium-term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem functions. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years.	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.
2	Minor effects on biological or physical environment. Environmental damage can be	Low positive impacts experience by very few of population.	Limited Limited to the site and its	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
	rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.		immediate surroundings.		happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 13-2: Probability Consequence Matrix for Impacts

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 13-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which 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	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)

Score	Description	Rating
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. 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 social and/or natural environment.	Negligible (negative)
-36 to -72	An important negative impact which 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 social and/or natural environment.	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)
-109 to -147	A very serious negative impact which 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.	Major (negative)