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Hydropedology Assessment for the Amendment of the EMP and IWUL for the Dorstfontein East Coal Mine

Hydropedology Assessment

Prepared for:
Exxaro Coal (Pty) Ltd

Project Number:
EXX5725

September 2021

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EXECUTIVE SUMMARY

Exxaro Central Coal (Pty) Ltd holds an approved Mining Right with reference number **MP 30/5/1/2/3/2/1 (51) MR** for opencast and underground mining at the Dorstfontein East Coal Mine (DECM) situated in the Mpumalanga Province. The current study aims to extend the existing approved underground mining area (approved under the ownership of Total Coal South Africa (Pty) Ltd) and introduce supporting infrastructure to achieve this. Exxaro Central Coal aims to extend the underground mining area of the 2 Seam and 4 Seam associated with the Mining Right. This report is a hydropedological assessment to identify water flow paths in order to determine potential impacts on water resources resulting from the proposed mining development.

The project aims to expand the DECM's underground mining area within the existing Mining Right Areas (MRAs) MP30/5/1/2/51MR. Subsequently, additional coal reserves have been identified for mining which are not covered under the existing approval. Exxaro Central Coal is also approved to undertake underground mining of deeper coal reserves at DECM. The underground mining operations will be accessed from the existing Pit 2 open cast and Dorstfontein West operations. DECM therefore intends to further extend the Life-of-Mine (LoM) through the exploitation of these identified additional coal reserves between 2021 until 2034 (14 years). In addition, a portion of Pit 3, which is approved for opencast mining, will now be included into the underground mining extension. The Pit 3 coal reserves are contained in Seam 4. Additional surface infrastructure includes a sewage treatment plant, water treatment plant, water storage tank and a discard processing plant, which will be constructed on already disturbed land within the MRA.

The project site is characterised by a temperate climate with cool dry winters and warm summers. The Mean Annual Precipitation (MAP) for quaternary catchments B11B and B11D are 688 mm and 671 mm, respectively. The Mean Annual Evaporation (MAE) for quaternary catchments B11B and B11D are 1 587 mm and 1 647 mm, respectively (WRC, 2015). The region clearly experiences higher evaporation than precipitation, giving rise to dry winters and wet summers with a negative natural water balance. Dominant land uses include commercial annual rain-fed/ dryland cropping, fallow land & old fields (grass), fallow land & old fields (bare) and natural grassland.

During the desktop and field assessments, 565.8 ha of wetlands were identified within the study area. As per the most recent proposed underground mine plan, planned surface infrastructure affects 395.69 ha of wetlands. Twenty-four (24) HGM units and eight (8) dams were identified and categorized based on terrain units. These include depressions (pans), hillslope seeps, unchanneled valley bottoms, and channelled valley bottoms. Wetlands in the crest and mid-slope were typically characterized as Hillslope seeps and Unchanneled Valley Bottom Wetlands. A pan wetland was identified within the currently mined area. Wetlands in the middle slope, foot-slope, and bottomland were typically identified as valley bottom wetlands. Scattered dams in the project area and a large dam within a large valley bottom in the bottomland, were identified. These dams are typically used for irrigation, livestock

watering, and domestic use. Some of the wetlands were unimpacted by direct mining and agricultural activities, whereas other wetlands were almost completely mined out, fragmented, or cultivated.

Identified soil forms within the DECM project site include the Avalon (Av), Bainsvlei (Bn), Clovelly (Cv), Dresden (Dn), Wasbank (Ws), Glencoe (Ge), Hutton (Hu), Kroonstad (Kd), Longlands (Lo) and Pinedene (Pd). The dominant flow path at undisturbed hillslope catenas at the DECM project site is the interflow (A/B), which is characterized predominantly by lateral flow as a result of difference in soil texture which facilitates temporary build-up of water within the soil profile. The hillslopes at landscapes at the DECM site showed characteristics of Prolonged saturation as evidenced by mottles, concretions, and illuviation was observed during field hydropedological survey. The proposed project description indicates the expansion of underground mining operations and limited associated surface infrastructure within already disturbed parts of the MRA.

The impacts on the hydropedology (groundwater-surface water interaction) is not expected to be significant since no excavation on undisturbed land will be conducted and the proposed mining extension will be underground. Impacts will only be experienced at already disturbed areas where new surface infrastructure will be constructed and these impacts are rated negligible negative. Current conditions of wetlands in the area will likely not be significantly impacted on even by surface infrastructure since these will be constructed on already disturbed land.

The discard wash plant will be placed on a Witbank soil, which is a shallow recharge hydrological soil type. Any runoff from the discard wash plant should be conveyed to the PCD through HDPE lined channels to prevent or minimise contamination of groundwater resources.

The identified potential impacts during the construction phase include sedimentation and siltation of nearby watercourses due to vegetation clearing which will leave the soil prone to erosion. Additionally, handling of general and hazardous waste including spillages of hydrocarbons such as oils, fuels and grease have potential to contaminate nearby water resources when washed off into rivers, streams and pans. During the operational phase, the potential impacts relate to surface water contamination by runoff from dirty water areas and disruption of flow paths. During the decommissioning phase demolition of infrastructure, will cause disturbance and subsequent erosion of soils into nearby watercourses. Post closure, a positive impact is envisaged as water freely flows to downstream water users after re-profiling and re-vegetation of rehabilitated land, likely partially restoring hillslope subsurface and overland flows towards streams. Mined-out areas may be prone to subsidence, therefore, recommendations provided in the geotechnical report should be adhered to and adequately managed (ECC, 2021).

The following recommendations are proposed:

- Ongoing water quality monitoring of surface and groundwater monitoring is imperative during the life of mine to allow for early detection of potential contaminants that may cause unforeseen negative impacts on the receiving environment;

- It is recommended that the proposed management actions in this study be implemented to ensure that the identified risks are mitigated;
- Expansion into the undisturbed wetlands and interflow soils should be avoided as far as practically possible;
- The discard wash plant will be placed on a Witbank soil, which is a shallow recharge hydrological soil type. Any runoff from the discard wash plant should be conveyed to the PCD through HDPE lined channels to prevent or minimise contamination of groundwater resources;
- Any runoff from the discard wash plant should be conveyed to the PCD through HDPE lined channels to prevent or minimise contamination of water resources.; and
- Implementation of geotechnical recommendations should to be undertaken to ensure surface stability and to mitigate the potential risk of subsidence as a result of underground mining out of the coal seams within the DECM (ECC, 2021). It is essential that the ground is stabilized through the proposed bord and pillar mining method to stabilise the land and conserve the hydropedological recharge mechanisms as much as is practically possible.

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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
HGM	Hydro-Geomorphic
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)
S&EIR	Scoping and Environmental Impact Reporting
WMA	Water Management Area
WRC	Water Research Commission
WUL	Water Use Licence

1 Introduction

Exxaro Central Coal (Pty) Ltd (hereafter ECC) holds an approved Mining Right with reference number **MP 30/5/1/2/3/2/1 (51) MR** for opencast and underground mining at the Dorstfontein East Coal Mine (DECM) situated in the Mpumalanga Province. The current study aims to extend the existing approved underground mining area (approved under the ownership of Total Coal South Africa (Pty) Ltd) and introduce supporting infrastructure to achieve this. Exxaro Central Coal aims to extend the underground mining area of the 2 Seam and 4 Seam associated with the Mining Right. This report is a hydropedological assessment to identify potential impacts on soil-water resources resulting from the proposed mining development.

The proposed study area is situated within the Emalahleni Local Municipality, in the Nkangala District Municipality in the province of Mpumalanga. The closest town is Kriel which is approximately 10 km from the proposed project area (Figure 1-1).

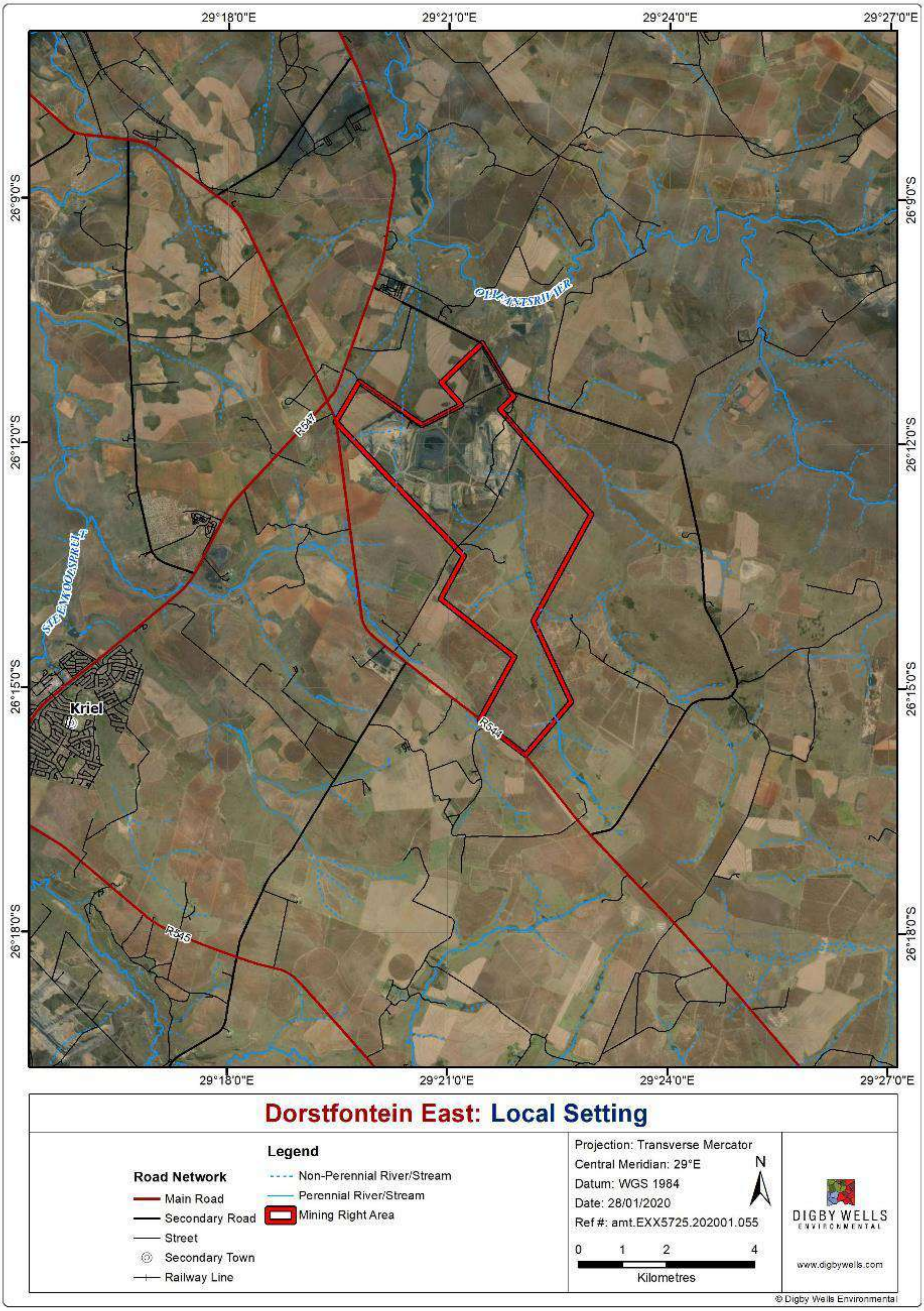

Figure 1-1: Locality of the DECM

2 Project Description

This application pertains to the expansion of underground mining and associated surface infrastructure. These activities are explained in more detail below.

2.1 Underground Mining

The project aims to expand the DECM's underground mining area within the existing Mining Right Areas MP30/5/1/2/51MR. DECM was previously owned by Total Coal South Africa (Pty) Ltd (Total) and was ceded to ECC on 20 August 2015 which has an approved Environmental Management Programme (EMPr), dated October 2017. Exxaro Central Coal is now applying to expand the underground mining areas as approved under Total. Subsequently, additional coal reserves have been identified for mining which are not covered under the existing approval. Exxaro Central Coal is also approved to undertake underground mining of deeper coal reserves at DECM. The underground mining operations will be accessed from the existing Pit 2 open cast and Dorstfontein West operations. Dorstfontein East Coal Mine, therefore, intends to further extend the Life-of-Mine (LoM) through the exploitation of these identified additional coal reserves between 2021 until 2034 (14 years).

In addition, a portion of Pit 3, which is approved for opencast mining, will now be included into the underground mining extension. The Pit 3 coal reserves are contained in both Seam 4 and Seam 2.

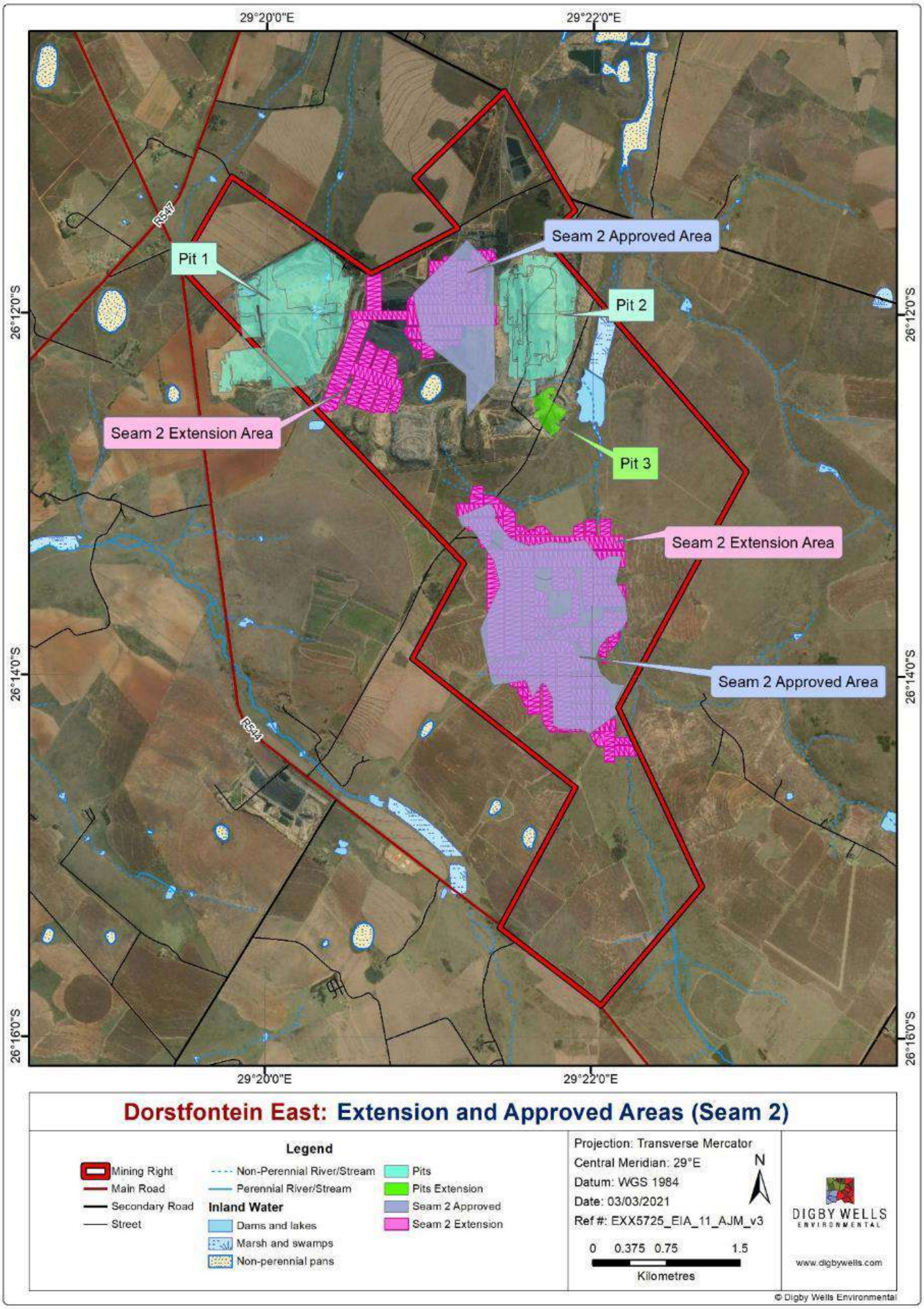

Figure 2-1: Approved and Proposed Underground Areas (Seam 2)

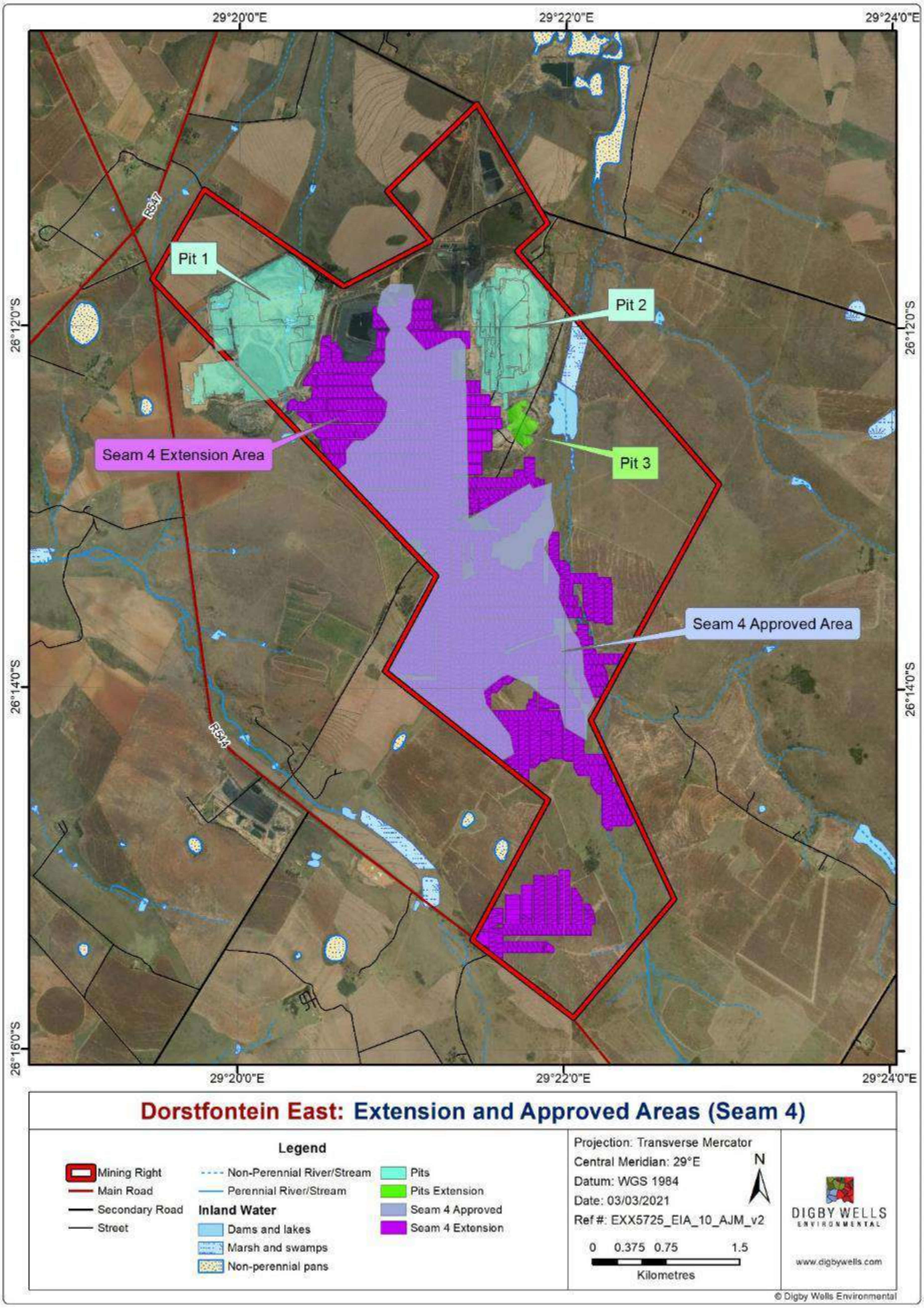

Figure 2-2: Approved and Proposed Underground Areas (Seam 4)

2.2 Additional Surface infrastructure

For the proposed expansion, DECM will require a new Sewage Treatment Plant, a new Water Treatment Plant, a water storage tank and a Coal Discard Processing Plant (CDPP), amongst other infrastructure (Figure 2-3).

2.2.1 Sewage Treatment Plant

DECM has an approved Sewage Treatment Plant (STP) on site, however, with the extension of underground operations additional sewage capacity is required. The plant will be located in a “dirty water area” in the main workshop and office area and will service up to 220 people per day. The treatment plant will require 45m^3 of water per day to process 16.2kg of organic load. The plant is 3m high, with a 2.3m diameter, with a 10m^3 volume. The STP will discharge into the existing pollution control dams (PCDs).

2.2.2 Water Treatment Plant

The proposed Water Treatment Plant is located north of the main workshop and office area, also within a previously disturbed area. The plant will treat domestic wastewater only, therefore, no gypsum or brine by-products will result from the treatment process. The effluent emanating from the plant will be collected by the existing pollution control dams (PCDs).

2.2.3 Water Storage tank

Water from the PCDs will be stored in a raw water tank with a capacity of 300m^3. This dirty water will be fed into the sewage treatment plant.

2.2.4 Discard Processing Plant

A coal discard processing plant has been additionally proposed to treat 100 kilotons per month (ktpm) of re-mined coal discard. The plant will process discard from both the existing discard dump and the coal handling and preparation plant (CHPP). The plant will also accommodate all future DECM discard production. The product will be transported to the plant feed stockpile area by means of truck haul and from there, fed into the plant through a conveyor.

Figure 2-3: Surface Infrastructure Layout

3 Relevant Legislation, Standards and Guidelines

The table below summarises the legal framework applicable to this hydropedology impact assessment. The assessment includes the opencast mining operations and the establishment of associated infrastructure within the DECM.

Table 3-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
National Water Act, 1998 (Act No. 36 of 1998)	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 DECM. The hydropedology study will form part of the impact assessment to minimize and remedy the pollution and degradation of the water resources in the proposed mining activities.
Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) All water uses listed in terms of Section 21 of the National Water Act (NWA) need to be licenced, unless it is a permissible water use in terms of Section 22 of the NWA.	The water use within the DECM does not constitute as permissible water use in terms of Section 22 of the NWA.
Regulation 7 of the General Authorisation for Section 21(c) and (i) water uses (GN R 509 of 2016) A risk assessment should be undertaken to determine whether the General Authorisation (GA) applies to Section 21 (a), (c), (f), (g), (i) and (j) water uses at DECM, or whether a WUL will be required	It is imperative to understand any potential residual impacts that might result from the proposed additional mining activities and associated infrastructure to ensure corrective measures are in place.
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 DECM.
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	The proposed mining activities trigger a licence and may result in the release of effluent or pollution of receiving waterbodies.

Legislation, Regulation, Guideline or By-Law	Applicability
commencement of that activity and to identify competent authorities in terms of sections 24(2) and 24D of the Act.	
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 in within the Act, unless the waste has been listed under the waste activities that do not require a waste management licence.	The proposed additional mining areas may result in waste that needs to be classified and handled appropriately.

4 Methodology

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

4.1 Desktop Assessment and Literature Review

The following literature and reports were reviewed for better understanding of hydrological processes within the DECM:

4.1.1 Wetlands Report

The wetlands report (Digby Wells , 2020) was reviewed as part of the hydropedology assessment to provide wetland delineations in the DECM which have an impact on the anticipated hydropedological functions. This report, therefore, must be read in conjunction with the wetland assessment report compiled as part of this study

4.1.2 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 P. , et al., 2011). Dominant streams are preferably used for delineation of the lower side boundary of the identified hillslopes (Le Roux P. , et al., 2011). The typical terrain units that were used in the land type classification are presented in Figure 4-1.

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.

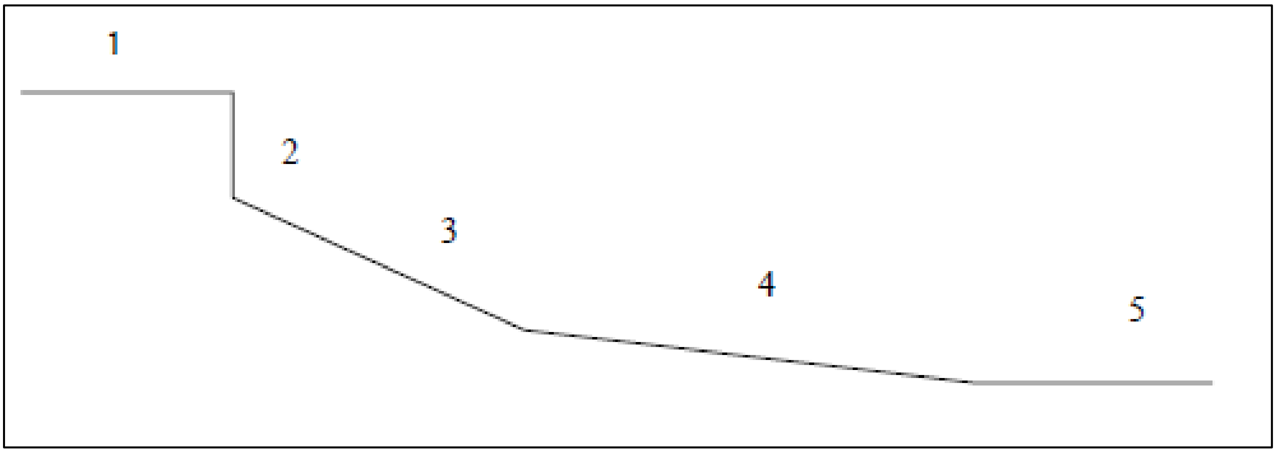

Figure 4-1: Terrain morphological units where 1= crest, 2= scarp, 3= midslope, 4= footslope, 5= valley bottom (Soil Classification Working Group, 1991)

4.1.3 Site Visit

The site visit was undertaken on 5 February 2020 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.

4.2 Hydrological Soil Types and Hillslope Hydrology

Knowledge of soil forms and their physical and chemical properties enables hydropedological classifications to be undertaken to determine hydrological soil types. A description of the different hydrological soil types is summarized in Table 4-1, while the typical arrangement of hydrological soil types on the hillslope is demonstrated in Figure 4-2.

Table 4-1: Hydrological Soil Types of the Studied Hillslopes (source: (van Tol J. , Le Roux, Lorentz, & Hensley, 2015))

Hydrological Soil Type	Description
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.
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates build-up of water in the topsoil. Duration of drainable water depends on rate of evapotranspiration, 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.

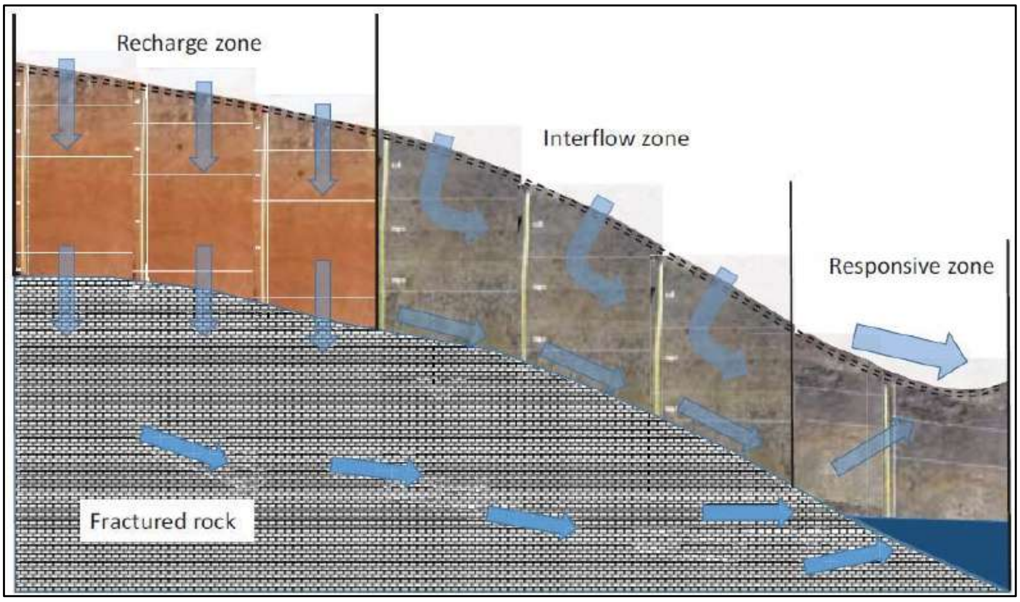

Figure 4-2: Example of hydrological flow paths on different hydropedological soil types – hillslope hydropedological behaviour

4.3 Impact Assessment

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

5 Findings

This Section details the findings of the hydropedology impact assessment.

5.1 Baseline Environment

The baseline environment within the DECM is detailed within this sub-section. This includes the climate, surface water hydrology, topography, land types and land use within the project area.

5.1.1 Climate

The project site is characterised by a temperate climate with cool dry winters and warm summers. The Mean Annual Precipitation (MAP) for quaternary catchments B11B and B11D is 688 mm and 671 mm, respectively. The combined average MAP for the two quaternary catchments is likely to be distributed as indicated in Figure 5-1. The normal rainfall (70% of events) for the wettest month (January) will likely not exceed 126 mm, while extreme rainfall (10% of the events) will likely not exceed 183 mm. This implies that the region experiences moderate to high rainfall.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Percentile	116	168	158	183	143	127	90	45	24	19	24	56
70 Percentile	89	139	133	126	105	92	50	20	6	4	11	27
50 Percentile	71	111	108	109	86	70	35	10	2	0	2	14
30 Percentile	49	82	86	88	66	53	24	4	0	0	0	7
10 Percentile	30	53	63	66	41	39	9	0	0	0	0	3

Figure 5-1: Monthly Rainfall Distribution

The Mean Annual Evaporation (MAE) for the quaternary catchments B11B and B11D is 1 587 mm and 1 647 mm, respectively (WRC, 2015). The region clearly experiences higher evaporation than precipitation, giving rise to dry winters and wet summers with a negative natural water balance. The average monthly distribution of potential evaporation and rainfall for both quaternary catchments can be seen in Figure 5-2.

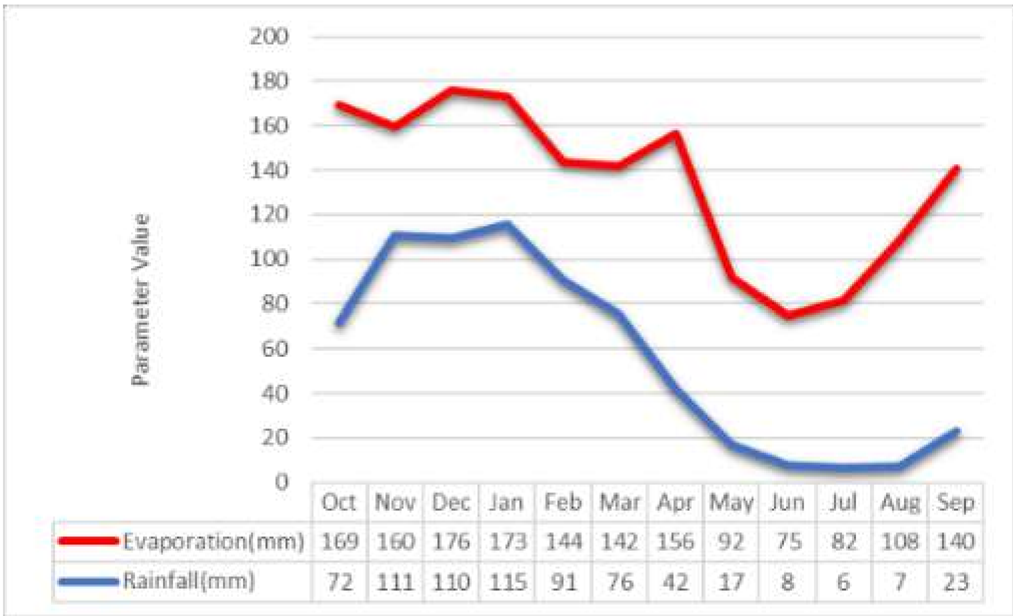

Figure 5-2: Monthly Evaporation and Rainfall

The Mean Annual Runoff (MAR) depth for the area was calculated to be 50.78 mm. This runoff accounts for approximately 7% of the MAP for the area. The 90th (extreme flow) and 70th (normal flow) percentiles of runoff during the month of January are 26.1 mm and 8.5 mm, respectively. The average MAR for quaternary catchments B11B and B11D is likely to be distributed as indicated in Figure 5-3.

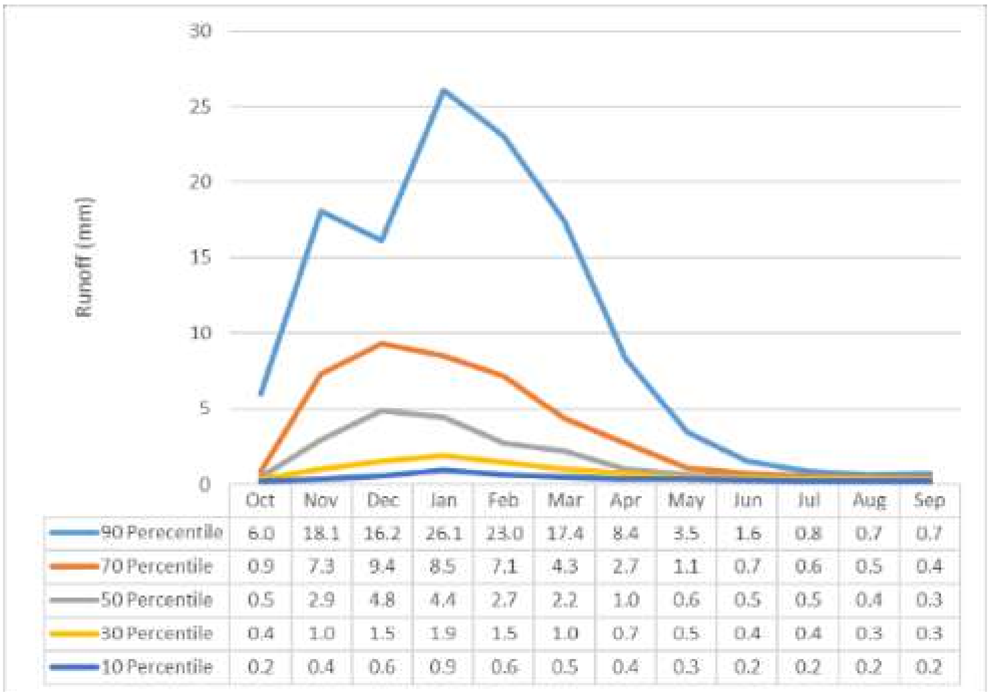

Figure 5-3: Monthly Runoff Distribution

5.1.2 Surface Water Hydrology and Topography

The elevation of the study area ranges between 1515 – 1660 mamsl (See Figure 5-4). The study area is dominated by gentle slopes and low-lying areas. The proposed open cast pits stretch from midslope to footslope positions within hillslopes.

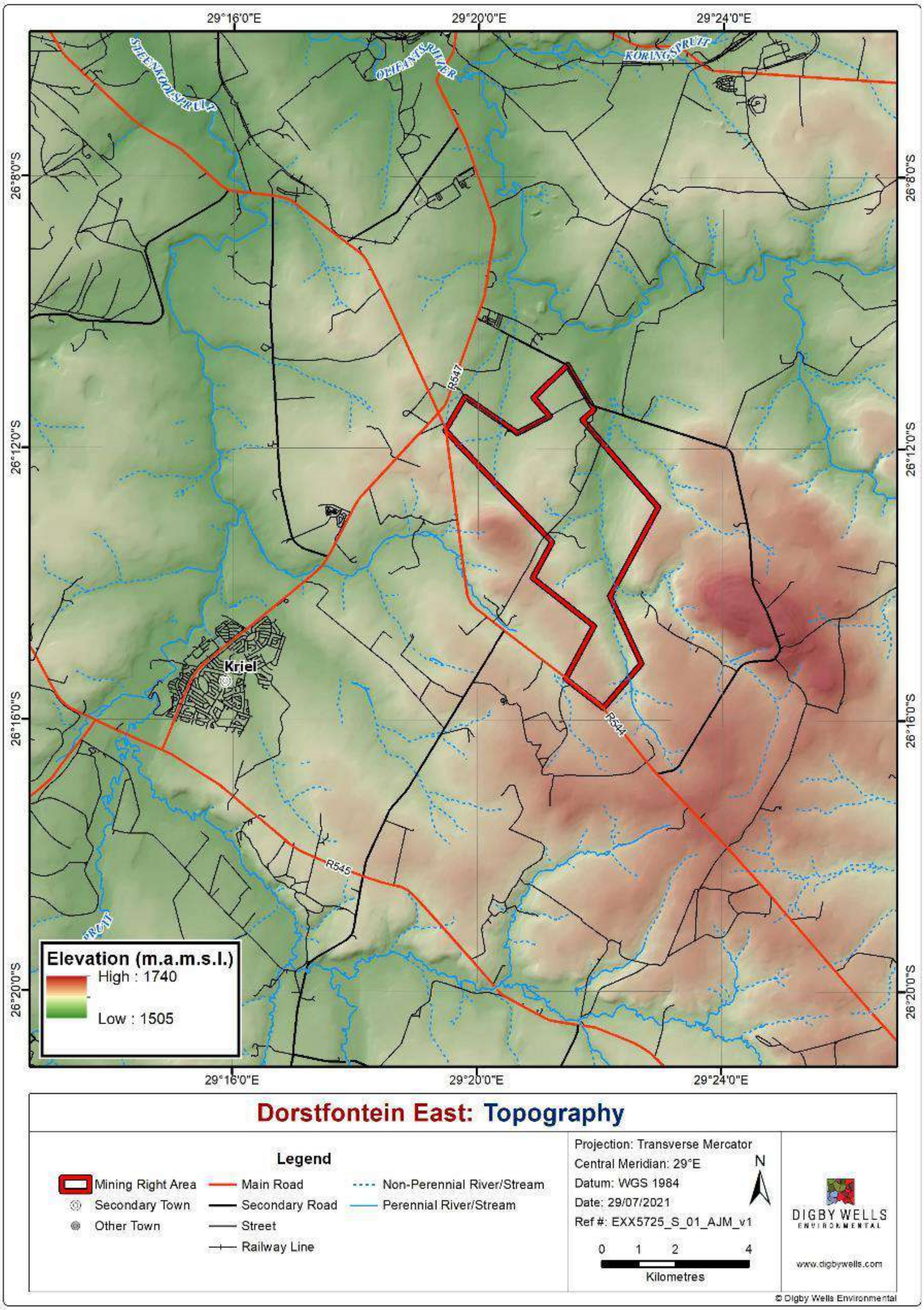

Figure 5-4: Elevation within the DECM

5.1.3 Land Type and Hydrological Soil Types

The dominant land type within the project boundary is land type Bb4. Portions of the study area are also occupied by land types Bb5 and Fa8 (See Figure 5-5). The terrain of the land types that are found within the study area are presented in Figure 5-6.

The expected soil forms within land type Bb4 include the Avalon, Hutton, Glencoe, Mispah, Longlands, Rensburg, Estcourt, Katspruit, Valsrivier, Arcadia, Sterkspruit and Kroonstad.

Within land type Bb5, expected soil forms include Mispah, Glenrosa, Hutton, Rensburg, Glencoe, Wasbank, Avalon, Valsrivier, Clovelly, Swartland, Katspruit, Estcourt, Longlands and Kroonstad.

Finally, the expected soil forms within land type Fa8 include Mispah, Clovelly, Hutton, Wasbank and Estcourt. Additionally, bare rocks and stream beds are expected within this land type.

Based on the diagnostic horizons and materials associated with the expected soil forms, the probable hydrological soil types can be summarized as follows:

- Recharge – Hutton, Clovelly;
- Interflow (A/B) – Estcourt, Longlands, Valsrivier, Sterkspruit, Glenrosa;
- Interflow (Soil/Bedrock) - Glencoe, Wasbank, Swartland;
- Responsive (Shallow) – Mispah, Arcadia; and
- Responsive (Saturated) – Avalon, Rensburg, Katspruit, Kroonstad.

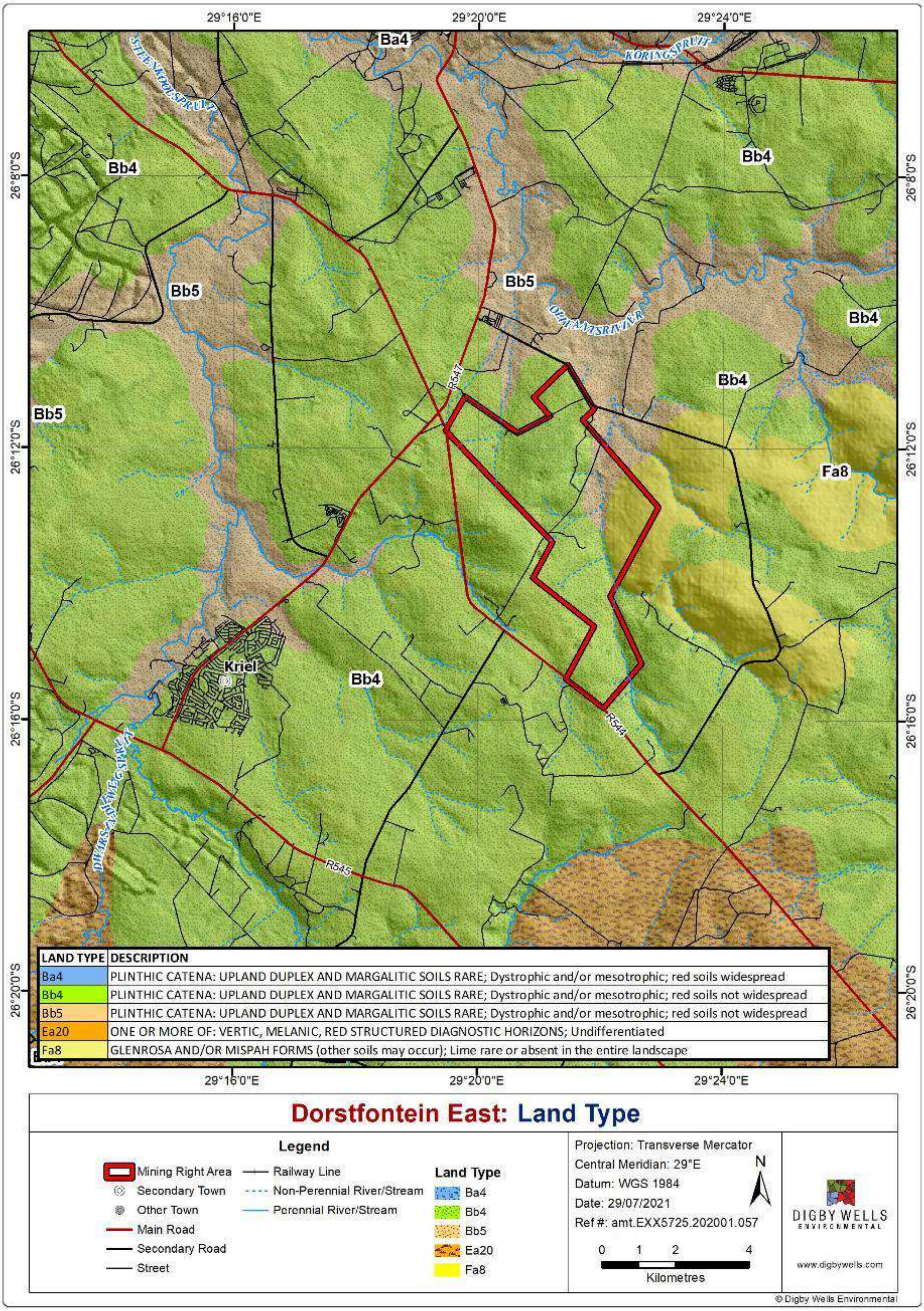

Figure 5-5: Land types within the DECM

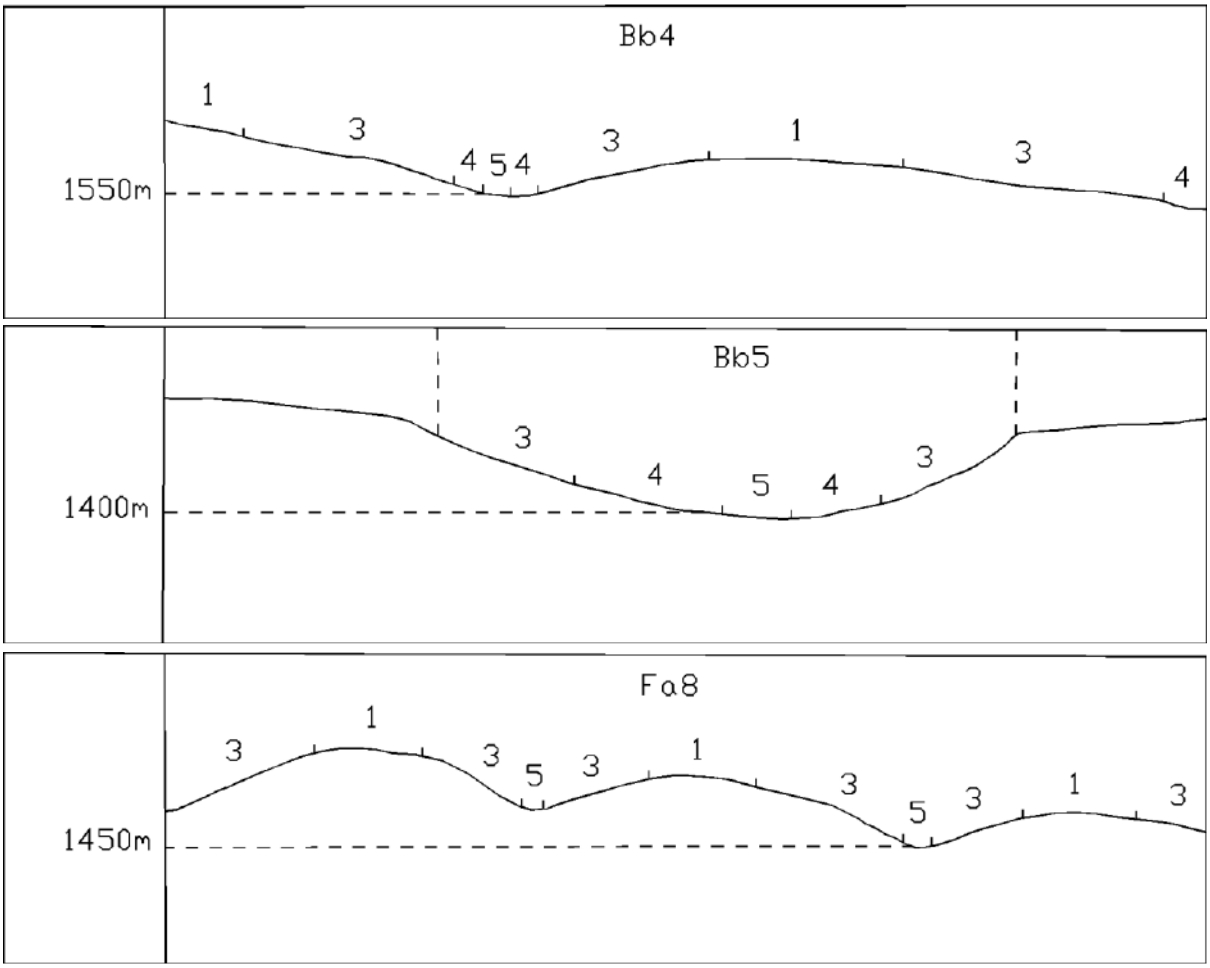

Figure 5-6: Terrain morphological units within the DECM project area

5.1.4 Land Use

The land uses associated with the DECM are indicated in Figure 5-7 below and include the following:

- Commercial annual crops rain-fed/ dryland;
- Fallow land & old fields (grass);
- Fallow land & old fields (bare);
- Natural grassland;
- Herbaceous wetlands (currently mapped);
- Herbaceous wetlands (previously mapped);
- Mines: extraction pits, quarries; and
- Mine: tailings and resource dumps.

The dominant land uses include commercial annual crops rain-fed/ dryland, fallow land & old fields (grass); fallow land & old fields (bare) and natural grassland as indicated in the figure below.

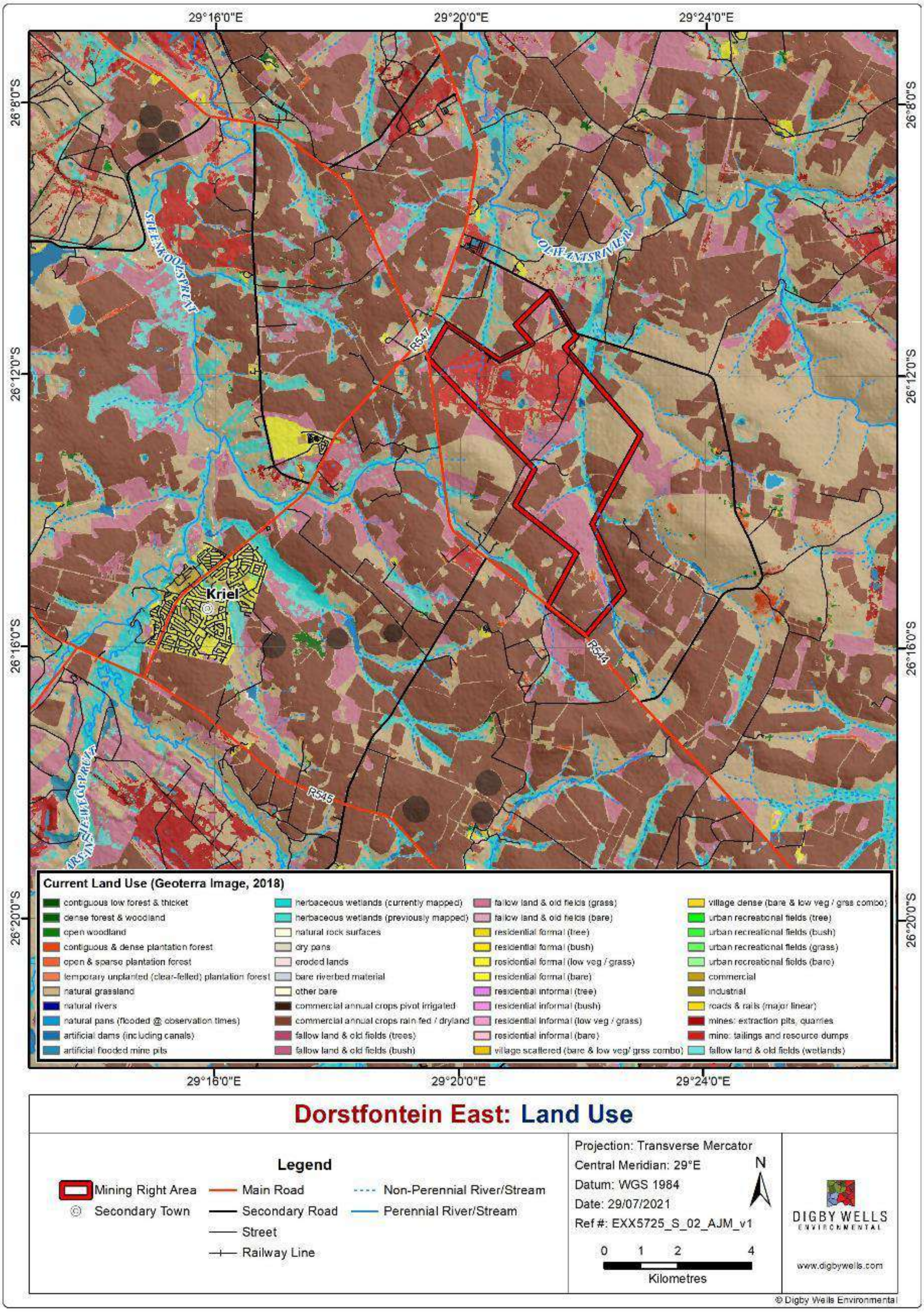

Figure 5-7: Land Uses within the DECM

5.2 Wetlands

A site visit was conducted in September 2019 (10th – 12th September 2019) to assess the ecological integrity, delineate the wetlands, and determine their Present Ecological State (PES), Ecological Services (ES) and Ecological Importance and Sensitivity (EIS) state. A more detailed description of the wetland environment can be found in the wetland report (Digby Wells , 2020).

During the desktop and field assessment, 565.8 ha of wetlands were identified within the project area (Table 5-1). As per the most recent proposed underground mine plan, surface infrastructure is planned and affects 395.69 ha of wetlands as indicated in Figure 5-8. Twenty-four (24) Hydro-Geomorphic (HGM) units and eight (8) dams were identified and categorized based on terrain units. These include depressions (pans), hillslope seeps, unchanneled valley bottoms, and channelled valley bottoms. Wetlands in the crest and mid-slope were typically characterized as Hillslope seeps and Unchanneled Valley Bottom Wetlands. A pan wetland was identified within the currently mined area. Wetlands in the middle slope, foot-slope, and bottomland typically identified as valley bottom wetlands. Scattered dams in the project area and a large dam within a large valley bottom in the bottomland were identified. These dams are typically used for irrigation, cattle watering, and domestic use.

Some of the wetlands were unimpacted by direct mining and agricultural activities, whereas some wetlands were almost completely mined out, fragmented, or cultivated.

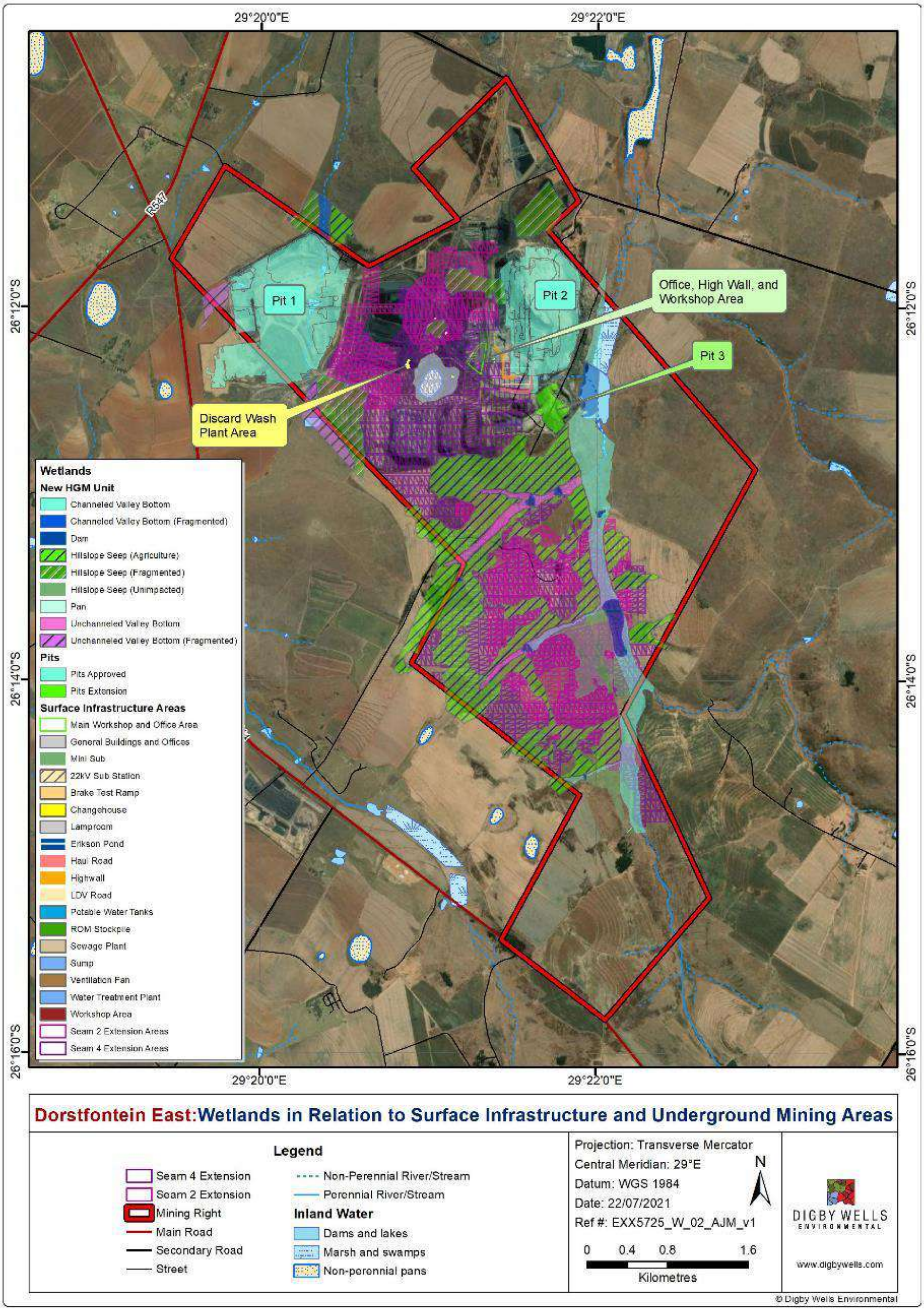

Figure 5-8: Wetland delineations within the DECM

Table 5-1: Combined HGM Units identified within the DECM

No.	Name	Acronym	Area (Ha)	Wetland and Ecological Health Assessment
1	Pan	Pan	15.9	The pan is located within the mine operational area. The entire catchment as well as the pan has been impacted by mining activities, changes to the hydrological functioning, increased AIPs, and excavations, and dumping was evident within the pan. Ecological functioning has been highly impacted by dominantly mining activities
2	Channelled Valley Bottoms	CVBs	90.9	The CVBs have mainly been impacted by agro-pastoral activities, including cattle grazing, dams, and cultivation. Large dams exist within the CVB, together with evidence of cattle trampling, erosion, and compaction. This impacted the natural hydrology, ground cover, and changes to the natural vegetation.
3	Channelled Valley Bottoms (fragmented)	CVBs Fragmented	4.4	In addition to the aforementioned, some of the CVBs have been fragmented by linear infrastructure, including mining activities, agro-pastoral activities as well as roads, powerlines, and fence lines. Fragmentation of wetlands impacts the natural habitat, functionality, and health of a wetland. Linear infrastructure within wetlands is prone to creating erosion, channelling, drying out of wetlands, and increased AIPs.
4	Unchanneled Valley Bottoms	UVBs	17.0	The UVBs within the project area were dominantly used for cattle grazing. There were no clear signs of channelling, erosion, or extensive cattle trampling. The vegetation was stable with little changes to water inputs to the systems. The systems were in a stable condition, well-functioning, and creating habitat for various fauna and flora species.
5	Unchanneled Valley Bottoms (fragmented)	UVBs Fragmented	19.3	Regardless of some of the UVBs being moderately impacted, some of the systems were fragmented by mining, agro-pastoral and linear infrastructure. Dams were also indicated in some of the systems. The fragmentation of the UVBs changes the natural habitat and health of the systems.
6	Hillslope Seep (Agriculture)	HS Agriculture	293.6	– The majority of the Hillslope Seep wetlands were used for agro-pastoral activities, including commercial cultivation and cattle grazing. The soils within Hillslope Seep wetlands (Hutton, Clovelly) are typically used for cultivation due do the decent water-holding-capacity, fertility, and soil depth. However, cultivation changes the natural vegetation, hydrological functioning as well as the geomorphology by ploughing, ripping, and tillage.
7	Hillslope Seep (Fragmented)	HS Fragmented	66.9	Regardless of some Hillslope Seeps being impacted by agro-pastoral activities, some of the seeps have been impacted by mining activities and linear infrastructure, including roads, dams, and powerlines. Some sections of the seeps have almost completely been removed by these activities or completely separated and cut off from the rest of the system.
8	Hillslope Seep (Unimpacted)	HS Unimpacted	39.6	Unimpacted Hillslope Seep wetlands were recorded within the project area . These wetlands were mainly used for cattle grazing, however, was well regulated and little erosion and impacts on the vegetation and geomorphology were noted.
*	Dams	Dams	18.2	
Total area			**565.8**	

*Dams are not regarded as an HGM unit, however, is included in the calculations due to forming part of other HGM units

5.3 Soil Forms and Hydrological Soil Types

Soil indicators including soil forms and soil wetness, such as mottling and gleying of soils, were used throughout the project area to identify and confirm wetlands. Low-lying areas within the project area showed increased clay content and soil wetness (Figure 5-9). These soils were identified as wetland soils (hydromorphic soils) and are saturated for long periods with a fluctuating water table, changing the morphology of the soils. 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). 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. Kroonstad and Glencoe soils consist of sandy, from yellow-brown B-horizons to bleached B-horizons indicating interflow soils, high drainage, and high leaching potential, however, these soils have a high leachability and often low in soil organic material.

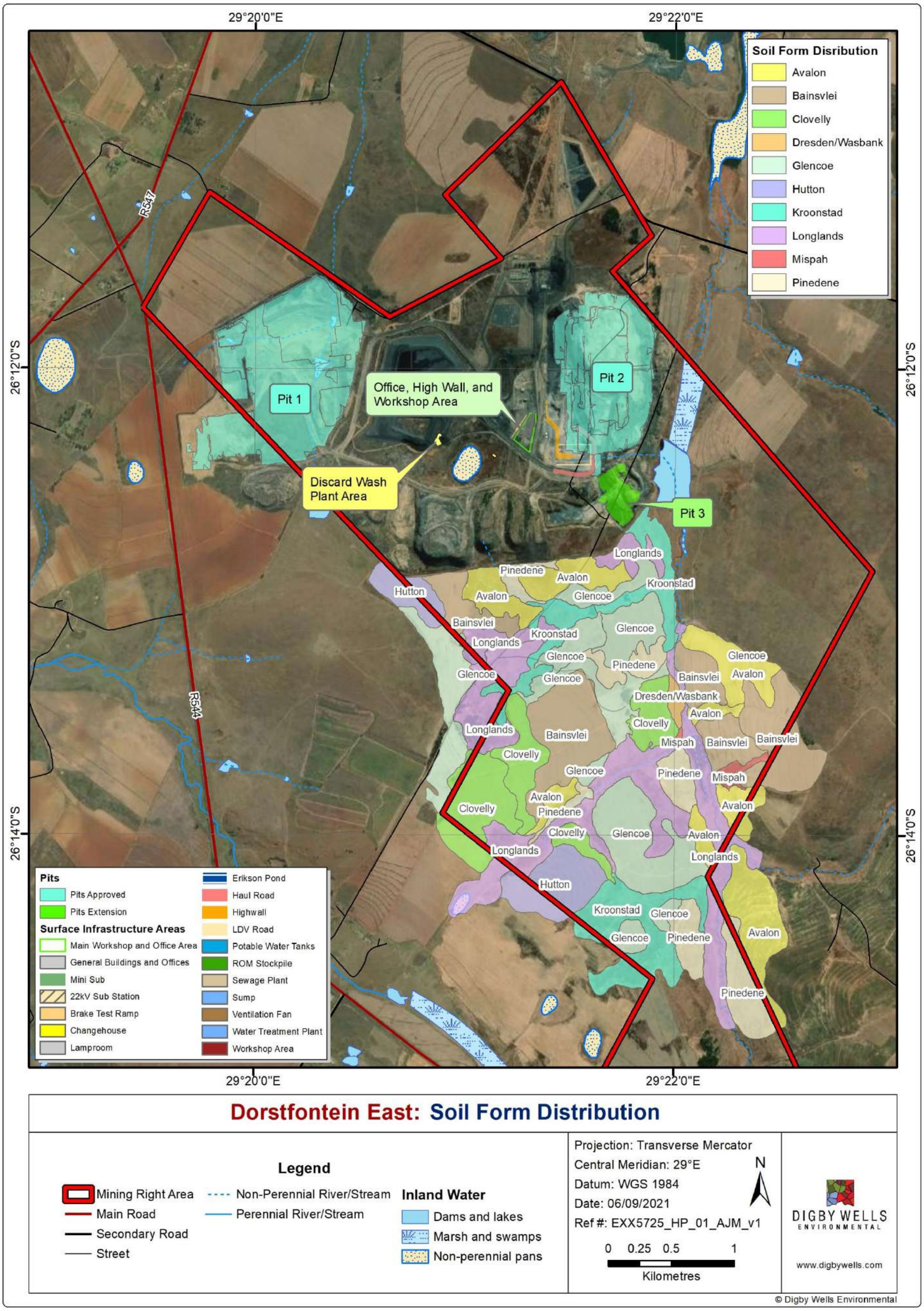

Figure 5-9: Identified Soil Forms within the DECM

Table 5-2: Observed Soil Cahrecteristics and Classified Soil Forms within the DECM

Soil Classification	Diagnostic Horizons	Observation	Hydropedological Soil Type
Avalon	Orthic A Yellow brown apedal B Soft plinthic B	The Avalon soils within the Study Area were very deep, sandy soils with a light-yellow soil matrix. The soils are mainly cultivated and found in the upper slopes. Soil wetness increased with soil depth due to increasing clay content and the semi-permeable soft plinthic B2-horizon. Accumulation of iron and manganese were observed, forming mottles around 800 mm depth.	Interflow (A/B)
Bainsvlei	Orthic A Red apedal B Soft plinthic B	The Bainsvlei soils were very deep, sandy soils with a dark, red soil matrix. The soils were mainly used for cultivation and found in the upper slopes. Soil wetness increased with soil depth due to increasing clay content and the semi-permeable soft plinthic B2-horizon. Accumulation of clay, iron, and manganese was observed within 800 mm depth.	Interflow (A/B)
Clovelly	Orthic A Yellow brown apedal B	The Clovelly Soil Forms within the project area were very deep, sandy soils mainly used for cattle grazing and perennial grassland. These soils are low in Soil Organic Material (SOM) and therefore not used for cultivation, but rather grassland. The Clovelly soils in the low-lying areas contained high clay content with soil depth and evidence of mottling due to a fluctuation water table indicating wetland soils.	Interflow (A/B)
Dresden/ Wasbank	Orthic A E horizon Hard plinthic B	The Dresden and Wasbank soils within the Study Area were found in the upland landscapes used for manly cattle grazing as these soils have restrictions for cultivation due to soil depth. The A-horizons are highly susceptible to erosion due to a lack of vegetation cover and stability. Large Iron and Manganese peds were observed on the surface of the soil. The soil depth of the B-horizon, in the lower-lying areas, increased, exceeding 350 mm, thus qualifying as a Wasbank soil form.	Interflow (Soil/ Bedrock)
Glencoe	Orthic A Yellow brown apedal B Hard plinthic B	Glencoe soil forms within the project area were predominantly shallow and had a restricting layer at 400 mm where the auger hit the Hard-plinthic layer. Large peds of Fe and Mn were evident on the soil surface as well as occurring through the soil profile. These areas were mainly used for grassland and cattle grazing. These shallow soils are not ideal for cultivation due to root development restrictions and low drainage potential.	Interflow (Soil/ Bedrock)
Hutton	Orthic A Red apedal B	The Hutton soil forms within the Dorstfontein project area were deep, sandy recharge soils with a maize crop cover. The soil profile contained small Iron and Manganese peds, indicating Ferricrete underlying geology. The soils had an increased clay content with depth together with soil wetness.	Recharge
Kroonstad	Orthic A E horizon G horizon	The Kroonstad soil forms within the Dorstfontein project area were widespread towards the wetlands and low-lying areas. The soils matrix of these soils was highly leached, low in SOM, and light in colour with clear indications of Fe and Mn mottles within the deeper horizons. The G-horizon contained high amounts of clay with clear signs of a fluctuating water table. The areas containing Kroonstad soil forms were mainly classified as wetlands and used for cattle grazing.	Responsive (Saturated)
Longlands	Orthic A E horizon Soft plinthic B	The Longlands soils within the study Area were deep, very sandy, and well-vegetated. Signs of wetness (mottles) were observed within the first 100 mm of the soil, indicating wetland soils. The soils were mostly found in the low-lying areas used for cattle grazing. The soils are susceptible to erosion and should be monitored.	Responsive Saturated)
Pinedene	Orthic A Yellow brown apedal B Unspecified material with signs of wetness	The Pinedene soils of the project area were generally high in clay content with clear signs of mottles within the first 500 mm of the profile (indicating wetland soils). The soils were very wet with a high water-holding-capacity. The yellow brown apedal B-horizon had clear indications of wetness with increasing clay content with depth. The soils in the B2 horizon were very wet and leached with a greyish soil matrix and red, yellow, and black mottles.	Interflow (A/B)

5.4 Dominant Hydrological Hillslopes in the DECM

The dominant flow path at the DECM is through the interflow (A/B), which is characterized predominantly by lateral flow as a result of difference in soil texture which facilitates temporary build-up of water within the soil profile (Figure 5-11). The hillslopes in the DECM showed characteristics of prolonged saturation as evidenced by mottles, concretions and illuviation. As indicated in Figure 5-10, most of the delineated hillslopes comprise the Interflow (A/B) and Responsive (Saturated) hydrological soil types. The dominant flow path indicates the potential impact on downstream wetland areas as a result of flow disruptions on upstream hillslope areas. In the case of DECM, there is already existing mine infrastructure.

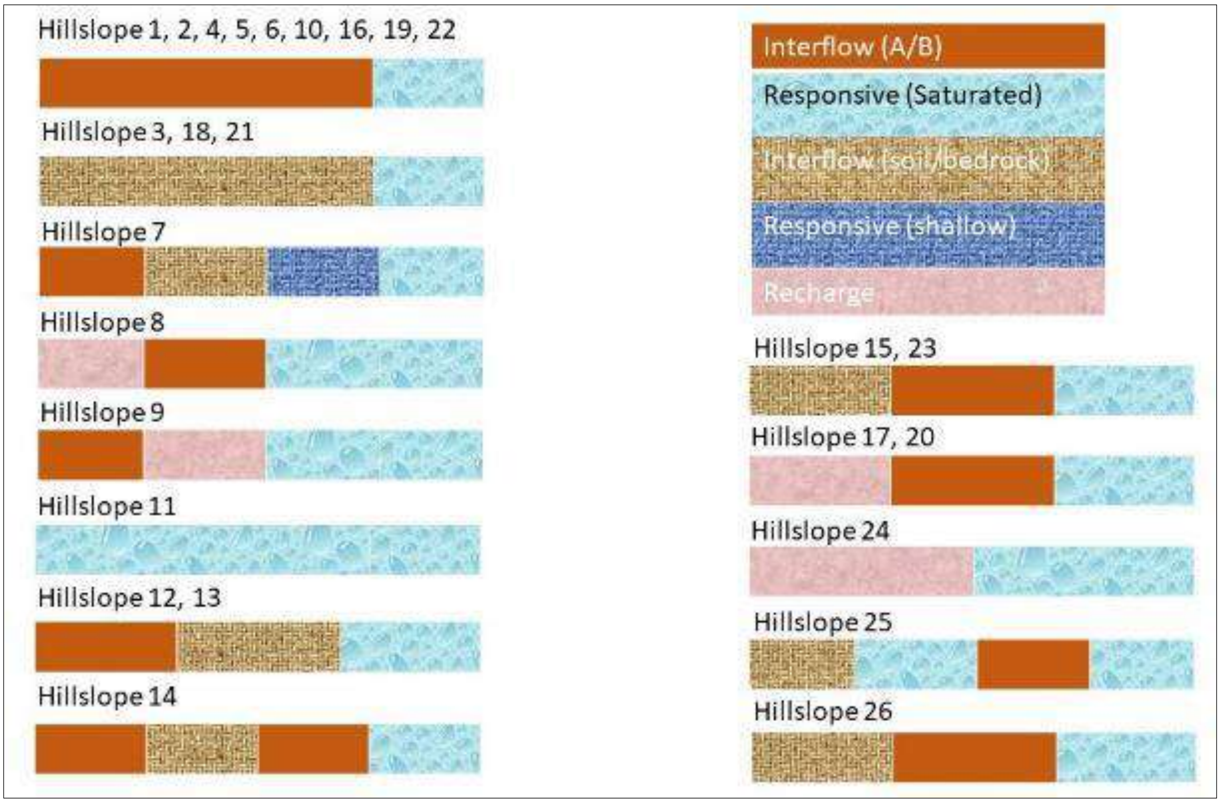

Figure 5-10: Conceptual Hillslope Classification at DECM within the Seam 2 and Seam 4 Extension Areas

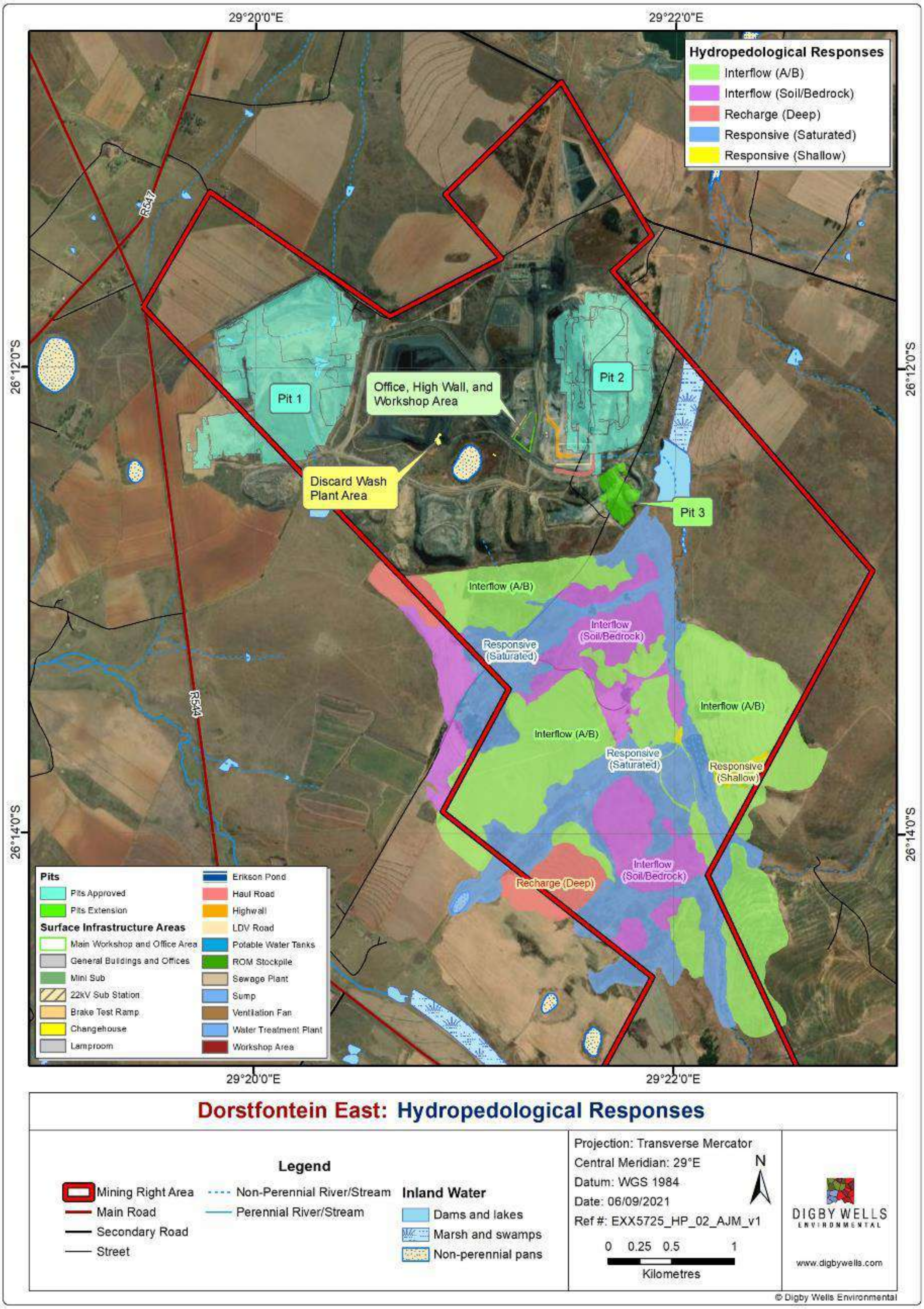

Figure 5-11: Hydrological Soil Types within the DECM

5.5 Hydropedological Implications of the Proposed Mining Activities

This section details the hydropedology implications of the proposed mining within the DECM site.

5.5.1 Expansion of Underground Workings and Proposed Discard Wash Plant

The expansion of underground workings will mostly be done on already disturbed areas and is not envisaged to result in significant losses of soil-water interactions that existed prior to the establishment of the existing underground workings.

The discard wash plant will be placed on a Witbank soil, which may be classified as a recharge hydrological soil type. Potential contamination of groundwater resources can be minimised by conveying contaminated water from this site through an HDPE lined channel to the PCD.

The dominant hydrological soil types within the proposed extension area are the interflow (A/B) and the responsive (Saturated). On undisturbed areas, the implication of this is that the proposed mining activities would result in the loss of wetland areas and reduce the amount of flow into the receiving non-perennial streams and subsequently into the Olifants River. However, the expansion of underground working will take place on already disturbed areas and is not envisaged to have significantly negative impacts of the soil-water interactions that were not already altered prior to the proposed expansion. The expected impact will be experienced on already disturbed areas where surface infrastructure is proposed, and these impacts are considered as negligible negative.

5.5.2 Establishment of Additional Surface Infrastructure

The layout of the proposed infrastructure will occur in an area that is dominated by hillslope seepage wetlands, which are fed predominantly through the interflow (A/B) interface which occurs predominantly in a lateral direction. The proposed mining area occurs in an area with several wetlands which will be impacted by the proposed mining and associated activities. However, it should be noted that all surface water infrastructure is planned to occur within already disturbed areas and therefore, this will not significantly disrupt the soil-water interactions as a result of surface infrastructure establishment.

6 Impact Assessment

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

6.1 Construction Phase

Activities during the construction phase that may have potential impacts (Table 6-1) on the soil-water interactions are described and the appropriate management/mitigation measures are provided below.

Table 6-1: Interactions and Impacts of Activity

Interaction	Impact
Construction of mining and associated surface infrastructure	The proposed construction may lead to fragmentation of wetlands and may also result in soil compaction.
Site preparation including vegetation clearance and excavations, leading to exposure of soils.	Siltation and sedimentation of water resources leading to deteriorated water quality.
Handling of hydrocarbons and other chemicals; Loading, hauling and transportation of product coal.	Contamination of water resources leading to deterioration of water quality.

6.1.1.1 Impact Description: Sedimentation and siltation of nearby watercourses

Clearing or removal of vegetation leaves the soils prone to erosion during rainfall events, and as a result runoff from these areas will be high in suspended solids increasing turbidity in the natural water resources.

Also, dust generated during the construction activities and caused by increased vehicle movements can also be deposited into the local water courses, thereby contributing to the accumulation of suspended solids in the water course, leading to the siltation of these water bodies.

6.1.1.2 Impact Description: Contamination of water resources leading to deterioration of water quality

Handling of general and hazardous waste including spillages of hydrocarbons such as oils, fuels and grease have potential to contaminate nearby water resources when washed off into rivers, streams and pans.

6.1.1.3 Management Objectives

Management objectives during the construction phase are mainly to minimize the potential contamination of receiving waterbodies as a result of siltation, hydrocarbon spillages, and hazardous chemical leaks associated with the construction activities.

6.1.1.4 Management Actions

- Buffer zones need to be delineated and established as specified in the Wetlands report (Digby Wells , 2020) to prevent the destruction of wetlands within DECM;
- Developments near undisturbed wetlands need to be avoided as much as possible;
- Rehabilitate the land to the most suitable post-mining land use;
- 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;

- Dust suppression on the haul roads and other cleared areas must be undertaken on regular basis to prevent or limit dust generation;
- 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 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.

6.1.1.5 Impact Ratings

The following tables rate the impacts for the construction phase:

Table 6-2: Impact Significance Rating for the Construction Phase

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses			
Duration	5	The impact will likely occur during construction	72- Minor (negative)
Intensity	4	Serious to medium term environmental effects	
Spatial scale	3	Impact has the potential to extend across the site and to nearby water resources.	
Probability	6	Almost certain that the impact will occur	
Post-mitigation			
Duration	2	The impact will only likely occur in the short term given implementation of recommended mitigation measures	18- Negligible (negative)
Intensity	2	Minor effects on biological or physical environment are expected if silt traps and soil stabilisation procedures are followed	
Spatial scale	2	With proper management, the impact will be localized to the immediate downstream of the site	
Probability	3	There is a possibility that the impact will occur	

Dimension	Rating	Motivation	Significance
Impact: Contamination of water resources leading to deterioration of water quality			
Duration	6	The impact will likely remain for some time after the life of the project	70 - Minor (negative)
Intensity	5	This may cause very serious, long-term impacts on the water quality and the ecosystem functionality for downstream users	
Spatial scale	3	The impacts will be localized extending across the site and 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 localized 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	

6.2 Operational Phase

Activities during the operational phase that may have potential impacts on the hydropedology interface are summarised in Table 6-3 and further described together with recommended management/mitigation measures in the following subsections.

Table 6-3: Interactions and Impact Activity

Interaction	Impact
Runoff from the dirty water areas or catchments (coal stockpile areas, mine processing plant, workshops etc.)	Surface water contamination and deterioration of water quality on the natural water resources
Hydrocarbons and chemicals spillages and leakages from equipment, moving haulage trucks and machinery	Water contamination by hydrocarbon waste and deterioration of water quality through runoff and potential groundwater contamination where leaks and spillages occur within recharge soils

6.2.1.1 Impact Description: Surface water contamination by runoff from dirty water areas

Surface water contamination may occur as a result of runoff from contaminated surfaces within the mine into nearby watercourses. The dirty water areas include coal stockpile areas, processing plant areas, workshop areas etc. The runoff generated from these areas will likely be contaminated and thus will have a detrimental effect on the water quality of nearby streams thereby affecting aquatic ecosystems and downstream water users.

6.2.1.2 Impact Description: Surface water contamination from hydrocarbon and chemical spillages and leakages

The operational machinery, transportation and storage at the mine site are potential sources of hydrocarbon and chemical spills and leakages. When not properly managed, hydrocarbon and chemical spills and leakages will be washed away with the runoff generated on site and thereby contaminate surface water resources within and in proximity to the study area.

6.2.1.3 Management Objectives

Management objectives during the operational phase are mainly to minimize the disruption of flow paths, potential contamination of receiving waterbodies as a result of mine contaminated runoff, hydrocarbon spillages, and hazardous chemical leaks associated with the operational activities.

6.2.1.4 Management Actions

The following mitigation measures are recommended:

- The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites;
- The overall housekeeping and storm water system management (including the maintenance of berms, de-silting of dams and conveyance channels and clean-up of leaks) must be maintained throughout the LoM;
- The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances;
- Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended; and
- Vehicles must only be serviced within designated service bays.

6.2.1.5 Impact Ratings

The following tables rate the impacts for the operational phase:

Table 6-4: Impact Significance Rating for Operational Phase

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination by runoff from dirty water areas			
Duration	3	The impact will remain for a medium to short term	60-Moderate (negative)
Intensity	5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate	
Spatial scale	4	The impacts will likely extend to watercourses in the whole municipal area affecting downstream water users	
Probability	5	The impact may occur if no measures are put in place	
Post-mitigation			
Duration	2	The impact will not last long post mitigation	18-Negligible (negative)
Intensity	2	Proper and continued implementation of storm water management plan and water quality monitoring will lower the intensity of the contaminated runoff impact on proximal water resources	
Spatial scale	2	Limited spatial extent if mitigation measures are adequately implemented	
Probability	2	The possibility of the impact occurring is very low if mitigation measures are adequately implemented	

Dimension	Rating	Motivation	Significance
Impact: Surface water Contamination from hydrocarbon and chemical spillages and leakages			
Duration	5	The impact will likely occur for the duration of the operational phase	72- Minor (negative)
Intensity	4	Moderate impacts to water quality and ecosystem functionality are expected	
Spatial scale	3	The impact may extend across the site and to nearby settlements if contaminants are washed into proximal watercourses	
Probability	6	It is most likely that the impact will 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 intensity will be low	
Spatial scale	2	With proper management, the impact will be localised to incident sites, where contaminants will quickly be cleaned up	
Probability	2	The possibility of the impact occurring is very low if mitigation measures re adequately implemented	

6.3 Decommissioning and Closure Phase

Activities during the decommissioning and closure phase that pose potential impacts on surface water resources are summarised in Table 6-5 and further described together with recommended management/mitigation measures in the following subsections.

Table 6-5: Interactions and Impact Activity

Interaction	Impact
Demolition of mine infrastructure (PCDs, workshops, haul roads, processing plant etc.) Disturbance of soils and erosion by overland flow	Sedimentation and siltation of nearby watercourses and deterioration of water quality
Rehabilitation of disturbed sites close to pre-mining conditions	Restoration of pre-mining streamflow regime in nearby watercourses
Potential risk of subsidence	The mined-out areas may be prone to subsidence

6.3.1.1 *Impact Description: Sedimentation and siltation of nearby watercourses and deterioration of water quality*

During the decommissioning phase demolition of infrastructure, will cause disturbance and subsequent erosion of soils into nearby watercourses. This will result in higher rates of sedimentation and siltation in nearby streams thereby reducing their flow/storage capacities and their ability to sustain aquatic ecosystems. The quantity and quality of water for downstream water users will thus be compromised if the activities are not properly managed.

6.3.1.2 Impact Description: Improvement of streamflow regime in nearby watercourses

In accordance with the Government Notice 704 (GN 704) of the NWA, the mine is required to separate clean and dirty water to prevent contamination of the clean water resources. Dirty water is required to be contained on site for re-use in mine processes or allowed to evaporate. In pre-mining period, this is the runoff which could have been reporting to natural streams, so containment of dirty water runoff in the mine reduces the amount of runoff reporting to downstream segments of the study area. A decrease in the catchment yield may have an impact on downstream water users as they may not have sufficient water for their needs, while also decreasing the required natural ecological flows. A positive impact is thus envisaged as water freely flows to downstream water users due to restoration of higher streamflow regime close to pre-mining conditions.

6.3.1.3 Impact Description: Potential risk of land subsidence leading to disturbance of water flow paths

The mined-out areas may be prone to subsidence as described in the geotechnical report for the DECM (ECC, 2021). If subsidence occurs, this will affect water flow paths which feed wetlands.

6.3.1.4 Management Objectives

The management objectives for the decommissioning and closure phase are to minimize potential contamination of receiving waterbodies as a result of the associated decommissioning activities. Furthermore, strategic removal of surface infrastructure should be implemented so that potentially contaminated runoff is diverted away from designated clean water areas. This may be achieved by temporarily retaining stormwater infrastructure to divert dirty water from clean areas while the potentially contaminating sources are decommissioned.

6.3.1.5 Management Actions

The following mitigation measures are recommended:

- Restore the topography to pre-mining conditions as much as is practically possible by backfilling, removing stockpiles and restore the slope gradient and angle of the site;
- Immediate revegetation of cleared areas;
- Where practical, decommissioning activities should be prioritized during dry months of the year (May to September);
- Movement of demolition machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance;
- Use of accredited contractors for removal or demolition of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages;

- Ensure that the infrastructure (pipelines, fuel storage areas, pumps) are first emptied of all residual material before decommissioning;
- Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site;
- If decant occurs post-closure, passive treatment with lime or other alkaline compounds can be applied to neutralise AMD at the decant points;
- If decant occurs, the decant needs to be captured, contained and treated to acceptable or prescribed water quality standards prior to discharge into the natural water resources; and

- Mined-out areas may be prone to subsidence, therefore, recommendations provided in the geotechnical report should be adhered to and adequately managed (ECC, 2021). It is essential that the ground is stabilized through the proposed bord and pillar mining method to stabilise the land and conserve the hydropedological recharge mechanisms as much as is practically possible.

6.3.1.6 Impact Ratings

The following tables rate the impacts for the decommissioning and closure phases:

Table 6-6: Impact Significance Rating for Decommissioning Phase and Closure Phase

Dimension	Rating	Motivation	Significance
Impact: Deterioration of water quality of receiving waterbodies caused by hydrocarbon waste and other contaminants			
Duration	5	The impact will likely occur throughout the decommissioning phase.	84- Moderate (negative)
Intensity	4	Moderate impacts to water quality and ecosystem functionality are expected.	
Spatial scale	3	The impact may extend across the site and to nearby settlements if contaminants are washed into proximal watercourses.	
Probability	7	It is most likely that the impact will occur.	
Post Mitigation			
Duration	5	The impact will likely occur during the decommissioning phase.	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact intensity will be low.	

Dimension	Rating	Motivation	Significance
Spatial scale	2	With proper management, the impact will be localised to incident sites, where contaminants will quickly be cleaned up.	
Probability	2	The possibility of the impact occurring is very low if mitigation measures re adequately implemented.	

Dimension	Rating	Motivation	Significance
Impact: Restoration of pre-mining streamflow regime in nearby watercourses			
Duration	7	Permanent benefits are anticipated once closure and recharge has been undertaken.	90- Moderate (positive)
Intensity	5	On-going and widespread benefits to local communities are anticipated over time.	
Spatial scale	3	The extent of the benefits will extend across the site and to nearby settlements.	
Probability	6	The impact is highly probable.	

Dimension	Rating	Motivation	Significance
Impact: Potential risk of subsidence			
Duration	7	The impact will remain beyond the life of the project.	96-Moderate (negative)
Intensity	5	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem.	
Spatial scale	4	The impacts will be localized to the immediate surroundings of the mine site.	
Probability	6	It is most likely that the impact will occur.	
Post-mitigation			
Duration	6	The impact will occur beyond the Life of Mine	40-Minor (negative)
Intensity	2	With proposed mitigation measures, the impact will have low to moderate intensity	
Spatial scale	2	Limited to the site and its immediate surroundings.	

Dimension	Rating	Motivation	Significance
Probability	4	It is probable that the impact will occur.	

7 Cumulative Impacts

Surrounding land uses in proximity to the DECM include commercial cultivation and cattle grazing which have contributed to the degradation of the present wetlands within the project area. Additionally, the existing mining activities have also contributed to land use change, resulting in the loss of the valuable ecological functions provided by the wetlands within the study area.

The proposed extension of the underground mining is, however, not expected to significantly increase impacts on the hydropedology of the DECM project area. This is because the proposed surface infrastructure will be placed on already disturbed areas and mining extension will be conducted underground, as mentioned. Cumulative impacts will, therefore, be negligible on the nearby water resources especially with the implementation of proposed mitigation measures.

8 Environmental Management Programme

This section provides a summary of the proposed project activities, environmental aspects and impacts on the receiving surface waterbodies. The frequency of mitigation, timing of implementation, the roles and responsibilities of persons implementing the EMrP are summarized (Table 8-1).

Table 8-1: Environmental Management Programme during the Life of Mine within the DECM

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
Construction of mining infrastructure including vegetation clearance, construction of access roads and associated infrastructure	• Disruption of flow paths • Soil erosion and compaction • Water quality degradation due to the use of hydrocarbons and other waste products	• Wetland ecosystems • Nearby watercourses • Water quality	Construction and site establishment phase	• Buffer zones need to be delineated and established as specified in the Wetlands report (Digby Wells , 2020) to prevent the destruction of wetlands within DECM; • Developments near undisturbed wetlands need to be avoided as much as possible; • Rehabilitate the land to the most suitable post-mining land use; • 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; • Dust suppression on the haul roads and other cleared areas must be undertaken on regular basis to prevent or limit dust generation; • 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 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 the impacts within the DECM by implementation of the proposed mitigation measures during the construction and site establishment phases	During the construction phase

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
Mine operational activities including blasting where necessary, use and maintenance of mining machinery	• Geotechnical instability as a result of mining out the underground coal seams may result in disruption of flow paths which feed downstream wetlands • Deteriorating water quality as a result of handling waste products and hydrocarbons associated with the proposed mining activities	• Surface topography • Flow paths within the DECM • Water quality of nearby watercourses	Operational phase	• The cutting sequence should live pillars in place to ensure that the supporting roof are stable and safe during the operational phase of the mining operation. • The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites; • The overall housekeeping and storm water system management (including the maintenance of berms, de-silting of dams and conveyance channels and clean-up of leaks) must be maintained throughout the LOM; • The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances; • Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended; and • Vehicles must only be serviced within designated service bays.	Control the impacts within the DECM by implementation of the proposed mitigation measures during the operational phase	Operational phase

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
Decommissioning and Closure	Contamination of receiving waterbodies	Nearby watercourses	Decommissioning phase	• Restore the topography to pre-mining conditions as much as is practically possible by backfilling, removing stockpiles and restore the slope gradient and angle of the site; • Immediate revegetation of cleared areas is recommended; • Decommissioning activities should be prioritized during dry months of the year (May to October) where practical; • All leaks and spillages should be cleaned as soon as possible and disposed of by accredited vendors; • Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; • The constructed stormwater management infrastructure should remain intact until post closure to ensure dirty water is captured and contained during removal of infrastructures; • Ensure that the infrastructure (pipelines, fuel storage areas, pumps) are first emptied of all residual material before decommissioning; • Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site; • An appointed Environmental Control Officer (ECO) must always be available to ensure implementation of the recommended mitigation/management measures during the planned decommissioning of the project.	Control contamination of receiving waterbodies by strategic decommissioning and removal of infrastructure to minimize potential environmental impacts and through continued water quality monitoring 5 years post closure.	During the decommissioning and closure phases

9 Recommendations

The following recommendations are applicable within this hydropedological impact assessment:

- Ongoing water quality monitoring of surface and groundwater is imperative during the life of mine and post-closure to allow for early detection of potential contaminants that may cause unforeseen negative impacts on the receiving environment;
- It is recommended that the proposed management actions in this study be implemented to ensure that the identified risks are mitigated;
- Concurrent rehabilitation, where applicable, is recommended throughout the proposed mining to promote vegetation cover and to preserve the topography as much as practically possible for the best post-mining land use;
- Expansion of surface infrastructure into the wetlands and interflow soils should be avoided;
- The discard wash plant will be placed on a Witbank soil, which is a shallow recharge hydrological soil type. Any runoff from the discard wash plant should be conveyed to the PCD through HDPE lined channels to prevent or minimise contamination of groundwater resources; and
- Mined-out areas may be prone to subsidence, therefore, recommendations provided in the geotechnical report should be adhered to and adequately managed (ECC, 2021). It is essential that the ground is stabilized through the proposed bord and pillar mining method to stabilise the land and conserve the hydropedological recharge mechanisms as much as is practically possible.

10 Reasoned Opinion Whether Project Should Proceed

Based on the hydropedological impact assessment and proposed mitigation measures it is the opinion of the specialist that the project should proceed provided that the mitigation measures are adequately implemented.

11 Conclusions

This hydropedological assessment was undertaken for the amendment of the Environmental Management Programme (EMPr) and Integrated Water Use License (IWUL) for and the expansion of underground mining and associated infrastructure at the Dorstfontein East Coal Mine (DECM) in the Mpumalanga Province, South Africa.

During the desktop and field assessment, 565.8 ha of wetlands were identified within the study area and the planned surface infrastructure affects 395.69 ha of wetlands. The identified HGM units include depressions (pans), hillslope seeps, unchanneled valley bottoms, and channelled valley bottoms. Some of the wetlands were unimpacted by direct mining and agricultural activities, whereas some wetlands were almost completely mined out, fragmented, or cultivated.

Identified soil forms within the DECM project site include the Avalon (Av), Bainsvlei (Bn), Clovelly (Cv), Dresden (Dn), Wasbank (Ws), Glencoe (Ge), Hutton (Hu), Kroonstad (Kd), Longlands (Lo) and Pinedene (Pd). The dominant flow path at the DECM is through the interflow (A/B), which is characterized predominantly by lateral flow as a result of difference in soil texture which facilitates temporary build-up of water within the soil profile. The hillslopes in the DECM showed characteristics of prolonged saturation as evidenced by mottles, concretions, and illuviation. The dominant flow path indicates the potential impact on downstream wetland areas because of flow disruptions on upstream hillslope areas. The proposed project description indicates the expansion of underground mining operations and limited associated surface infrastructure within already disturbed parts of the MRA.

The proposed mining activities in seam 2 and seam 4 will occur in an area that is dominated by hillslope seepage wetlands, which are fed predominantly through the interflow (A/B) interface which occurs predominantly in a lateral direction. The impacts on the hydropedology (groundwater-surface water interaction) is not expected to be significant since no extensive excavation on undisturbed land will be conducted and the proposed mining extension will be underground. Current conditions of wetlands in the area will likely not be significantly impacted on even by surface infrastructure since these will be constructed on already disturbed land.

The identified potential impacts during the construction phase includes sedimentation and siltation of nearby watercourses due to vegetation clearing which will leave the soil prone to erosion. Additionally, handling of general and hazardous waste including spillages of hydrocarbons such as oils, fuels and grease have potential to contaminate nearby water resources when washed off into rivers, streams and pans. During the operational phase, the potential impacts relate to surface water contamination by runoff from dirty water areas and disruption of flow paths. During the decommissioning phase demolition of infrastructure, will cause disturbance and subsequent erosion of soils into nearby watercourses. Post closure, a positive impact is envisaged following landscape re-profiling which facilitates free drainage to watercourses.

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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 12-1The probability consequence matrix for impacts is displayed in Table 12-2, with the impact significance rating described in Table 12-3.

Table 12-1: 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 12-2: Probability Consequence Matrix for Impacts

Significance

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

Score	Description	Rating
-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)