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HYDROPEDOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL AUTHORISATION AND WATER USE LICENCE APPLICATION PROCESSES FOR THE PROPOSED MINING EXPANSION ACTIVITIES AT THE KOLOMELA MINE, NEAR POSTMASBURG, NORTHERN CAPE PROVINCE

Prepared for

EXM Environmental Advisory (Pty) Ltd

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EXECUTIVE SUMMARY

The Zimpande Research Collaborative (ZRC) was appointed by EXM Environmental Advisory (Pty) Ltd to conduct a hydropedological assessment as part of the Environmental Authorisation (EA) process for the proposed expansion activities at Kolomela mine near Postmasburg within the Tsantsabane Local Municipality, Northern Cape Province. The footprint area under which the proposed expansion activities are to occur will henceforth be referred to as the "investigation area".

The purpose of this investigation was to investigate the hydropedological properties of the soils associated with the watercourses which are distributed across the landscape and associated with the proposed mining development. These watercourses which exist as cryptic wetlands, preferential flowpaths as well as episodic drainage lines which are more likely to be impacted by the proposed developments. This is due to the bulk earthworks associated with mining and thus may intercept and redirect both surface and subsurface flows (if any) in the vadose zone contributing to the recharge of the watercourses as well as affect vadose zone recharge mechanisms. Consequently, it was deemed necessary to investigate the recharge mechanisms of the watercourses within the investigation area to ensure that development planning takes cognisance of any potentially hydropedologically important areas and hence enable informed decision making and to guide construction design in support of sustainable development and Integrated Environmental Management. Recommendations on mitigation were then considered and presented.

The proposed development area is associated with cryptic wetlands and seasonal depressions; thus it was deemed important to understand the status of the affected wetland in terms of their Present Ecological State and Ecological Importance and Sensitivity to ensure that the necessary protection is afforded. The results presented below focus on the features that will be directly and indirectly impacted by the proposed expansion project. Refer to Table A below.

The Freshwater Assessment conducted by SAS (2021) identified 75 cryptic wetlands based on distinct topographic features, specifically relating to endorheic (inward draining) depressions. In addition, 12 episodic drainage lines in the riparian zones as well as numerous seasonal depressions, preferential flow paths, and anthropogenically-derived channels were identified. The extent of modification on these above-mentioned systems will vary, depending on the nature of the proposed activity and proximity to affected wetlands. The full summary of the freshwater assessment findings is presented in Table A below. Protection of these features where feasible is deemed important, in line with the National Water Act No. 36 of 1998 and National Environmental Management Act No. 107 of 1998.

Table A: Summary of results of the field assessment of the identified freshwater features associated with the project footrptint

Watercourse Grouping	PES Category	EIS Category
CW 1	B (1.08)	High
CW 2	B (1.57)	High
CW Group 3	B (1.08)	High
CW Group 4	B (1.26)	High
CW Group 5	B (1.11)	High
CW 55	D (4.71)	High
EDL 1 (western portion of assessment area)	B / C	Moderate
Welgevondenspruit system	B / C	Moderate
Unnamed tributaries of the Groenwaterspruit	B / C	Moderate

The structure of the soils associated with the investigation area as sandy with loose and single grained structure. A calcrete layer is present at shallow depth within most part of the landscape and is moderately impermeable with a moderate to good water holding capability. The Cryptic wetlands however do not hold water long enough to create soil morphological properties indicative of prolonged saturation as the evaporative demand is greater than the water residence time within these features. Infiltration rates on the shallow soils underlined by the permeable fractured bedrock is anticipated to be very high due to large cracks present in the bedrock and thereby recharging the regional aquifers.

The recharge mechanism of the soils associated with the watercourses and their respective catchment areas are characterised by stagnating soils which are associated with high evapotranspiration demand areas. The subsurface flow contribution to the wetlands associated with the investigation area can be considered negligible. The shallow soils associated with the study area has resulted in streamflow channels associated with overland flow during rainfall events. These channels have the potential to recharge the wetlands in the investigation area. The wetland features are typically due to depressions in the landscape in the form of endorheic systems and perched shallow aquifers because of the low permeability of the hardpan carbonate and hard rock underlying the topsoil.

According to the ground water studies presented in the scoping report draft for public comment (2021) the static groundwater levels vary from zero meters (springs flowing out at surface), generally in the topographically lower lying areas, to a maximum of approximately 75 meters below surface to the north-east of Postmasburg (EXM Scoping Report Draft for Public Comment, 2021). Based on observation during the site visit, most of the wetlands were dry without freestanding water, however some did depict some form of wetness indicator (presence of lime precipitates). The groundwater component is not anticipated to have a significant contribution although the perched shallow aquifer may contribute (to a degree) during the rainy season. Overall, the watercourses will therefore negligibly be impacted by the proposed activities that will occur as part of the proposed expansion project.

No hydropedological losses is foreseen for these wetlands as interflow (sub-surface flows recharging the wetlands) soils were not present within the catchment of these systems. Even though this is the case, direct impact is foreseen for the wetlands overlain by the proposed developments, thus the recommendation of the freshwater report compiled by SAS (2021) should strongly be considered. Additionally, other components in the water balance, with specific mention of recharge by surface water runoff may be impacted particularly in areas where the surface infrastructure is located within the catchment area and separation of clean and dirty water areas takes place.

The footprint area is largely dominated by cryptic wetlands, thus total avoidance of direct impact on the watercourses will be not be feasible. The construction activities should aim to avoid developing within the scientific buffers where feasible. Alternatively, the mine should aim to minimise the disturbance within the scientific buffers as far as practically possible. Key recommendations presented below and those presented in the freshwater report compiled by SAS (2021) should strongly be considered, particularly during the finalisation stage of the footprint layout. This will ensure that the Present Ecological State (PES), wetland functionality as well as impact on the Ecoservices the wetland provides remain unchanged during all phases of development.

Recommendations have been developed in the points below to mitigate impacts on the receiving environment:

- Although some wetlands will be directly impacted, all development footprint areas to remain outside of the wetlands and associated scientific buffer as far as practically possible;
- Contractor laydown areas, and material storage facilities to remain outside of the cryptic wetlands, as well as the applicable scientific buffer;
- The watercourses must be protected against erosion arising from the stormwater runoff from the associated infrastructural areas. In this regard, runoff should be attenuated before discharging into the wetland, thus recharging the wetlands in an ecologically appropriate manner;
- Water collected from clean surface should be redirected and discharged back into the adjacent watercourses in an attenuated manner;
- Should the development encroach on the wetlands and/or scientific buffer, any residual impact should be off setted to achieve a no net loss, in line with Anglo's Net positive impact approach to mining;
- Implementation of adequate erosion control measures to limit loss of soil and sedimentation of the wetlands adjacent to the proposed project;
- All surface development footprint areas should remain as small as possible and disturbance of soil profiles to be limited to what is absolutely essential;
- Following the completion of the construction phase, areas of disturbance, particularly adjacent to the watercourse should be monitored at least once after an erosive rainfall until the natural vegetation has well established.

If the above mitigatory measures are implemented, with careful construction practices, the PES class of the wetlands is unlikely to occur, and the development is deemed acceptable from a hydropedological and water balance perspective.

DOCUMENT GUIDE

No.	Requirements	Section in report
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Appendix A
2.2	Description of the preferred development site , including the following aspects-	Section 1.1
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns	Section 4
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified	Section 4
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status	Section 4
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater)	Section 4
2.3	Identify any alternative development footprints within the preferred development site which would be of a “low” sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification	Section 5.3
2.4	Assessment of impacts - a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 5.3
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 5.3
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 5 and 6
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.). d. Assessment of the risks associated with water use/s and related activities.	Section 5

2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system); b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over abstraction or instream or off-stream impoundment of a wetland or river); c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an Unchannelled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); and e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).	Section 5
2.4.5	How will the development impact on the functionality of the aquatic feature including: a. water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river) b. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an Unchannelled valley-bottom wetland to a channelled valley-bottom wetland). c. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); d. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); e. The loss or degradation of all or part of any unique or important features (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.) associated with or within the aquatic ecosystem.	Section 5
2.4.6	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 4 and 5
2.4.7	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 4 and 5
2.4.9	A motivation must be provided if there were development footprints identified as per paragraph 2.3 above that were identified as having a “low” biodiversity sensitivity and were not considered appropriate.	Section 5 and 6
3.	The report must contain as a minimum the following information:	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae;	Appendix A
3.2	A signed statement of independence by the specialist;	Appendix A
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 2
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Section 2
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 5.3
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts;	Section 5.3.3
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 5.3.2
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 5.3.3
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being not considered; and	None
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Section 6

3.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 6
3.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 7: Table 5.
3.14	A motivation must be provided if there were development footprints identified as per paragraph 2.3 for reporting in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) that were identified as having a “low” aquatic biodiversity and sensitivity and that were not considered appropriate.	None.
3.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 6
3.16	Any conditions to which this statement is subjected.	Section 6

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GLOSSARY OF TERMS

Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Aquifer	An aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials e.g. gravel, sand, or silt, that contains and transmits groundwater
Base flow:	Long-term flow in a river that continues after storm flow has passed.
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic condition, but having different characteristics due to variation in relief and drainage.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flow into a river, wetland, lake, and ocean or contributes to the groundwater system.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
Evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydro period	Duration of saturation or inundation of a wetland system.
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Intermittent flow:	Flows only for short periods.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Pedology	The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Vadose zone	The unsaturated zone between the ground surface and the water table (groundwater level) within a soil profile
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks

ACRONYMS

°C	Degrees Celsius.
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ET	Evapotranspiration
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
HGM	Hydrogeomorphic
m	Meter
MAP	Mean Annual Precipitation
MPRDA	Minerals and Petroleum Resources Development Act, Act 28 of 2002
NEMA	National Environmental Management Act
NWA	National Water Act
PSD	Particle Size Distribution
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WMA	Water Management Areas
WULA	Water Use Licence Application

1 INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed by EXM Environmental Advisory (Pty) Ltd to conduct a hydropedological assessment as part of the Environmental Authorisation (EA) process for the proposed expansion activities at Kolomela mine located approximately 8,9 km southwest of Postmasburg within the Tsantsabane Local Municipality, Northern Cape Province. The footprint area under which the proposed expansion activities are to occur will henceforth be referred to as the "investigation area" (See Figure 1 and Figure 2). The assessment area encompasses the actual footprint area of the proposed developments.

1.1 Project Description

The Sishen Iron Ore Company (Pty) Ltd, part of Kumba Iron Ore Limited (hereafter Kumba), owns and operates Kolomela mine located approximately 8 km southwest of Postmasburg in the Tsantsabane Local Municipality, Northern Cape Province. The Minister of Mineral Resources granted a mining right for the mining of iron ore at Kolomela Mine on 5 May 2008, {Ref: (NC) 069 MR} and is valid until 17 September 2038, unless cancelled or suspended.

Kolomela mine operates as a conventional open cast mine where ore is extracted by means of drilling, blasting, loading and hauling. Ore extracted from the pits is transported to a direct shipping ore (DSO) plant which involves the crushing and screening of recovered ore material into stockpiles of 'lump' and 'fines'. The processed iron ore is loaded onto an internal railway line which is connected to a direct rail link to Transnet's Sishen-Saldanha railway line from where the iron ore is transported to the Port of Saldanha for export. Kolomela Mine also utilises a Modular Dense Media Separation (DMS) Processing Plant for the processing of low-grade ore not suitable for processing at the DSO plant. Kolomela produced 10.8 million tonnes during its first full year of production in 2013 and currently produces 13-14 million tonnes per annum (Mtpa) facilitated by enhanced stripping techniques and processing of 1-3 Mtpa of lower grade of ore at the Tierbult DMS Modular Plant.

Iron ore is currently extracted from three opencast pits, namely Klipbankfontein, Leeuwfontein and Kapstevel North. Kolomela is in the process of developing the Kapstevel South Pit which is required to sustain the mining production at approximately 14 Mtpa (Mtpa) until 2031. The current the Life of Mine (LoM) including the Kapstevel South Pit currently stands at 2032, but with the potential to be extended in future with the development of the Ploegfontein, Tierbult and Heuningkranz ore bodies, the mining of which are already authorised.

Kolomela proposes to expand and amend some of the existing activities and also develop new infrastructure to support continued and future production at the mine. This includes:

- Amendment of the Kapstevel South Pit footprint area.
- Amendment of the Kapstevel Waste Rock Dumps and haul roads.
- Amendment of Kapstevel Evaporation Ponds and stormwater management infrastructure.
- Additional park-up, laydown and ore stockpile areas.
- Development of new DMS tailings management infrastructure
- A new Photovoltaic Solar Facility.
- A new Waste Tyre Management Facility.
- A conveyor and railway line to transfer material to and from the DMS plant.
- Amendment to the future Kapstevel DMS conveyor footprint to facilitate widened haul roads.
- Amendment of Kapstevel Waste Rock Dumps and Additional Waste Rock Dumps.
- Additional Low Grade Ore Storage Areas.
- New radio masts.
- Provision for an area of relaxation and safety berms around pits.

The existing and planned infrastructure at Kolomela mine are shown in Figure 3 below.

Authorisation is thus being sought from the Department of Mineral Resources & Energy (DMRE) for activities listed under the National Environmental Management Act (No. 107 of 1998) and the National Environmental Management: Waste Act (No. 59 of 2008) as well as amendment of the environmental management programme in terms of Section 102 of the Minerals & Petroleum Resources Development Act (No. 28 of 2002).

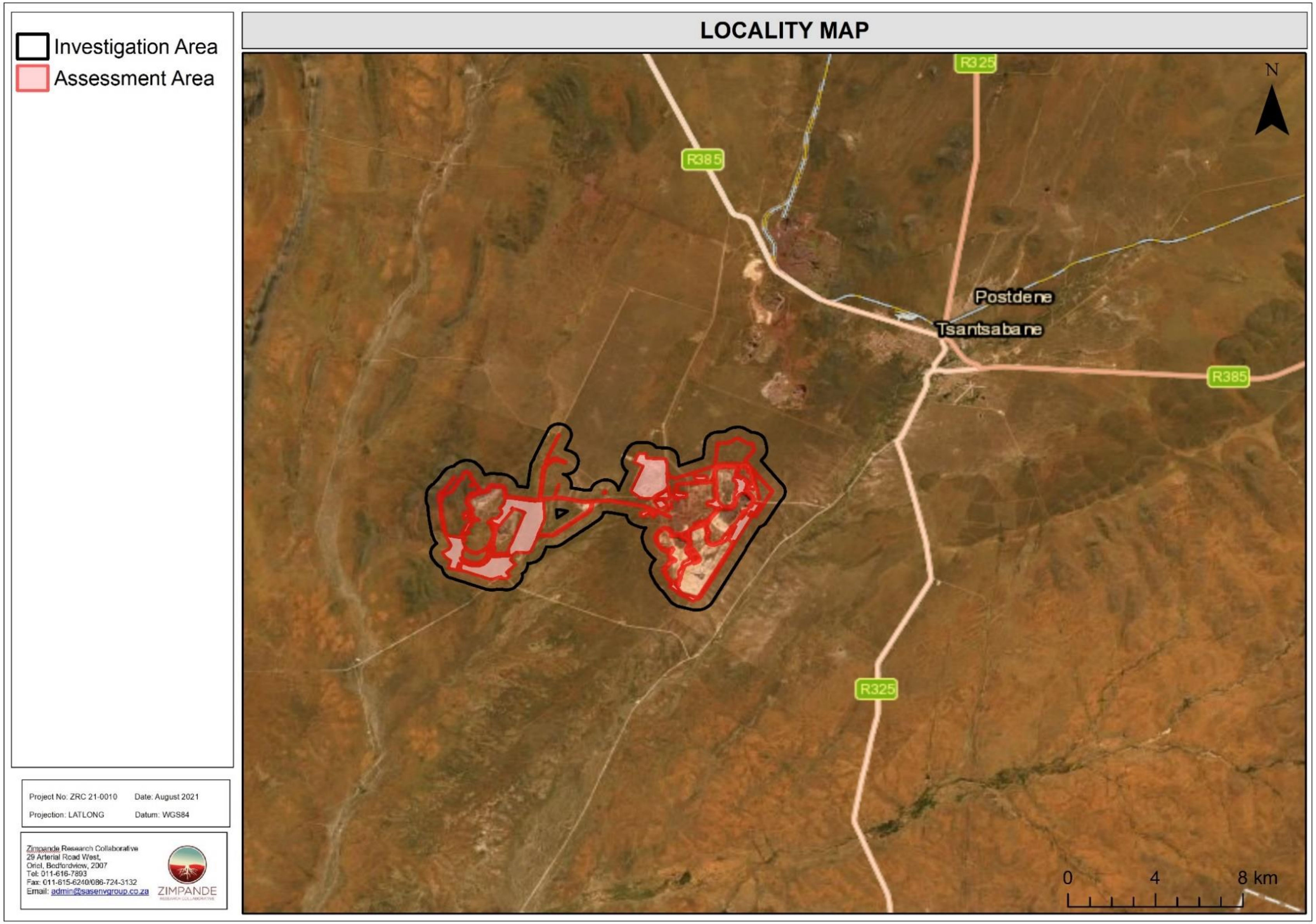


Figure 1: Locality map depicting the assessment area and the associated investigation area in relation to the surrounding areas, depicted on digital satellite imagery.

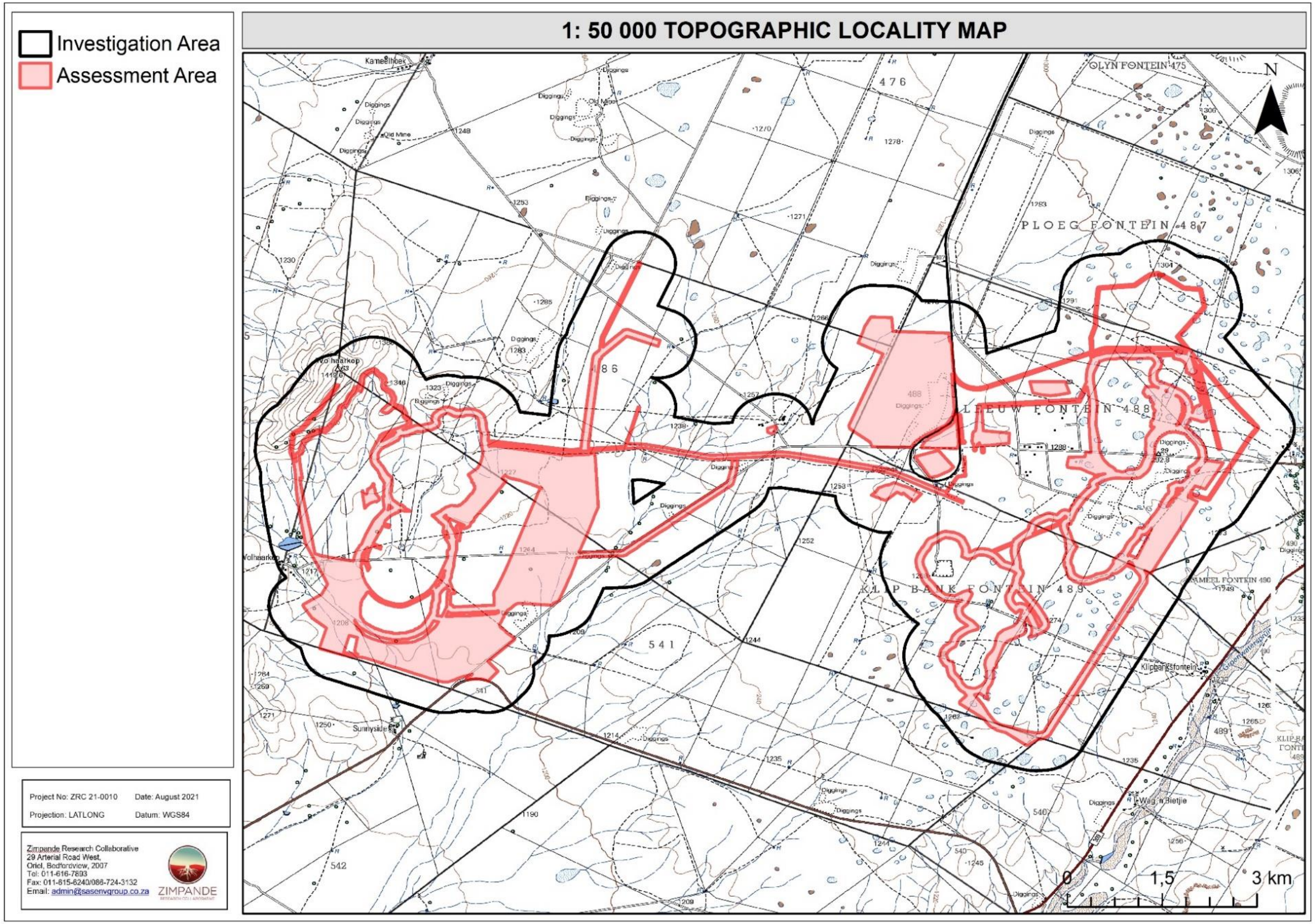


Figure 2: Locality map depicting the assessment area and the associated investigation area in relation to the surrounding areas, depicted on digital 1:50,000 topographic map.

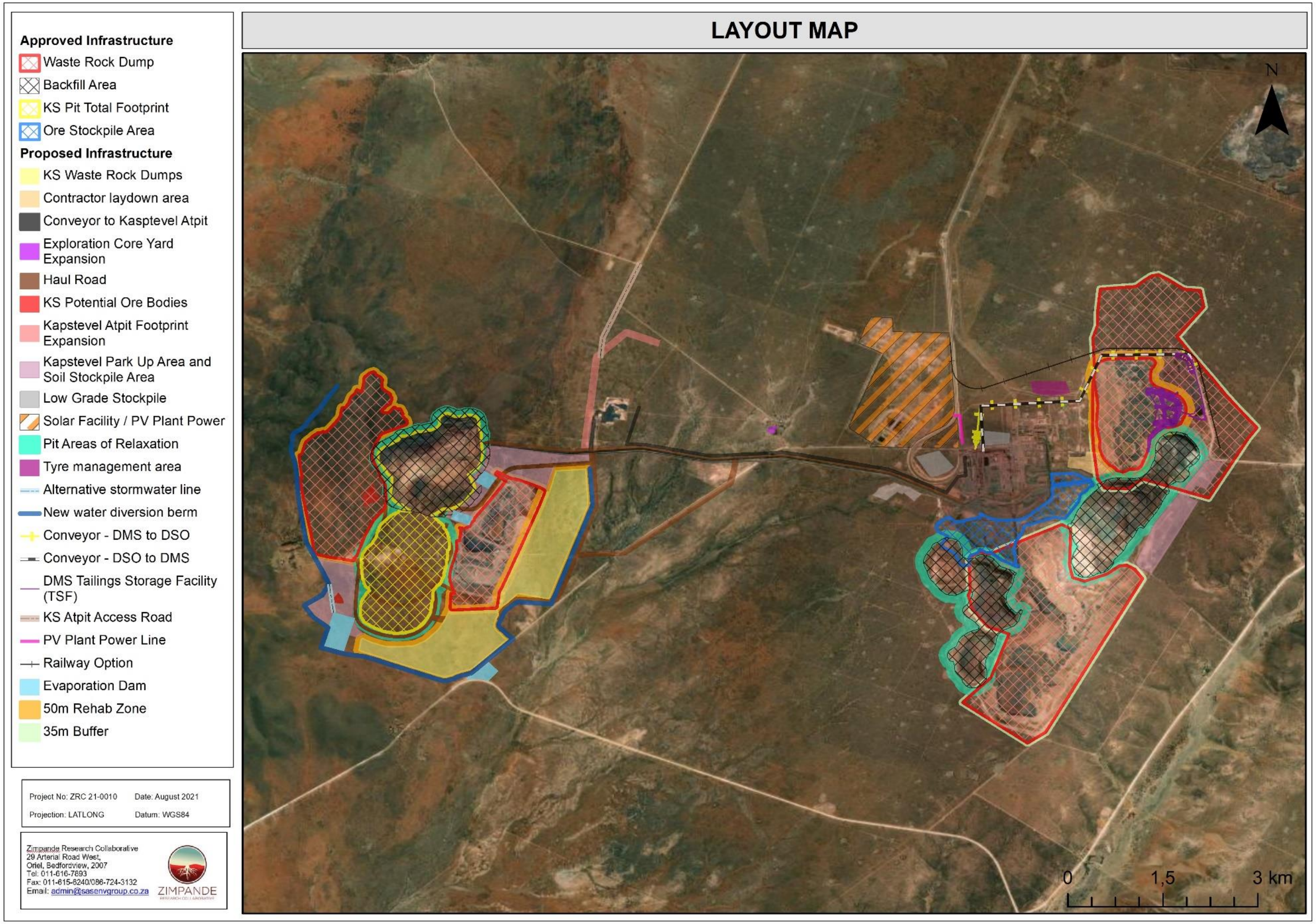


Figure 3: Locality of existing and planned infrastructure in relation to the surrounds, depicted on digital satellite imagery.

Figure 4: A general overview of the landscape setting in the investigation area.

1.2 Objectives

The purpose of this investigation was to investigate the hydropedological properties of the soils associated with the watercourses which are distributed across the landscape associated with the proposed developments. These watercourses which exist as cryptic wetlands, preferential flowpaths as well as episodic drainage lines are more likely to be impacted by the proposed developments. This is due to the bulk earthworks the proposed development will entail and thus may intercept and redirect both surface and subsurface flows (if any) in the vadose zone contributing to the recharge of the watercourses as well as affect vadose zone recharge mechanisms. Consequently, it was deemed necessary to investigate the recharge mechanisms of the watercourses within the investigation area to ensure that development planning takes cognisance of any potentially hydropedologically important areas and hence enable informed decision making and to guide construction design in support of sustainable development and Integrated Environmental Management. Recommendations on mitigation were then considered and presented.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The hydropedological assessment is confined to the investigation area as illustrated in Figures 1 and 2 and does not include the neighbouring and surrounding properties outside of the investigation area. This study however considers adjacent watercourse and the recharge mechanisms on a desktop level;
- Inaccuracies may exist in the delineation of the catchment scientific buffers of the cryptic wetlands associated with the project footprint due to the inaccuracies in the contours (acquired from Global Mapper) used during the delineation process;
- Hydropedological science and research is rapidly evolving and there are currently no standard methods to assess and/or model the recharge capacity of soils, as a result, the findings of this assessment are therefore a mix of qualitative and quantitative results and based on the specialist's training, opinion and experience with the hydropedological properties of the identified soil types topographic conditions and wetland characteristics;
- The modelling using SWAT+ to quantify the hydropedological losses was not conducted as part of this study due to the absence of hydrological important soils within the investigation and surrounding areas;
- The effects climate change dynamics were not considered as part this assessment; however, it is acknowledged that this might exacerbate the anticipated impacts associated with a reduction in water inputs and the resultant hydrological function of the remaining wetlands beyond the extent of the proposed development.

1.4 Legislative Requirements and Provincial Guidelines

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment:

- The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996);
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);
- The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA); and

2 ASSESSMENT METHODOLOGY

A hydropedological survey was conducted in June 2021 to assess the hydropedological characteristics of the landscape and associated soils within the investigation area. A soil classification exercise was undertaken at selected representative points, considering the various soil types, in order to deduce the wetland recharge mechanisms and identify the anticipated hydropedological impacts of the proposed development on the wetland resources that will be affected by the proposed development. Subsurface soil observations were made by means of a standard hand auger and investigation methods.

Identification of the representative hillslope/s

Prior to the site visit a desk-based exercise was undertaken which included the following:

- Identification of land types (Land Type Survey Staff, 1972 – 2006) within the study area; and
- Identification of dominant hillslopes (from crest to stream) of the study area using terrain analysis.

Conceptualize hillslope hydropedological responses

- Transect soil survey was conducted on each of the identified hillslope (Le Roux et al., 2011);
- Soil observations were made at regular intervals, not exceeding 100 m, on the transect;
- Analysis of soil was made by means of a hand augur as well as analysis of exposed profile areas which depict the diagnostic horizon sequence; and
- soils observations were made until the layer of refusal.

Field assessment data included description of physical soil properties including the following parameters, in order to characterise the various recharge mechanisms of the investigated wetlands:

- Diagnostic soil horizon sequence;
- Landscape position in relation to the investigated wetlands (recorded on GPS); and
- Depth to saturation (water table), if encountered;

Conceptual hillslope hydropedological response

The occurrence, sequence, and coverage of the different hydropedological groups on a transect was used to describe the hydrological behaviour of the hillslope (van Tol *et al*., 2013). This includes a graphical representation of the dominant and sub-dominant flowpaths at hillslope scale prior to development (as presented in Section 5.3). This will include:

- Overland flow;
- Subsurface lateral flow;
- Bedrock flow;
- Return flow; and
- Storage mechanisms.

Step 3: Quantification of hydraulic properties and flowrates

- Identify the representative soil forms and horizons from the transect survey.
- Collect selected verification samples for textural analysis, bulk density and conductivity at a SANAS accredited analytical laboratory.
- Relate the measurements to the conceptualised hydropedological response model to provide a quantitative description of flowrates and storage.

Step 4: Quantification of hydropedological fluxes

- Quantify the hydropedological fluxes using SWAT+ Model (Bieger *et al*., 2017; van Tol *et al*., 2020a).
- Identify the potential impacts of the proposed mining development on the unsaturated flow processes and wetlands.
- Recommend suitable mitigation and management measures to alleviate the identified impacts on the wetland hydropedological drivers.
- Based on the outcome of the hydropedological assessment and taking into consideration the results of the geohydrological assessment, a scientifically determined buffer will be generated around the affected wetlands.
- Compile a specialist report on the conceptual hydropedological regime of the investigated wetlands based on the identified soil types under current conditions.

Table 1: Average permeability for different soil textures in cm/hour Food and Agriculture Organization (FAO), 1980.

Soil Texture	Permeability (cm/hour)
Sand	5
Sandy loam	2.5
Loam	1.3
Clay loam	0.8
Silty clay	0.25
Clay	0.05

Table 2: Soil permeability classes for agriculture and conservation (Food and Agriculture Organization (FAO), 1980.

Soil permeability classes	Permeability rates*	
	cm/hour	cm/day
Very slow	Less than 0.13	Less than 3
Slow	0.13 - 0.3	3 - 12
Moderately slow	0.5 - 2.0	12 - 48
Moderate	2.0 - 6.3	48 - 151
Moderately rapid	6.3 - 12.7	151 - 305
Rapid	12.7 - 25	305 - 600
Very rapid	> 25	> 600

****Saturated samples under a constant water head of 1.27 cm***

Table 3 : DWS range of hydraulic conductivities in different soil types (DWS Groundwater Dictionary, 2011)

Soil Type	Saturated Hydraulic Conductivity, K_s (cm/s)
Gravel	$3x10^{-2}$ – 3
Coarse Sand	$9x10^{-5}$ – $6x10^{-1}$
Medium Sand	$9x10^{-5}$ – $5x10^{-2}$
Fine Sand	$2x10^{-5}$ – $2x10^{-2}$
Loamy Sand	$4.1x10^{-3}$
Sandy Loam	$1.2x10^{-3}$
Loam	$2.9x10^{-4}$
Silt, Loess	$1x10^{-7}$ – $2x10^{-3}$
Silt Loam	$1.2x10^{-4}$
Till	$1x10^{-10}$ – $2x10^{-4}$
Clay	$1x10^{-9}$ – $4.7x10^{-7}$
Sandy Clay Loam	$3.6x10^{-4}$
Silty Clay Loam	$1.9x10^{-5}$
Clay Loam	$7.2x10^{-5}$
Sandy Clay	$3.3x10^{-5}$
Silty Clay	$5.6x10^{-6}$
Unweathered marine clay	$8x10^{-11}$ – $2x10^{-7}$

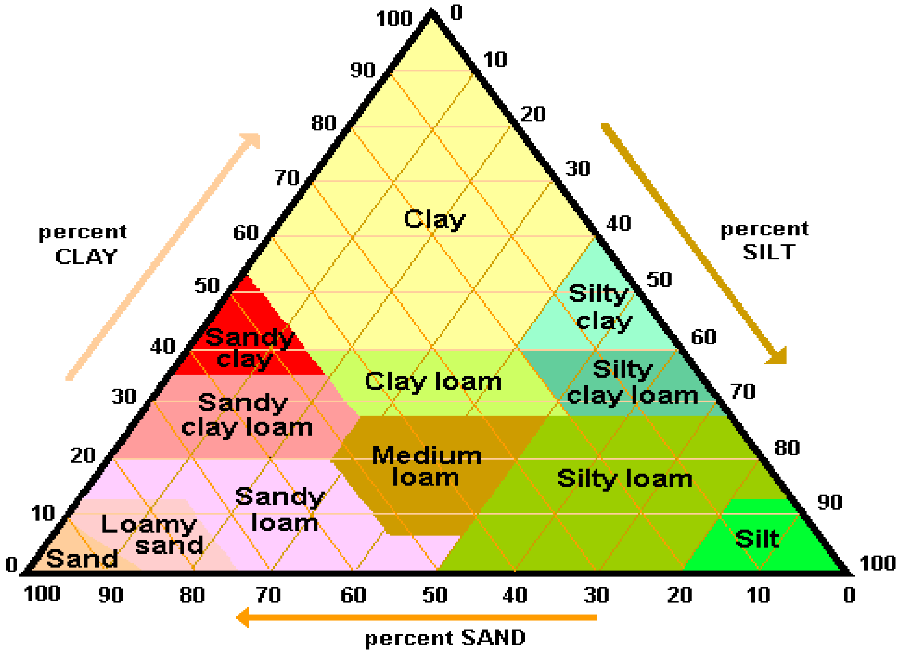


Figure 5: Soil texture classification chart (Food and Agriculture Organization (FAO), 1980).

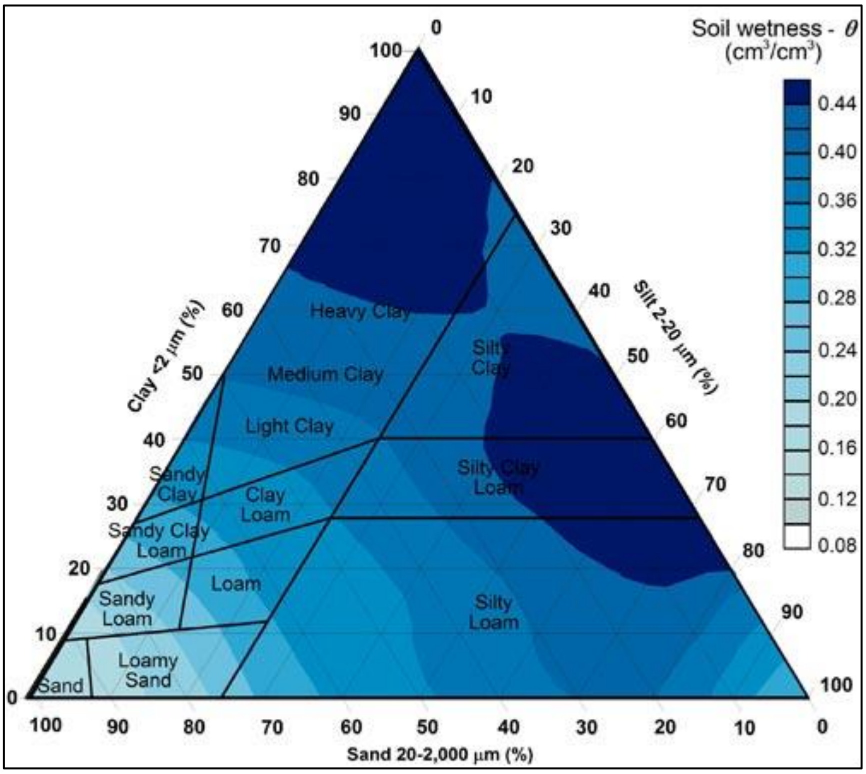


Figure 6: A diagram depicting soil wetness based on soil textural class

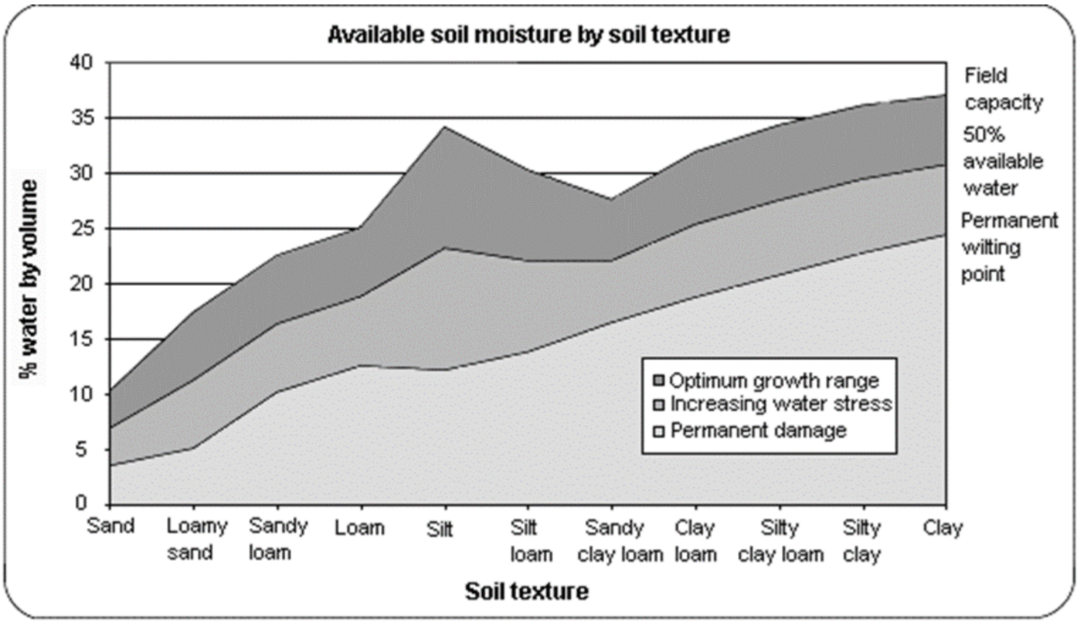


Figure 7: A diagram depicting the percentage volume of water in the soil by soil texture.

Table 4: Impact categories for describing the impact significance of the proposed development on the wetlands and associated hydropedological drivers.

Severity	SSI Reduction	Change Class	Description
No Impact	0 – 2.5 %	No change	Hydropedological process are predicted to be unmodified and the functionality of the wetland will remain unchanged.
Low	2.5 – 5 %	No significant change	Small effect on the hydropedological process are predicted, however the functionality of the wetland remains unchanged and no change in resource class is expected.
Low to Moderate	5 – 10 %	Limited change with a change in PES category possible	A slight change in hydropedological processes is predicted and a small change in the in the wetland may have taken place but is change to the PES, EIS or wetland functionality and ecoservice provision is limited with no more than one PES class predicted.
Moderate	10 – 15 %	Significant change with a change in PES Category definite and possibly a change of more than one category	A moderate change in the hydropedological processes is predicted to occur. The change in PES may exceed one category but no change in EIS takes place. No loss of important ecoservices is predicted to occur.
High	15 – 22.5 %	Very significant change with a change in PES of more than two categories	Modifications have reached a very significant level and the hydropedological processes are predicted to be largely modified with a large change in the PES, EIS of the wetland feature as well as a significant loss in ecoservice provision.
Very High	22.5 -60%	Serious to Critical change with a change in PES of more than three categories or a permanent complete loss of wetland resource	Modifications have reached a serious level and the hydropedological processes have been seriously modified with an almost complete loss of wetland integrity, functionality and service provision.

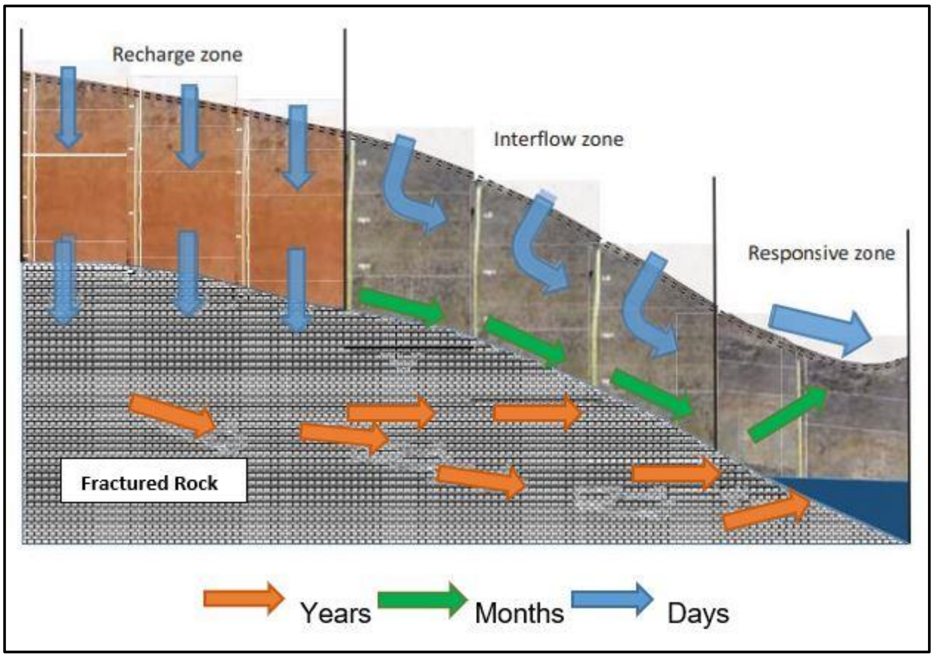
3 HYDROPEDOLOGICAL BEHAVIOUR OF SOIL TYPES

Hydropedological behaviour of different soils can vary significantly, depending on the soil drainage patterns. The discussion below is largely based on the concept presented in Figure 8 and Table 5 below.

Hydropedological soil types classified as “stagnating” dominate the investigation area. These soils are termed stagnating due to the occurrence of hard carbonate layers in the landscape. In these types of soils lime has accumulated to a point that it is hardened and restricts water movement. These soils are typical of arid regions with a very high evapotranspiration demand. Although infiltration occurs readily in the topsoil, the dominant hydrological flow path in the soil is upward, driven by evapotranspiration (van Tol and le Roux, 2019).

Recharge shallow soils also dominate in the landscape. These soils are without any morphological indication of saturation. This implies that water flows through and out of the profile into the underlying rock material recharging the underlying aquifers. These soils can either be shallow on fractured rock with a limited contribution to evapotranspiration or deep freely drained soils that can contribute significantly to evapotranspiration.

Figure 8 presents a conceptual diagram of the recharge mechanism of different soil types within the landscape and their influence on freshwater resources.



*stagnating soils are not included in the diagram they are not considered hydropedologically important

Figure 8: A typical conceptual presentation of hydrological flow paths on different hydropedological soil types- hillslope hydropedological behaviour.

Table 5: Hydrological soil types of the studied hillslopes (Le Roux, *et al.*, 2015).

Hydrological Soil Types	Description	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out 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 ground water regime.	
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates accumulation of water in the topsoil. Duration of drainable water depends on the 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-up 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 (Wet)	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.	
Stagnating	In these soils outflow of water is limited or restricted. The A and/or B horizons are permeable but morphological indicators suggest that recharge and interflow are not dominant however no wetland response is observed. These include soils with carbonate accumulations in the subsoil, accumulation and cementation by silica and precipitation of iron as concretions and layer. The dominant hydrological flow path in the soil is upward, driven by evapotranspiration	

The flow paths from the crest of a slope to the valley bottom is assessed and classified. According to Le Roux, *et al.* (2015), the classification largely takes into account the flow drivers during a peak rainfall event and the associated flow paths of water through the soil. The hillslope classes are:

- Class 1 – Interflow (Soil/Bedrock Interface);
- Class 2 – Shallow responsive;
- Class 3 – Recharge to groundwater (Not connected);
- Class 4 – Recharge to watercourse;
- Class 5 – Recharge to midslope; and
- Class 6 – Quick interflow (A/B horizon).

4 ECOLOGICAL SIGNIFICANCE

The proposed development area is associated with cryptic wetlands and seasonal depressions; thus it was deemed important to understand the status of the affected wetland in terms of their Present Ecological State and Ecological Importance and Sensitivity to ensure that the necessary protection is afforded. The results presented below focus on the features that will be directly and indirectly impacted by the proposed expansion project.

The Freshwater Assessment conducted by SAS (2021 identified 75 cryptic wetlands based on distinct topographic features, specifically relating to endorheic (inward draining) depressions. In addition,12 episodic drainage lines in the riparian zones as well as numerous seasonal depressions, preferential flow paths, and anthropogenically-derived channels were identified. The extent of modification on these above-mentioned systems will vary, depending on the nature of the proposed activity and proximity to affected wetlands. The full summary of the freshwater assessment findings is presented in Table 6 below. Protection of these features where feasible is deemed important, in line with the National Water Act No. 36 of 1998 and National Environmental Management Act No. 107 of 1998.

The watercourses identified within the investigation area were grouped according to their locality (See Figure 9, 10,11 and 12) as follows:

- Episodic drainage line 1: a network of small, episodic drainage lines situated in the far west of the assessment area;
- Welgevondenspruit system: a network of episodic drainage lines which form part of the network feeding the system locally referred to as the Welgevondenspruit, which ultimately flows into the Soutloop River approximately 9 km south-west of the assessment area;
- Unnamed tributaries of the Groenwaterspruit: several small episodic drainage lines located to the east of the existing mining activities which flow into the Groenwaterspruit, located approximately 1 km east of the assessment area;
- Cryptic Wetland 1 (CW 1): an isolated cryptic wetland in the west, which will be traversed by the proposed conveyor to the Kapstevel Atpit;
- Cryptic Wetland 2 (CW 2): located approximately 200 m to the west of the existing ore stockpile area, this wetland was assessed separately as it is clear that the modifiers to this wetland are slightly different to those of the other wetlands;
- Cryptic Wetlands Group 3, comprising CWs 3 to 10, 16 to 20, and CW 23. These are located to the west of the existing ore stockpile area and open pit (which will in due course be the Klipbankfontein Backfill Area);
- Cryptic Wetlands Group 4, comprising CWs 29, 30, 32, 33 and 34 (CW 34 is also known locally as Leeuwpan) located to the east of the existing open pit. CWs 30, 32, 33 and 34 are also located east of the proposed Kapstevel Park Up Area and Soil Stockpile Area;

- Cryptic Wetlands Group 5, comprising CWs 35, 36, 38, 39, 40, 41, 44, 46 to 53, 62, 65, 67 and 72. These are situated to the north-east and north-west of the existing open pit, which will in time become the Leeuwfontein north WRD (already approved) and DMS TSF, and are also associated with the proposed 35 m rehabilitation buffer around the approved Leeufontein North WRD expansion and the eastern portion of the proposed railway option; and
- Cryptic Wetland 55: this wetland is located on the eastern boundary of the existing pit.

Table 6: Summary of results of the field assessment of the identified freshwater features associated with the project footrptint.

Watercourse Grouping	PES Category	EIS Category
CW 1	B (1.08)	High
CW 2	B (1.57)	High
CW Group 3	B (1.08)	High
CW Group 4	B (1.26)	High
CW Group 5	B (1.11)	High
CW 55	D (4.71)	High
EDL 1 (western portion of assessment area)	B / C	Moderate
Welgevondenspruit system	B / C	Moderate
Unnamed tributaries of the Groenwaterspruit	B / C	Moderate

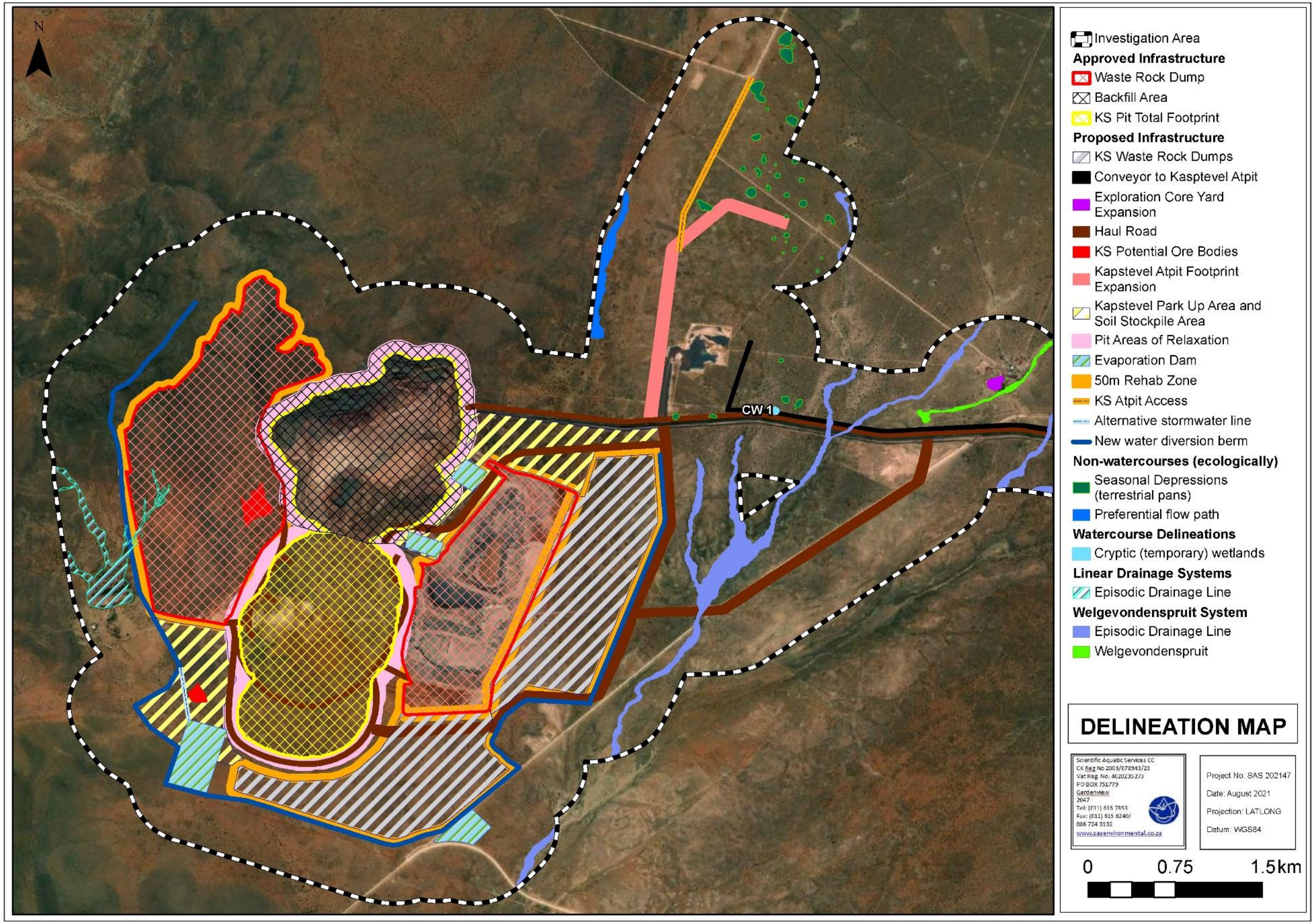


Figure 9: The location of the delineated watercourses within the north-western portion of the investigation area (coutersy of SAS).

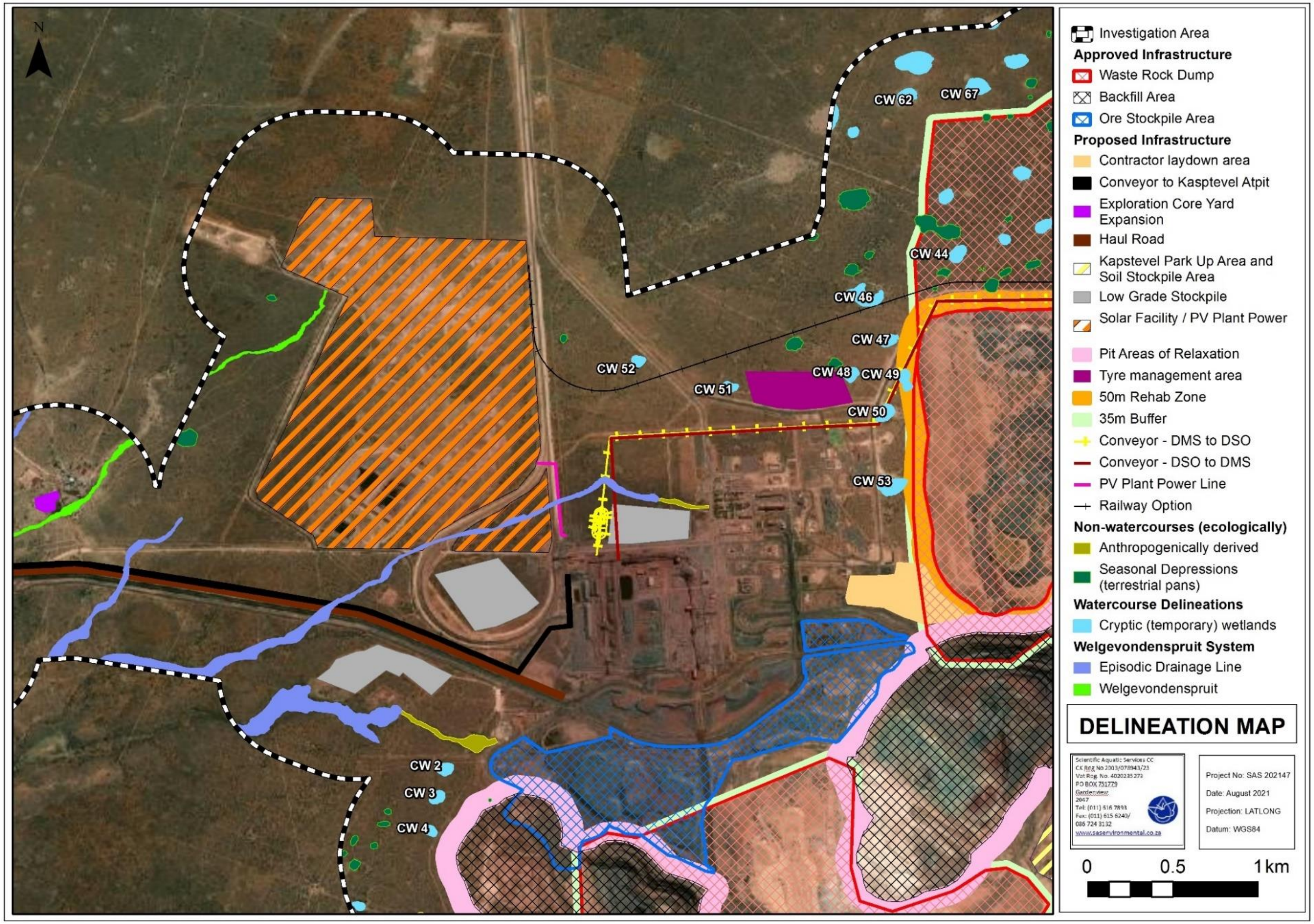


Figure 10: The location of the delineated watercourses within the central-eastern portion of the investigation area (courtesy of SAS).

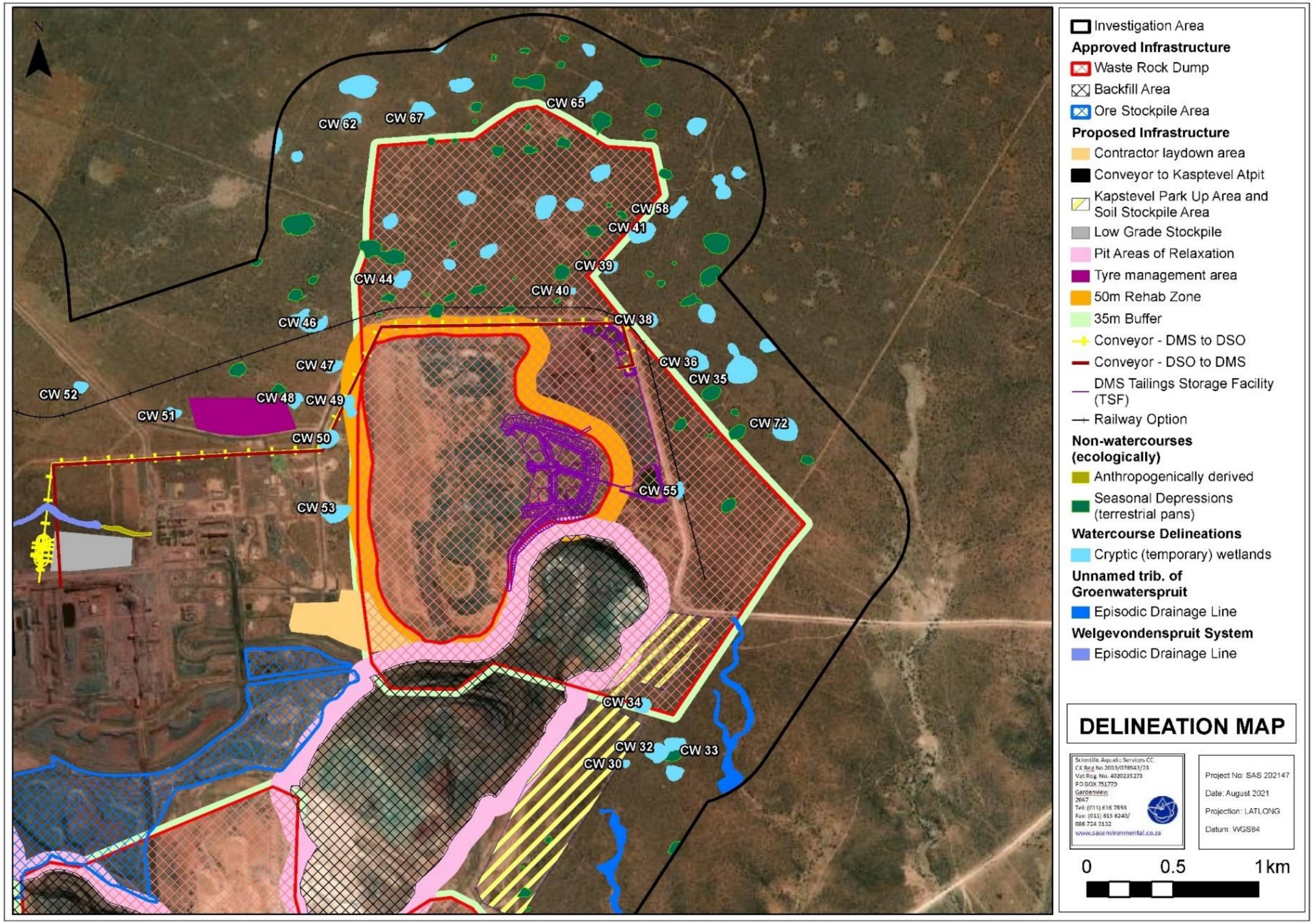


Figure 11: The location of the delineated watercourses within the central-eastern portion of the investigation area (courtesy of SAS).

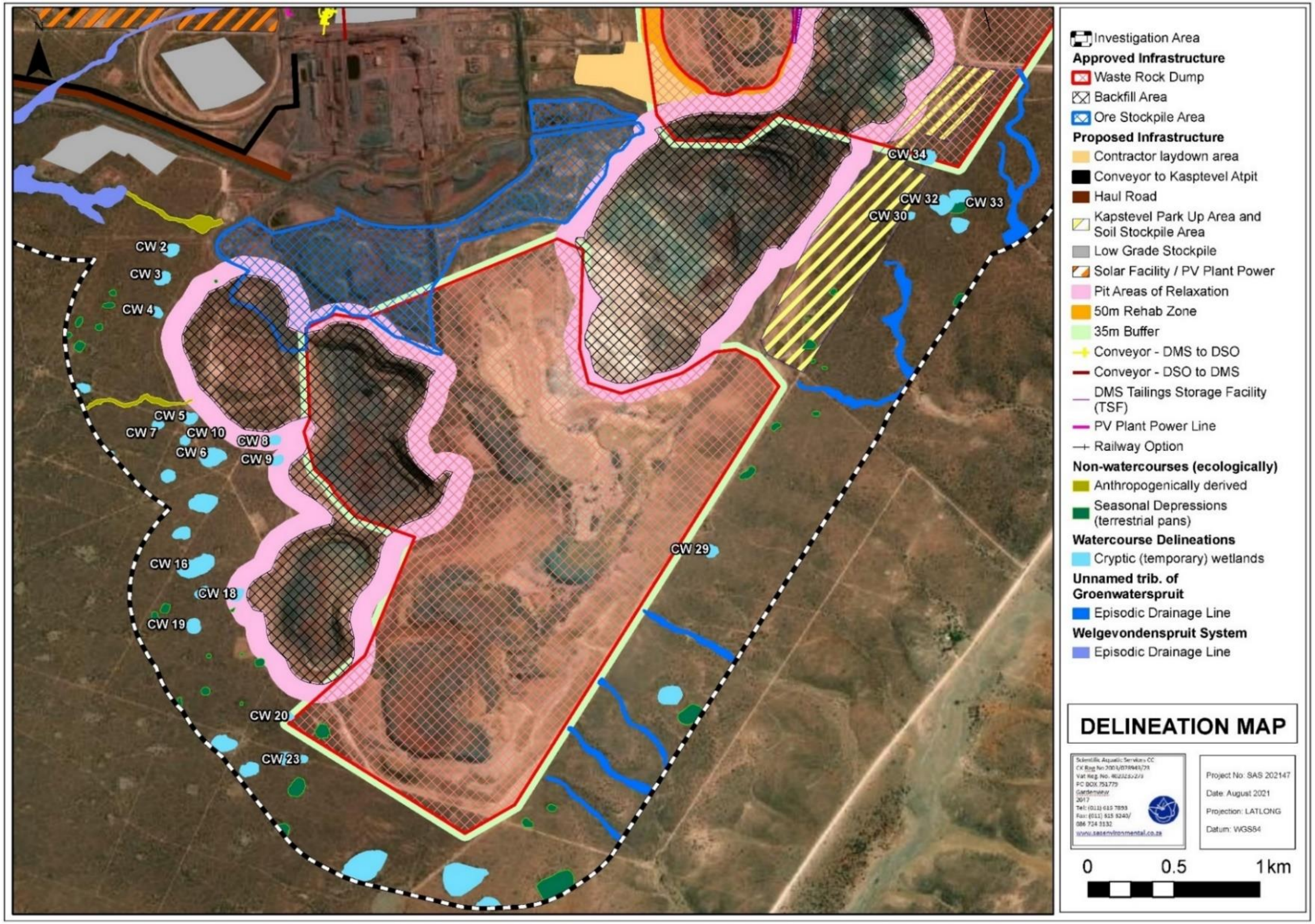


Figure 12: The location of the delineated watercourses within the south-eastern portion of the investigation area (courtesy of SAS).

5 RESULTS AND DISCUSSION

5.1 Morphological and Hydraulic Properties of Wetland and Hydropedologically Important Soils Associated with the Investigation area:

The catena of the wetlands is dominated by a Calcic topo sequence with limited strips of oxidic soils. Calcic soils associated with the investigation area can be classified as carbonate soil types, where the A horizon grades directly into a hard carbonate horizon e.g., Coega soil form (Soil Classification Working Group, 2018). In these soils calcium carbonate has leached from upper parts of the soil profile and accumulated at depth or from the parent material. These soils are common in arid and semi-arid regions (Soil Classification Working Group, 2018). In oxidic soils, oxides of iron accumulate through weathering and impart to many soils a colour which is essentially uniform, at least in the upper solum, since soils are well drained and aerated e.g., Nkonkoni and Plooysburg soil forms. Lastly, a lithic topo-sequence in which shallow soils are characterised by the presence of rock outcrops.

5.1.1 Physical Characteristics

The structure of the soils associated with the investigation area as sandy with loose and single grained structure. A calcrete layer is present at shallow depth within most part of the landscape and is deemed to have a moderate impermeability with a moderate to good water holding capability. The Cryptic wetlands however do not hold water long enough to create soil morphological properties indicative of prolonged saturation as the evaporative demand is greater than the water residence time within these features. Infiltration rates on the shallow soils underlined by the permeable fractured bedrock is anticipated to be very high due to large cracks present in the bedrock and thereby recharging the regional aquifers.

Figure 13 below presents the dominant soil forms associated with the proposed development as identified during the hydropedological assessment.

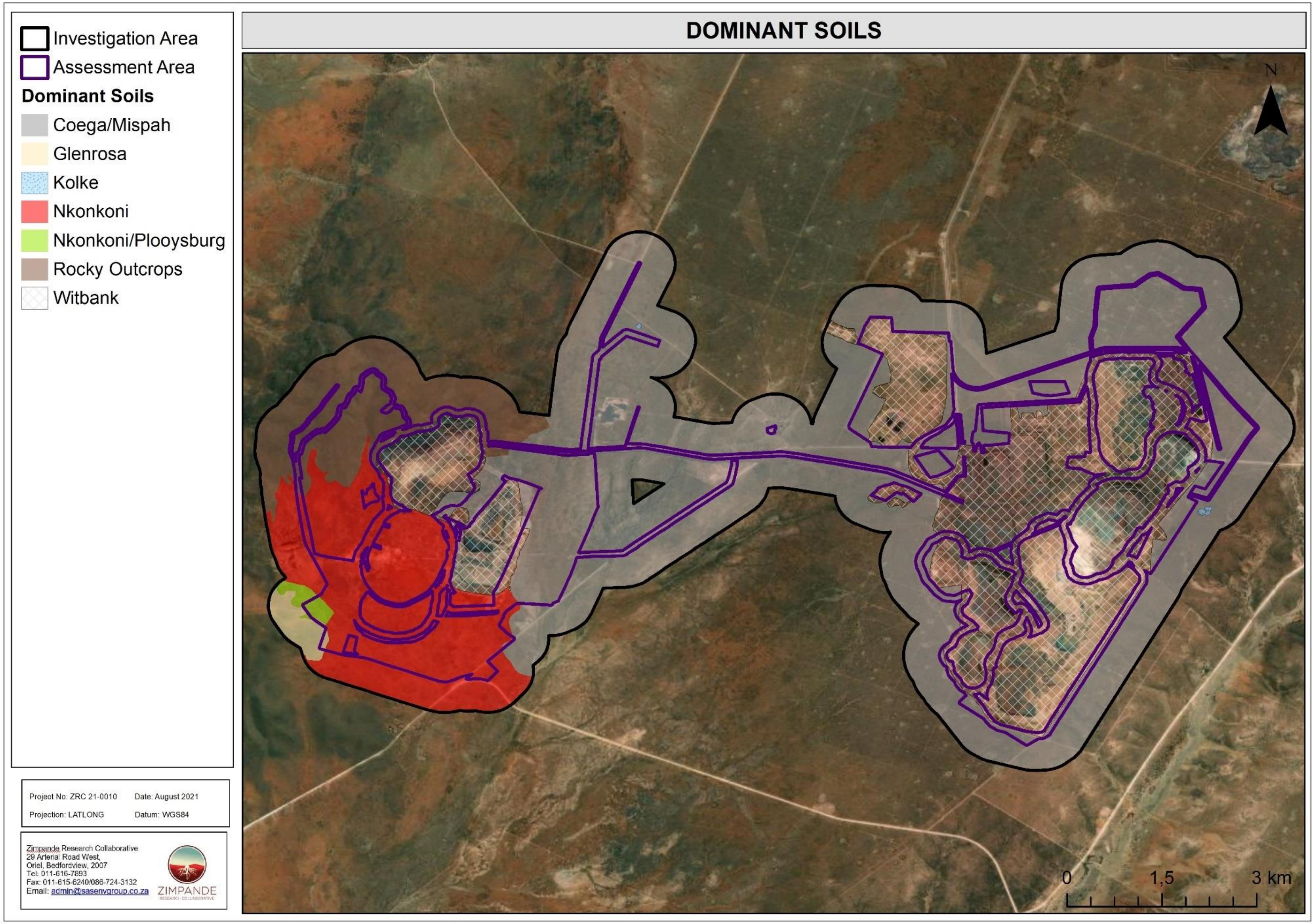


Figure 13: Map depicting spatial distribution of soils within the investigation area.

5.2 Recharge of the Cryptic Wetlands

Typically, there are four primary wetland recharge mechanisms, and these include precipitation (rainfall), surface flow (runoff), subsurface flow (interflow) through the vadose zone of the surrounding soils, and groundwater discharge. This section seeks to address the behavioural patterns of the different soil types from a hydropedological point of view, and the other recharge mechanisms will be highlighted in Section 5.3.1 of this report.

The identified soils with the investigation area have been grouped into hydropedological soil types and are discussed below in order to understand their contribution to wetland recharge. The subsections below present the hydropedological soil types which were identified within the investigation area during the site assessment.

5.2.1 Recharge (Shallow) soils

These soils are characterised by the absence of any morphological indication of saturation. In this instance these soils are mostly shallow underlined by a fractured bedrock. For this study the soils in question are Nkonkoni and Glenrosa forms. These soils are characterised weak structured and mostly sandy textured properties which allows for rapid infiltration of water. Below the soil material the presence of lithic material in the form of fractured rock still allows for percolation of water and thus the dominant hydrological pathway for these soils is vertical through and out the profile into the underlying aquifers. Therefore, these soils are referred to as recharge soils, as they are likely to recharge groundwater, or lower lying positions in the regolith via bedrock. Figure 14 below depicts typical ground water recharge soils identified within the investigation area.

Figure 14: An example groundwater recharge soils of associated with the investigation area.

5.2.2 Stagnating Soils

The soils in the investigation area can be classified as shallow stagnating for soil forms such as the Coega and the deep stagnating soils such as the Kolke soil form. The Coega soil form is characterised by the presence of a hard plinthic horizon underlying the Orthic A horizon. Whereas the Kolke soil form is characterised by the presence of a soft carbonate and material with signs of wetness underlying the Orthic A horizon. In both these soils outflow of water is limited or restricted due to the underlying impeding layer. The A and/or B horizons are permeable but morphological indicators suggest that recharge and interflow are not dominant. The solubility of lime in water makes it an important indicator of water accumulation in the landscape because it dissolves due to leaching and precipitates where water evaporates (van Tol *et al*., 2011). This phenomenon was observed in the Kolke soil forms where the presence of lime precipitates dominated the soil profile and these soils were observed more on depressional areas or wetlands. The hardpan carbonates of the Coega soil form were formed through cementation by silica and precipitation of iron as concretions and layers and thus cannot be cut with a spade. Both soils are frequently observed in regions with a very high evapotranspiration demand and the dominant hydrological flow path in the soil is upward, driven by evapotranspiration (Van Tol and Le Roux, 2019).Figure 15 below depicts typical stagnating soils identified within the investigation area.

Figure 15: An example of stagnating soils associated with investigation area.

Table 6 presents the hydrological grouping of soils occurring within the study area according to Van Toll and Le Roux (2016) while Table 7 presents their respective diagnostic horizon and textural characteristics.

Recharge (Deep)	Stagnating
Nkonkoni	Coega
Glenrosa	Mispah
	Plooysburg
	Kolke

5.3 Hydropedological and Recharge Implications

The recharge mechanism of the soils associated with the watercourses and their respective catchment areas are characterised by stagnating soils which are associated with high evapotranspiration demand areas. The subsurface flow contribution to the wetlands associated with the investigation area can be considered negligible. The shallow soils associated with the study area has resulted in streamflow channels associated with overland flow during rainfall events. These channels have the potential to recharge the wetlands in the investigation area. The wetland features are typically due to depressions in the landscape in the form of endorheic systems and perched shallow aquifers because of the low permeability of the hardpan carbonate and hard rock underlying the topsoil.

This section presents the hydropedological impacts that can be anticipated resulting from the proposed mine expansion project and considers the outcomes of the geohydrological studies in relation to the type of aquifers present and the groundwater levels. This section will also present an appropriate scientific buffer which is derived from taking into consideration the wetland ecology component as well as the significant wetland drivers to ensure that all wetland features are afforded protection in line with the applicable legislation.

No hydropedological losses is foreseen for these wetlands as interflow (sub-surface flows recharging the wetlands) soils were not present within the catchment of these systems. Even though this is the case, direct impact is foreseen for the wetlands overlain by the proposed developments, thus the recommendation of the freshwater report compiled by SAS (2021) should strongly be considered. Additionally, other components in the water balance, with specific mention of recharge by surface water runoff may be impacted particularly in areas where the surface infrastructure is located within the catchment area and separation of clean and dirty water areas takes place.

The results of the impacts based on the current layout can be summarised as follows:

- CWs 8, 9, and 18: These are located within the pit area may be subjected to various impacts as a result.

- CWs 1, 46, 49, 50, and 55 will be traversed by conveyors and the proposed railway line (for CWs 49 and 55 this is on the premise that the approved Leeuwfontein north WRD does not extend into those areas.
- CW 41 is partially located within the 35 m rehabilitation buffer around the approved Leeuwfontein north WRD expansion footprint.
- The remaining CWs, located between 20 m to 200 m of the proposed and existing activities are not expected to be subjected to serious impacts or to undergo extensive modification.
- Preferential flow paths will also be impacted although the severity of impact is considered limited. Refer to Freshwater report compiled by SAS (2021).

From a hydropedological perspective, if the cryptic wetlands and their applicable scientific buffers as defined in this report are avoided (as far as practicable) the proposed development is deemed acceptable. Avoidance of wetlands and applicable scientific buffers will ensure that the Present Ecological State (PES), wetland functionality as well as impact on the Ecoservices the wetland provides remain unchanged during all phases of development. It is therefore imperative that the recommendation presented in this document as well on the Freshwater Assessment Report (SAS, 2021), and the scientific buffer are implemented.

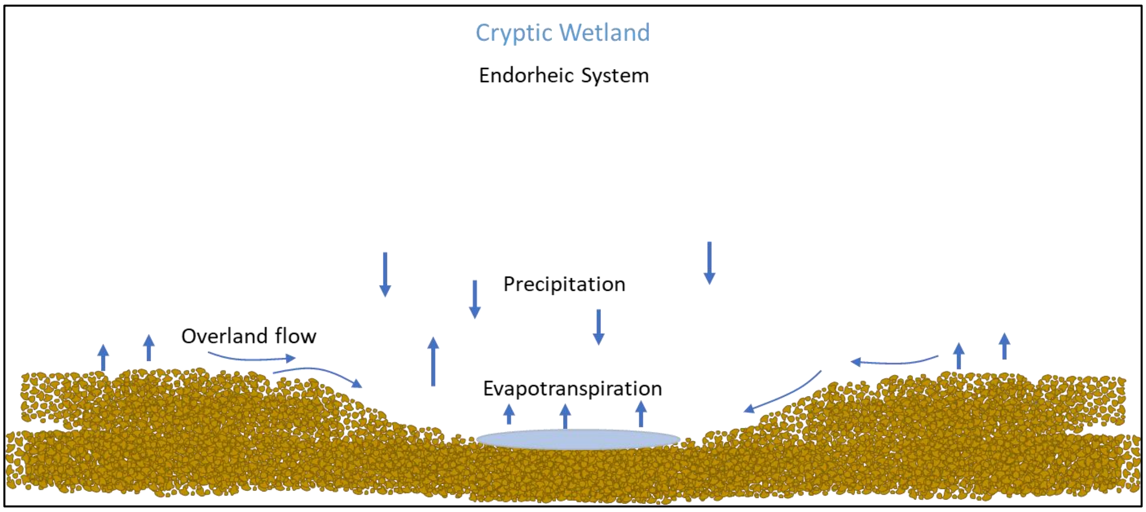


Figure 16: Conceptual hydrological flow paths of the wetlands associated with the investigation area

The outflow in the soils associated with the Cryptic wetlands is limited or restricted. The A and/or B horizons are permeable but morphological indicators suggest that recharge and interflow are not dominant. These include soils with carbonate accumulations and precipitates of lime in the subsoil, accumulation and cementation as concretions and layers. Although infiltration occurs readily, the dominant hydrological flow path in the soil is upward, driven by evapotranspiration (Van Tol and Le Roux, 2019). The drainage lines are anticipated to be recharged by direct precipitation and overland flow during the rainy season as they flow episodically.

5.3.1 Geohydrological Study Consideration

It should be noted that the groundwater information presented in this document was adopted from the scoping report draft for public comment (2021).

Aquifers

The geohydrological regime in the area is made up of two main aquifer systems namely:

- The upper, unconfined to semi-confined aquifer which occurs in the calcrete that covers the Kolomela mine. Spring formations are a common occurrence especially in the lower lying topography due to the shallow water table; and
- The deep semiconfined aquifer which is associated with fractures, fissures, joints and other discontinuities within the consolidated bedrock and associated intrusive of the Transvaal/Griqualand West sequences.

According to the draft scoping report (2021) effective recharge to the aquifer can be as high as 10% of rainfall and higher at certain areas. The major contributor to the recharge of the aquifer is through the rock cracks and fissures and the weathered zones in the calcrete surface cover or through sandy soils in depressional areas.

Groundwater levels

According to the ground water studies presented in the scoping report draft for public comment (2021) the static groundwater levels vary from zero meters (springs flowing out at surface), generally in the topographically lower lying areas, to a maximum of approximately 75 meters below surface to the north-east of Postmasburg (EXM Scoping Report Draft for Public Comment, 2021). Based on observation during the site visit, most of the wetlands were dry without freestanding water, however some did depict some form of wetness indicator (presence of lime precipitates). The groundwater component is not anticipated to provide a significant contribution although the perched shallow aquifer may contribute (to a degree) during the rainy season . Overall, the watercourses will therefore negligibly be impacted by the abstraction activities that will occur as part of the proposed expansion project

5.3.2 Buffer Determination Using Hydropedological Principles

A scientifically derived buffer was developed to ensure that appropriate consideration of the hydropedological drivers in the investigation area is given in support of the principles of Integrated Environmental Management (IEM) and sustainable development. Refer to Figure 19 and Figure 20. The buffer was developed to indicate the required setback to appropriately negate the impact of mining on the recharge mechanisms various cryptic wetlands pans to minimise impact in line with the mitigation hierarchy, although no significant impact would occur if slight encroachment on the buffer was to occur.

Due to the arid nature of the area where the proposed development is to occur and the absence of hydropedologically important soils, the scientific buffer was developed taking into consideration the catchment area of the wetlands to ensure that all runoff occurring under normal circumstances reaches the wetlands.

The proposed mining expansion footprints indicate that several watercourses and cryptic wetlands will be impacted as a result; the significance of impacts varies depending on the nature of the activity and extent thereof, but none are deemed to have ‘high’ risk significance and most can be feasibly mitigated (SAS, 2021). The footprint of the Leeuwfontein North Dump has already been approved for development and thus total avoidance of the cryptic wetlands within the footprint may not be feasible.

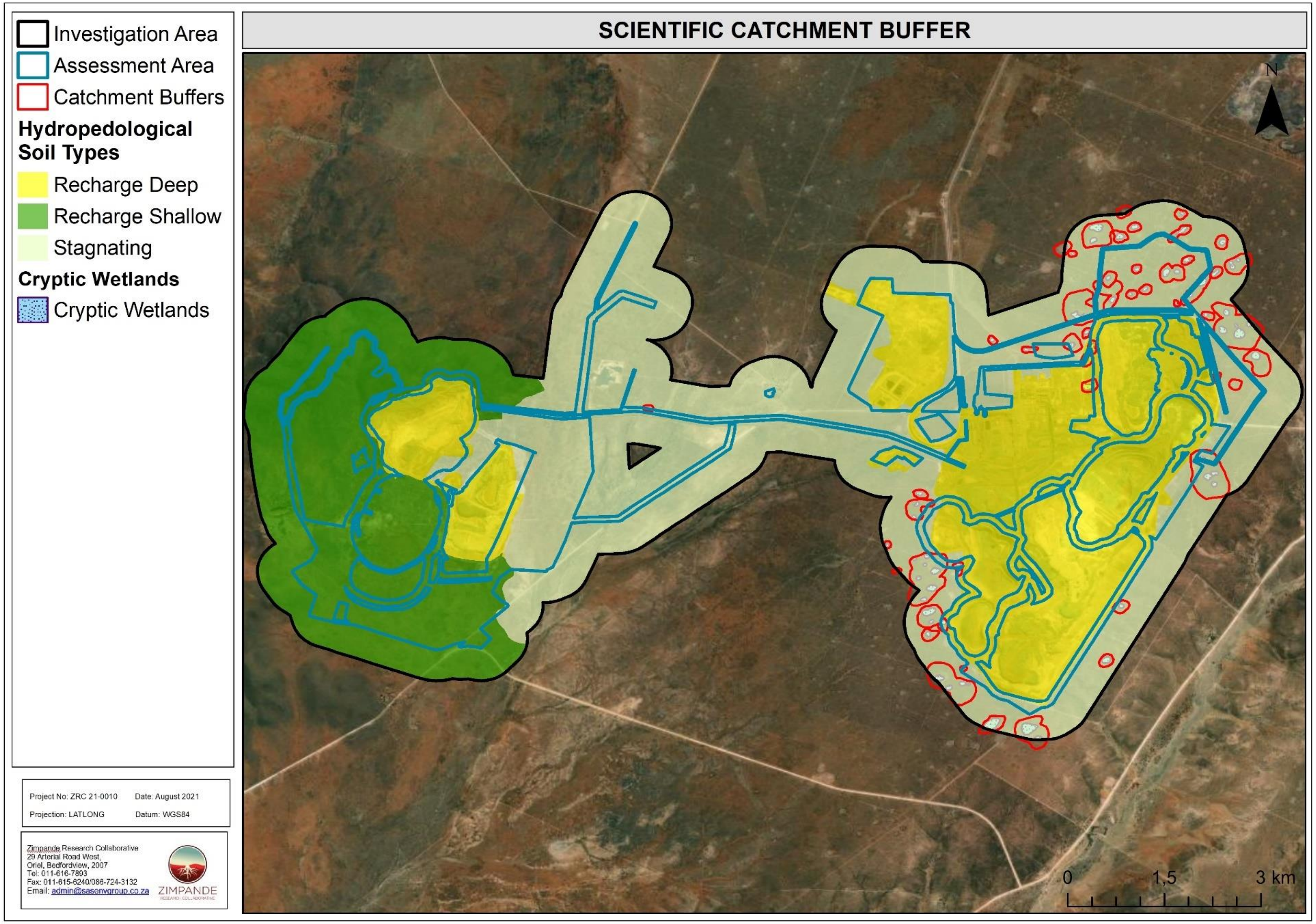


Figure 17: Applicable scientific buffer applicable to the wetlands for best practice in line with the mitigation hierarchy.

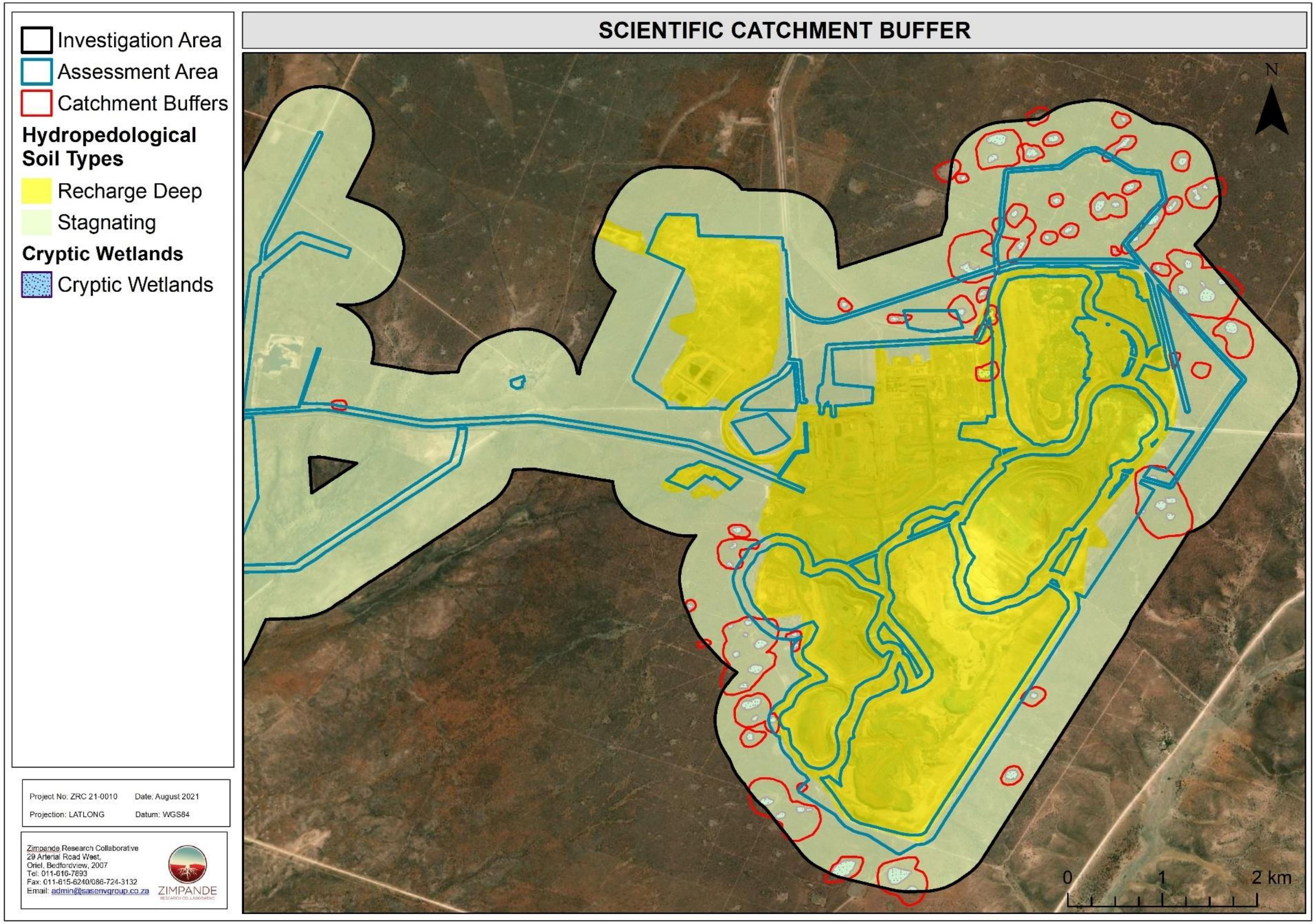


Figure 18: Applicable scientific buffer applicable to the wetlands for best practice in line with the mitigation hierarchy.

6 CONCLUSIONS AND RECOMMENDATIONS

The investigation area is characterised by soils with recharge and stagnating properties. The recharge shallow soils do not depict any signs of prolonged saturation, with the dominant flow direction being vertical through and out of the profile. On these types of soils, no wetland features were identified. On the other hand, soils with stagnating properties were dominated by cryptic wetlands and seasonal depressions features. This can be attributed to the low permeability of the hardpan carbonate and solid rock underlying the topsoil. These features occur on mostly on depressional areas and thus allow for wetland temporary zones, meaning they are saturated for short periods in a year due to the high evapotranspiration demand of the investigation area. Although, saturated for short periods these wetland features are still considered to be of Ecological Importance and should be afforded the necessary protection.

The draft scoping report for public comment (2021) indicated that the static groundwater levels vary from zero meters (springs flowing out at surface) typically in the lower lying areas, to a maximum of approximately 75 meters below surface to the north-east of Postmasburg (EXM Scoping Report Draft for Public Comment, 2021). During the site visit it was observed that majority of the wetland features and seasonal depressions were dry without freestanding water, however some did depict some form of wetness indicator (presence of lime precipitates). The groundwater component is not anticipated to have a significant contribution (if any) to the wetlands associated with the investigation area. The watercourses will therefore not be impacted by the development activities that will occur as part of the proposed expansion project.

No hydropedological losses is foreseen for these wetlands as interflow (sub-surface flows recharging the wetlands) soils were not present within the catchment of these systems. Even though this is the case, direct impact is foreseen for the wetlands overlain by the proposed developments, thus the recommendation of the freshwater report compiled by SAS (2021) should strongly be considered. Additionally, other components in the water balance, with specific mention of recharge by surface water runoff may be impacted particularly in areas where the surface infrastructure is located within the catchment area and separation of clean and dirty water areas takes place.

The footprint area is largely dominated by cryptic wetlands, thus total avoidance of direct impact on the watercourses will be impractical. The construction activities should aim to avoid developing within the scientific buffers where feasible. Alternatively, the mine should aim to minimise the disturbance within the scientific buffers as far as practically possible. Key recommendations presented below and those presented in the freshwater report compiled by

SAS (2021) should strongly be considered, particularly during the finalisation stage of the footprint layout. This will ensure that the Present Ecological State (PES), wetland functionality as well as impact on the Ecoservices the wetland provides remain unchanged during all phases of development

Recommendations have been developed in the points below to mitigate impacts on the receiving environment:

- Although some wetlands will be directly impacted, all development footprint areas to remain outside of the wetlands and associated scientific buffer as far as practically possible;
- Contractor laydown areas, and material storage facilities to remain outside of the cryptic wetlands, as well as the applicable scientific buffer;
- The watercourses must be protected against erosion arising from the stormwater runoff from the associated infrastructural areas. In this regard, runoff should be attenuated before discharging into the wetland, thus recharging the wetlands in an ecologically appropriate manner.
- Implementation of strict erosion control measures to limit loss of soil and sedimentation of the wetlands adjacent to the proposed project;
- All surface development footprint areas should remain as small as possible and disturbance of soil profiles to be limited to what is absolutely essential;
- Following the completion of the construction phase, areas of disturbance, particularly adjacent to the watercourse should be monitored at least once after an erosive rainfall until the natural vegetation has well established.

If the above mitigatory measures are implemented, with careful construction practices, the PES class of the wetlands is unlikely to occur, and the development is deemed acceptable from a hydropedological and water balance perspective.

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Van Tol, J.J., Le Roux, P.A.L. & Hensley, M. 2013. Pedological criteria for estimating the importance of subsurface lateral flow in E horizons in South African soils. Water SA (39):1

Van Tol, J.J., Le Roux, P.A.L., Lorentz, S.A., Hensley, M. 2013. Hydropedological classification of South African hillslopes. Vadose Zone Journal.

APPENDIX A: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

Braveman Mzila BSc (Hons) Hydrology University of KwaZulu-Natal

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Zimpande Research Collaborative		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

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Signature of the Specialist

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Braveman Mzila, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

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Signature of the Specialist

1. (c) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Tshiamo Setsipane, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

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Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments
- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments
- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies
- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment
- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment
- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments
- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Joined SAS Environmental Group of Companies	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Soil Science Society (SASSO)

Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

BSc (Hons) Environmental Hydrology (University of Kwazulu-Natal)	2013
BSc Hydrology and Soil Science (University of Kwazulu-Natal)	2012

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape, KwaZulu-Natal

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES (SEGC) –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF TSHIAMO SETSIPANE

PERSONAL DETAILS

Position in Company	Soil Scientist/ Hydropedologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Council for Natural Scientist Professions (SACNASP)

EDUCATION

Qualifications

M.Sc. (Agric) Soil Science (*Cum Laude*)	(University of the Free State)	2019
B.Sc. (Agric) Honours Soil Science	(University of the Free State)	2014
B.Sc. (Agric) Soil Science & Agrometeorology	(University of the Free State)	2013

COUNTRIES OF WORK EXPERIENCE

South Africa – Kwa-Zulu Natal, Northern Cape, Mpumalanga and Free State

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments