

Appendix C3_Hydropedological Assessment



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HYDROPEDOLOGICAL OPINION AS PART OF THE WATER USE LICENSE (WUL) APPLICATION PROCESS FOR THE PROPOSED KWEZI UNDERGROUND MINE EXPANSION IN RUSTENBURG, NORTHWEST PROVINCE.

1. INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed to provide a hydrogeological opinion as part of the Water Use License (WUL) application process for the proposed mining right expansion for Sibanye Stillwater Kwezi shaft underground mine, near the town of Rustenburg, North West Province. The boundary of the proposed mining right expansion, namely Block A and Block B, will hereafter be collectively referred to as the "study area".

The study area is situated approximately 4.2 km north of Rustenburg Central Business District (CBD) and 8.5 km southeast of Phokeng. The operation is located in the Rustenburg Local Municipality under the jurisdiction of Bojanala Platinum District Municipality in the Northwest Province. Refer to Figures 1 and 2 for the locality of the proposed Kwezi mining right expansion.

The footprint area for the proposed underground mine expansion comprises of a nearby watercourse. Thus, it was deemed necessary to investigate the recharge mechanisms of the watercourse system within the immediate surroundings and in close proximity to the study area to ensure that development and planning takes cognisance of the hydrogeologically important areas and hence, enable informed decision making, and construction design in support of the principles of sustainable development.

A site assessment was undertaken on the 5th of July 2024, where the desktop data, literature review, and the background researched information were field verified, the results of which are presented in this document.

The objective of this study was to:

- Investigate the hydrogeological drivers of the watercourse features to be affected by the proposed development;
- Determine the risk of the proposed development on the receiving watercourses, if any, due to changes that the proposed development will initiate in the hydrological drivers and particularly hydrogeological processes;
- Define whether the development is acceptable from a hydrogeological perspective;
- Determine a suitable scientific buffer to avoid direct impact of watercourse as well as minimise impact on the hydrogeological process (if any) which are important for recharging the affected watercourses; and
- Develop site specific mitigation measures to guide the proposed development.

This investigation focuses on the hydrogeological properties of the soils identified within the study area of the proposed development as well as the soils within the watercourse system identified within the immediate vicinity of the proposed development, to infer the potential recharge mechanisms and destination of the transferred water of the surrounding soils that may be affected by the proposed underground mine expansion.

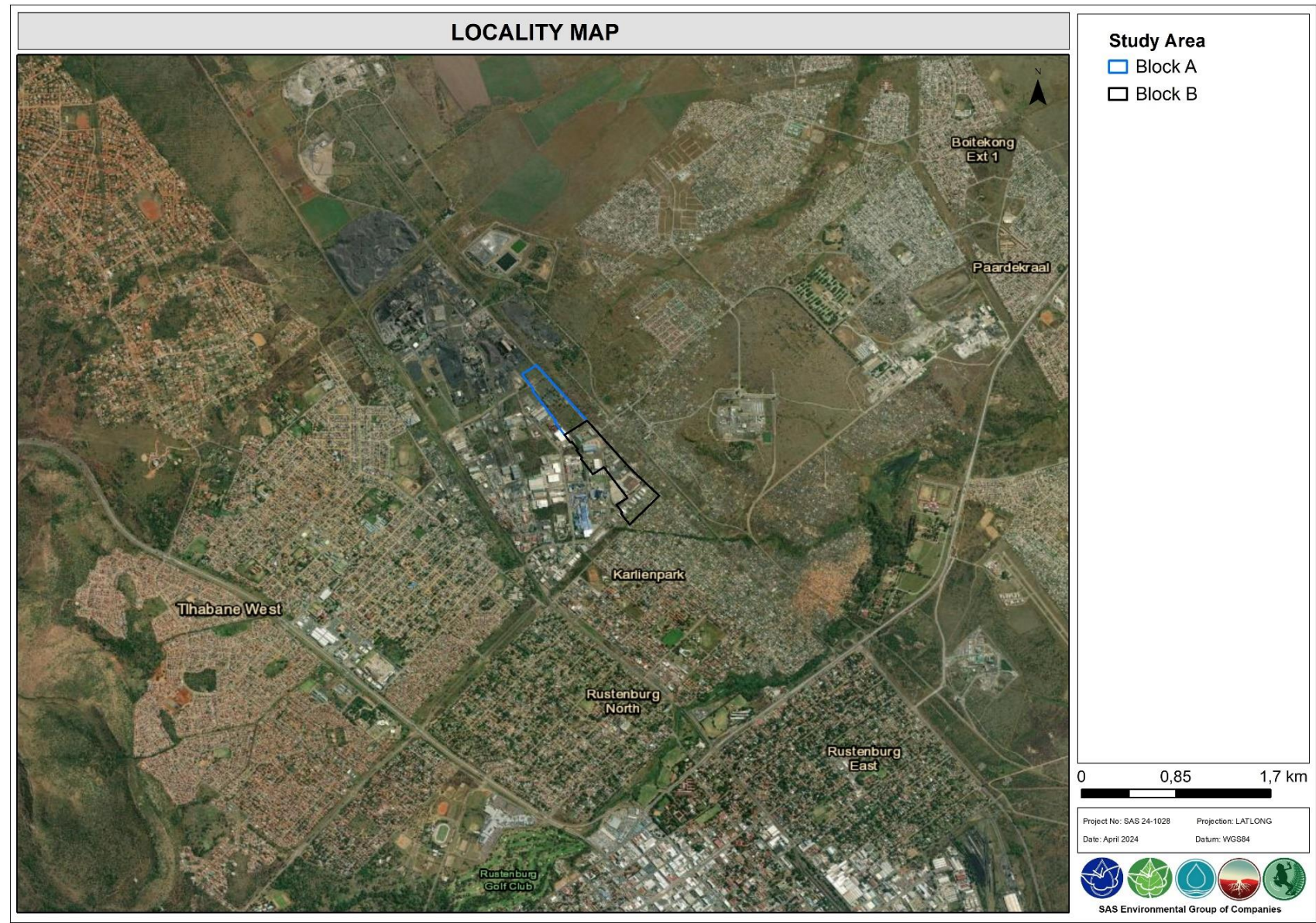


Figure 1: Locality map depicting the study area and surrounding areas.

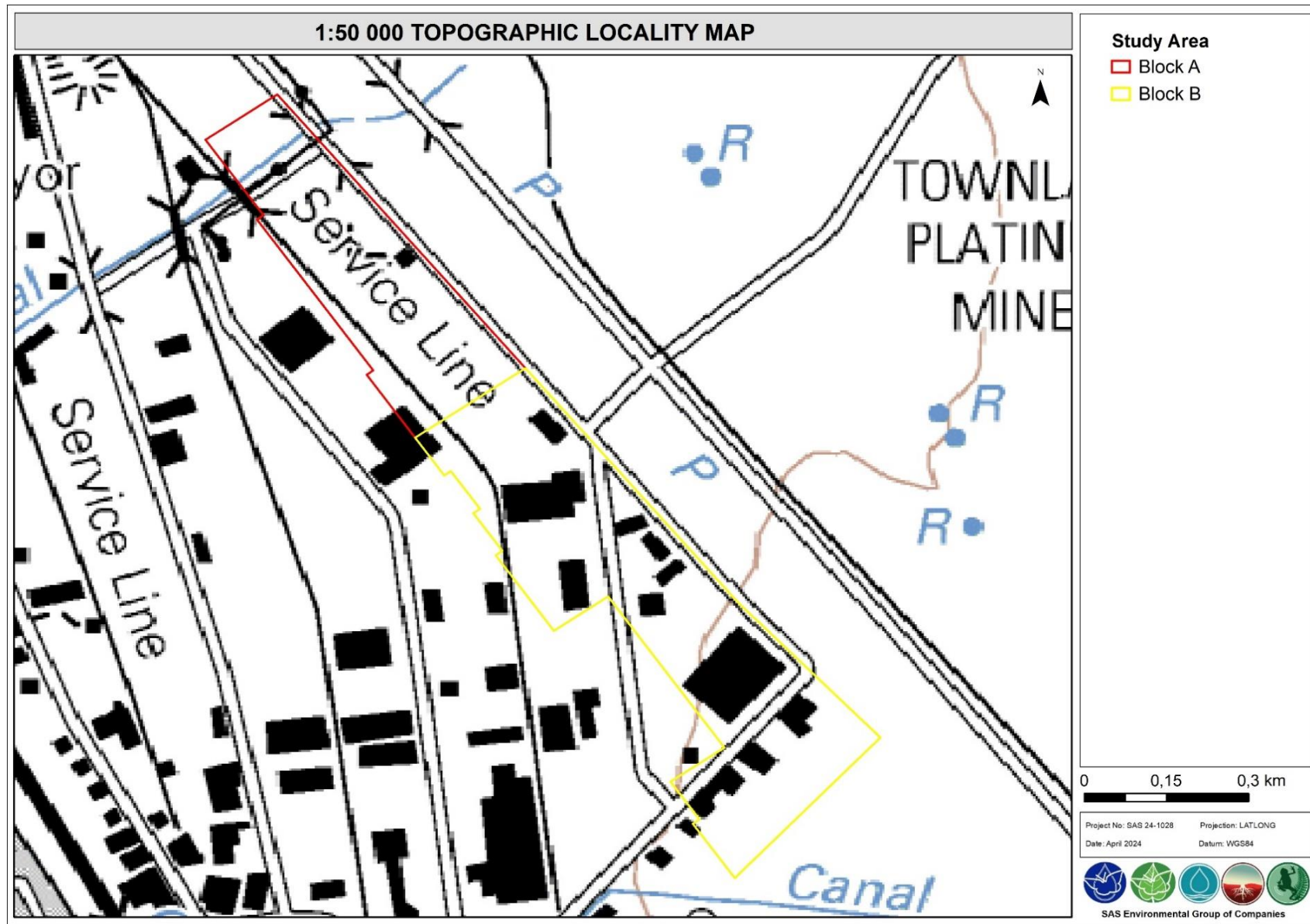


Figure 2: Topographic (1:50 000) locality map depicting the study area in relation to the surrounding areas.

2. ASSUMPTIONS AND LIMITATIONS

- This assessment is confined to the study area as depicted in Figure 1, and does not include the neighbouring and adjacent properties, although possible catchment impacts occurring on surrounding properties were taken into consideration.
- Although the delineations of the hydropedological soils is confined to the boundaries of the study area, adjacent areas were considered to understand the hillslope processes which drive the watercourse response.
- Sampling means that not all areas are assessed, and therefore some aspects of soil and hydropedological characteristics may have been overlooked in this assessment. However, it is the opinion of the professional soil specialist that this assessment was carried out with sufficient sampling and in sufficient detail to enable the proponent, the Environmental Assessment Practitioner (EAP) and the regulating authorities to make an informed decision regarding the proposed activity.
- The effects of climate change dynamics were not considered as part this assessment; however, it is acknowledged that this might exacerbate the anticipated reduction in water inputs and the resultant hydrological function of the watercourse beyond the extent of the proposed development.

3. SITE CONDITIONS

Upon the site visit conducted in July 2024, the following observations were made:

- The study area for the proposed underground mining right expansion is largely dominated by industrial activities, thus resulting in a significantly modified and heavily transformed landscape setting as well as already disturbed (Witbank – Transported Technosols) soil;
- Since the industrial area has been developed, it is characterised by impervious surfaces which have altered the hydrological and hydropedological processes of the area, with specific mention to surface runoff, infiltration and subsurface flows (if any); and
- Runoff from the constructed stormwater canal and adjacent roads have potentially augmented the surface water input into the downstream system such that the watercourse receives increased volumes of water, leading to development of prominent wetness indicators and hydrophilic vegetation.



Figure 3: Images depicting the landscape setting associated with the proposed underground mining area.

4. ECOLOGICAL CONSIDERATION

The proposed underground mining area is characterised by the channelled valley bottom (CVB) wetland to the north of the study area. The surrounding urbanised areas (and associated hardened surfaces and stormwater discharge) increases the volume and velocity of water draining into the wetland. However, small scale abstraction, road crossings and alien invasive plants (AIP) encroachment within the wetland has likely resulted in a decrease in the natural flood peaks of the wetlands.

The above-mentioned system will potentially be impacted by the proposed development; thus, it was important to get a sense of their Present Ecological Status (PES) to ensure that necessary protection is afforded. It should be noted that the results presented in the table below were sourced from a Freshwater study done by Scientific Aquatic Services (SAS) in 2024 and thus should be considered with caution as the condition of some portions of the systems may have changed.

Table A: Summary of the results of the field assessment, (SAS Freshwater Study, 2024).

Freshwater Ecosystem	PES	Ecoservices	EIS	REC
Channelled Valley Bottom (CVB)	E	Low to Very Low	Low/Marginal	D

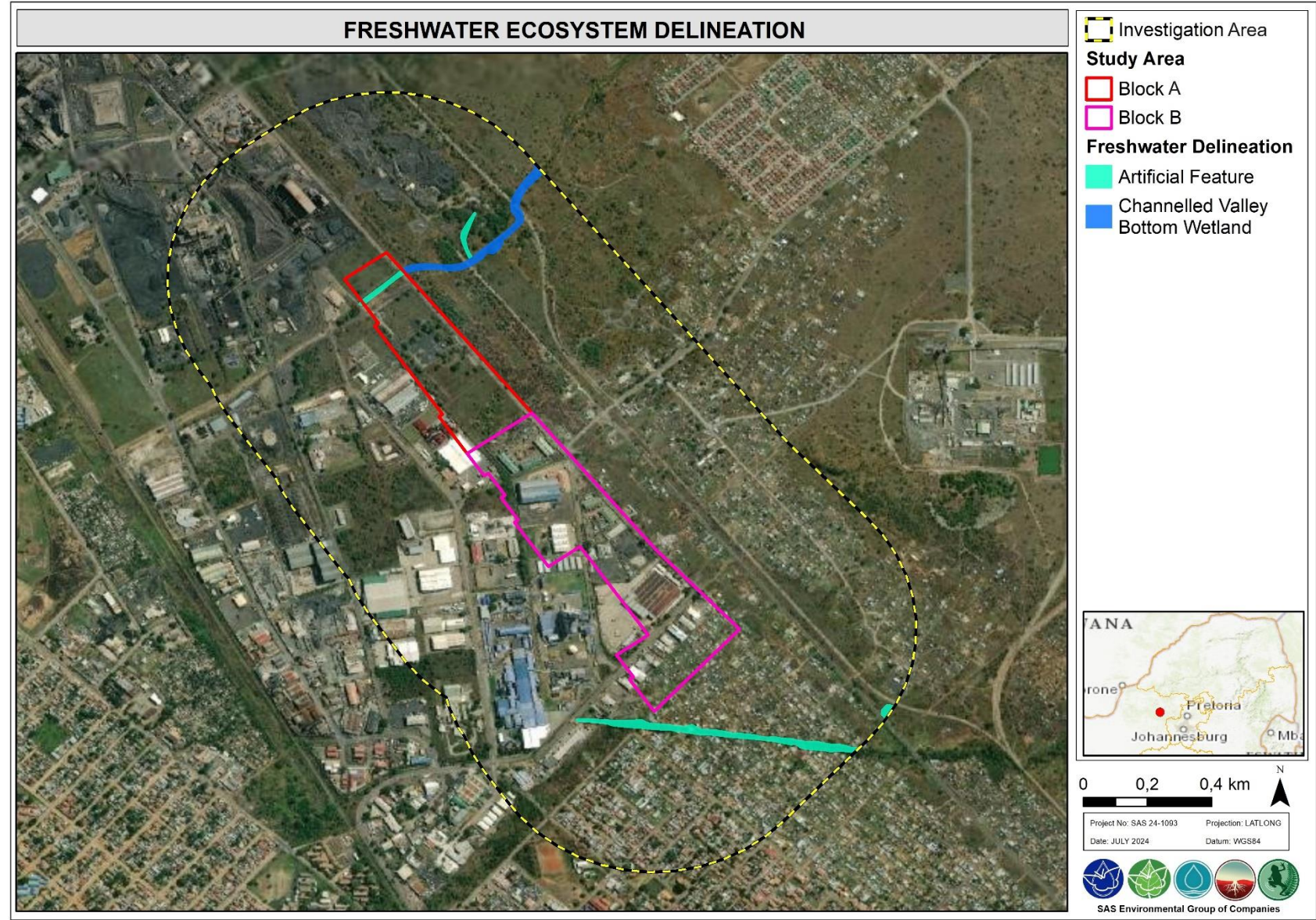


Figure 4: Freshwater features associated with the proposed underground mining right expansion.

5. HYDROPEDOLOGICAL CONSIDERATIONS

5.1 Recharge of the Watercourse Systems

Generally, there are four primary wetland recharge mechanisms, and these include direct precipitation (rainfall), surface flow (runoff), subsurface flow (interflow) through the vadose zone of the surrounding soils, and groundwater discharge. Identified soils within the study area have been grouped into hydro pedological soil types and are discussed below to understand their contribution to wetland recharge.

The study area is dominated by disturbed soils associated with the Witbank (Transported Technosols) soil forms which covers approximately 25.6 ha (62.2%) of the total enclosed area, whilst deep soils of the Swartland soil form account for approximately 10.9% of the total enclosed area. The Witbank soils have been extensively disturbed such that no natural and recognisable diagnostic soil morphological characteristics could be identified. As a result of this modification of the natural horizon, the soil structure and drainage properties have been altered. The Swartland soil form is characterised by an orthic topsoil horizon underlain by a high in clay content, pedocutanic subsurface horizon with a depth of approximately 70 – 80 cm. This soil form is hydro pedologically grouped as a recharge deep soil which contribute to the groundwater regime in the landscape.

The study area for the proposed underground mining right expansion also characterises shallow soils of the Glenrosa formation. The shallow nature of this soil form is largely attributed to the to rock weathering material which is semi-impermeable, and the soil depth is relatively shallow (0 – 20 cm) hence they quickly result in a generation of overland flow of water during rainfall events. Shallow soils are hydro pedologically termed responsive shallow.

Table 1 below presents the classification of different identified soil forms according to their hydro pedological soil groups while Table 2 provides a description of their respective recharge mechanisms.

Table 1: Classification of soils in terms of hydro pedological recharge mechanisms.

Responsive (Shallow – Watercourse)	Recharge (Deep)	Recharge (Shallow)	Responsive (Shallow)
Dundee (Alluvial)	Swartland	Witbank (Transported Technosols)	Glenrosa

Table 2: Description of soils in terms of hydro pedological recharge mechanisms.

Soil Forms	Recharge Mechanism	Diagnostic Horizons	Description
(Dundee) Alluvial	Responsive (Shallow) - Watercourse	- A: Orthic - B: Alluvial Material	These soils are made of deposited soil material from the upgradient areas in the catchment and have little signs of pedogenic horizonation. Some alluvial material along the banks of the watercourse may display evidence of stratification but not thick enough to be classified as separate horizons.
Glenrosa	Responsive (Shallow)	- A: Orthic - B: Lithic	Relatively shallow soils overlying lithic material or plinthic material. These soils are characterised by limited storage and typically located along sloping terrain which generally induces overland flow when the soil saturates.
Swartland	Recharge (Deep)	- A: Orthic - B: Pedocutanic - C: Lithic	Relatively deep, loamy sand of poor structural stability, overlying red/light brown, and unspecified material. Vertical flow is dominant. These soils are referred to as recharge soils, as they are likely to recharge groundwater, or lower lying positions in the regolith, via the bedrock.

Soil Forms	Recharge Mechanism	Diagnostic Horizons	Description
Witbank (Transported Technosols)	Recharge (Shallow)	Unspecified	These soils are disturbed such that the diagnostic horizon could not be identified. Vertical flow is dominant. These soils are referred to as recharge soils, as they are likely to recharge groundwater, or lower lying positions in the regolith, via the bedrock.

5.1.1 Responsive (Shallow - Watercourse)

A watercourse feature connected to the stormwater canal within the proposed mining area was identified immediately downgradient of the study area. This system is largely hydraulically driven by the discharge from the canal running over the proposed underground mining area. Responsive (shallow - watercourse) soils within a watercourse lead to a rapid runoff response time during intense rainfall events. This is attributed to the already present wetness/surface water which which inhibits further water infiltration into the soil. In addition, alluvial soils are often characterised by the presence of an impermeable underlying bedrock which leads to streamflow generation during a rainfall event. These soils are normally associated with artificial and/or natural watercourses such as the channelled valley bottom (CVB) and stormwater diversion and management plans.



Figure 5: Photograph presenting identified soils occurring within the watercourse system associated with the study area.

5.1.2 Recharge (Deep) Soils

These soils are characterised by the absence of any morphological indication of saturation and are typically associated with deep, well aerated, and freely drained soils. The dominant hydrological pathway for the recharge deep soils (Swartland) is vertical through and out the profile into the underlying bedrock. These soils are referred to as recharge soils, as they are likely to recharge groundwater, or lower lying positions in the regolith via bedrock.

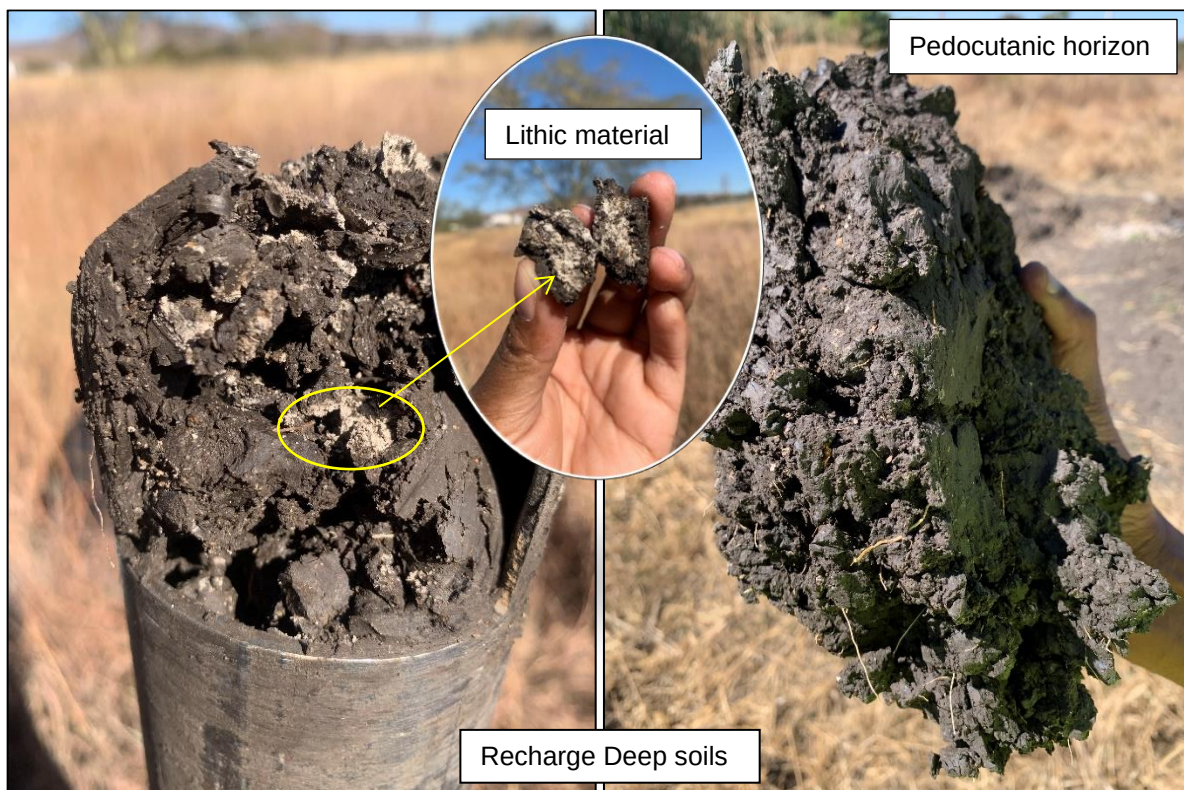


Figure 6: Photograph representing recharge deep soils.

5.1.3 Responsive (Shallow) Soils

The Glenrosa soils are loamy to loamy sand and often comprises of rock fragments which makes them relatively shallow (0 – 20 cm soil depth). These soils have a poor topsoil structure that is directly overlying a relatively impermeable bedrock. Responsive shallow soils are often characterized by an abrupt transition between the topsoil and the underlying horizon of a lithic/hard rock material. As a result, their limited water storage capacity that is attributed to their shallow nature inhibits water infiltration into the soil profile, consequently resulting in generation of overland flow following intense rainfall events. The impermeability of the underlying rock promotes slow and limited discharge to the stream on the soil/bedrock interface because it competes with evapotranspiration (ET) extraction of soil water. The slope positioning of the soils is typically the crest and scarp in most instances. Although these are not considered as wetland soils, they contribute significantly towards the recharge mechanisms of wetlands, particularly during rainfall events by means of overland flow.



Figure 7: Photograph presenting identified shallow soils associated with the responsive shallow hydropedological group.

Figure 8 below presents the dominant soil forms identified within the study area for the proposed underground mining right expansion while Figure 8 presents the hydropedological soil groups and their respective recharge mechanisms.

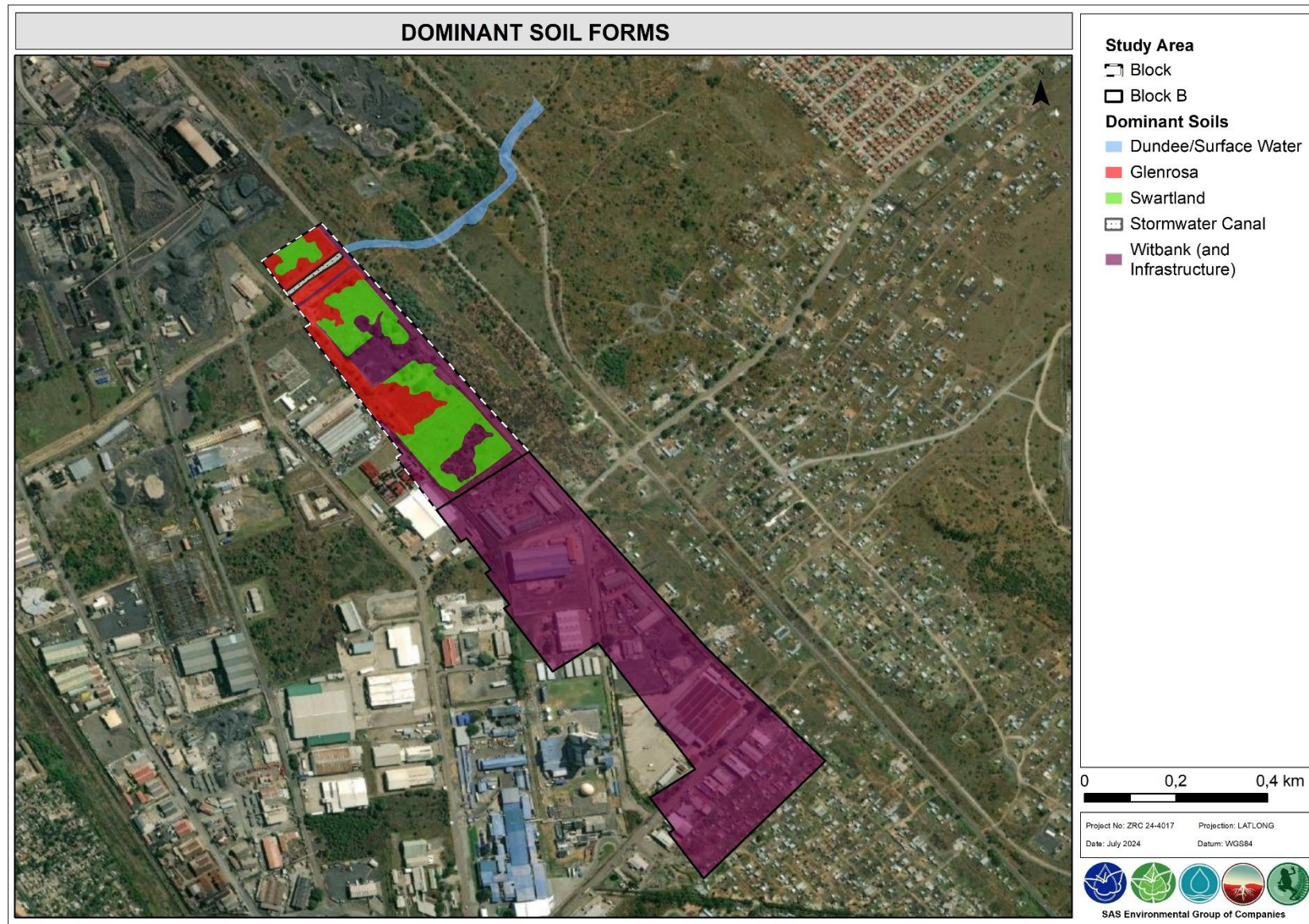


Figure 8: Dominant soil forms associated with the proposed development and immediate surroundings.

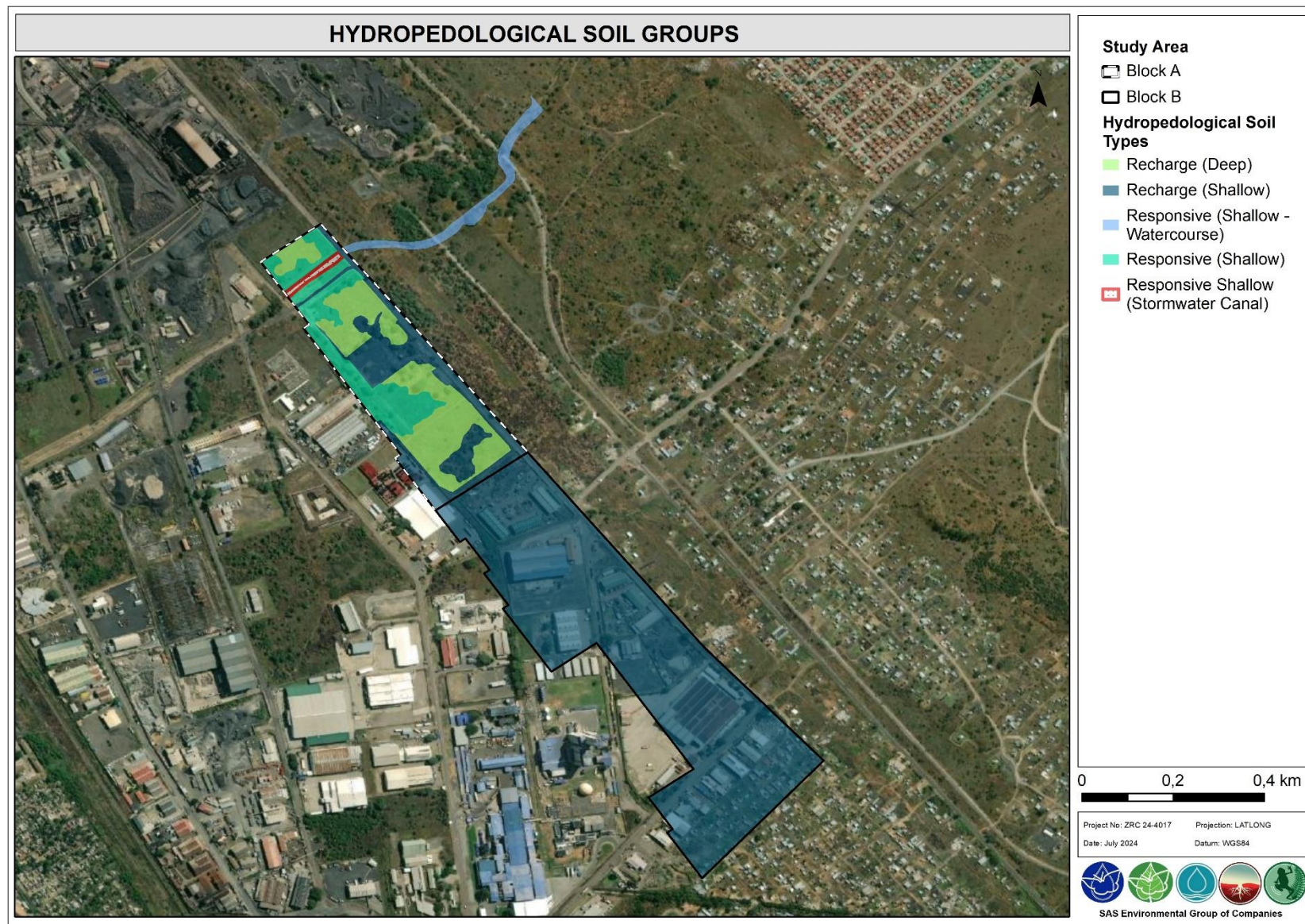


Figure 9: Hydromorphological soil groups associated with the soil forms identified within the study area and immediate surroundings.

6. FINDINGS AND IMPACT STATEMENT

The study area is dominated by mainly already disturbed soils (Witbank – Transported Technosols) associated with mining and related surface infrastructure, access roads, and sealed surfaces as a result of the industrialisation of the area. The impact of the proposed underground mining area on hydropedologically important soils or areas that are considered of increased importance in watercourse recharge is considered very low. This is attributed to the nature of the proposed mining operation (underground mining) and the dominant soils as well as their respective hydropedological recharge mechanisms (recharge and responsive shallow) which are not considered a risk from the proposed mining of the area. However, the study area also comprises portions of recharge deep soils which have the ability to recharge groundwater. The current underground mine workings have likely been dewatered and as such groundwater is not anticipated to significantly influence the functioning of surface water and surrounding watercourse features. However, this should be confirmed by the suitability of qualified geohydrologist to ensure that the important watercourse drivers remaining unimpacted during all phases of development.

No impact is therefore foreseen during the operational phase of the proposed underground mining expansion development because of underground mining and related activities. Additionally, the operation phase of the proposed development will not modify the hydropedological processes and the functionality of the wetland/watercourse will remain unchanged.

Table 3 below presents impact categories for describing the impact significance of the proposed development on the watercourses/wetlands and associated hydropedological drivers. The green-highlighted row indicates the impact category for this particular proposed development.

Table 3: Impact categories for describing the impact significance of the proposed development on the wetlands, and associated hydropedological drivers.

Severity	Percentage losses (Soil Saturation Index Reduction)	Change Class	Description
No Impact	0 – 2.5 %	No change ✓	Hydropedological processes 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 is 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 wetland may have taken place but 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	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.

		loss of wetland resource	
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From the above table, the proposed underground mining development is anticipated to have no significant impact on the hydrogeological drivers of the nearby watercourse system. the functionality of the wetland will remain unchanged during the operational phase.

7. SCIENTIFIC BUFFER DETERMINATION

The perceived impact of the proposed developments on the hydrogeologically important soils is considered to range between low and negligible given the absence of hydrogeologically important soils (interflow soils), as a result, the derivation of a scientific buffer is not deemed necessary, however an edge effect buffer of 50 m is recommended. This buffer serves as a precautionary measure for the proposed development and guides the proponent to minimise the risk of subsidence within the 50 m of the channelled valley bottom. Recommendations of the geotechnical specialist report should be adhered to in order to prevent subsidence. The proponent should be cognisant of the edge effects and the surface runoff as well as the groundwater component reporting to and recharging the watercourse system.

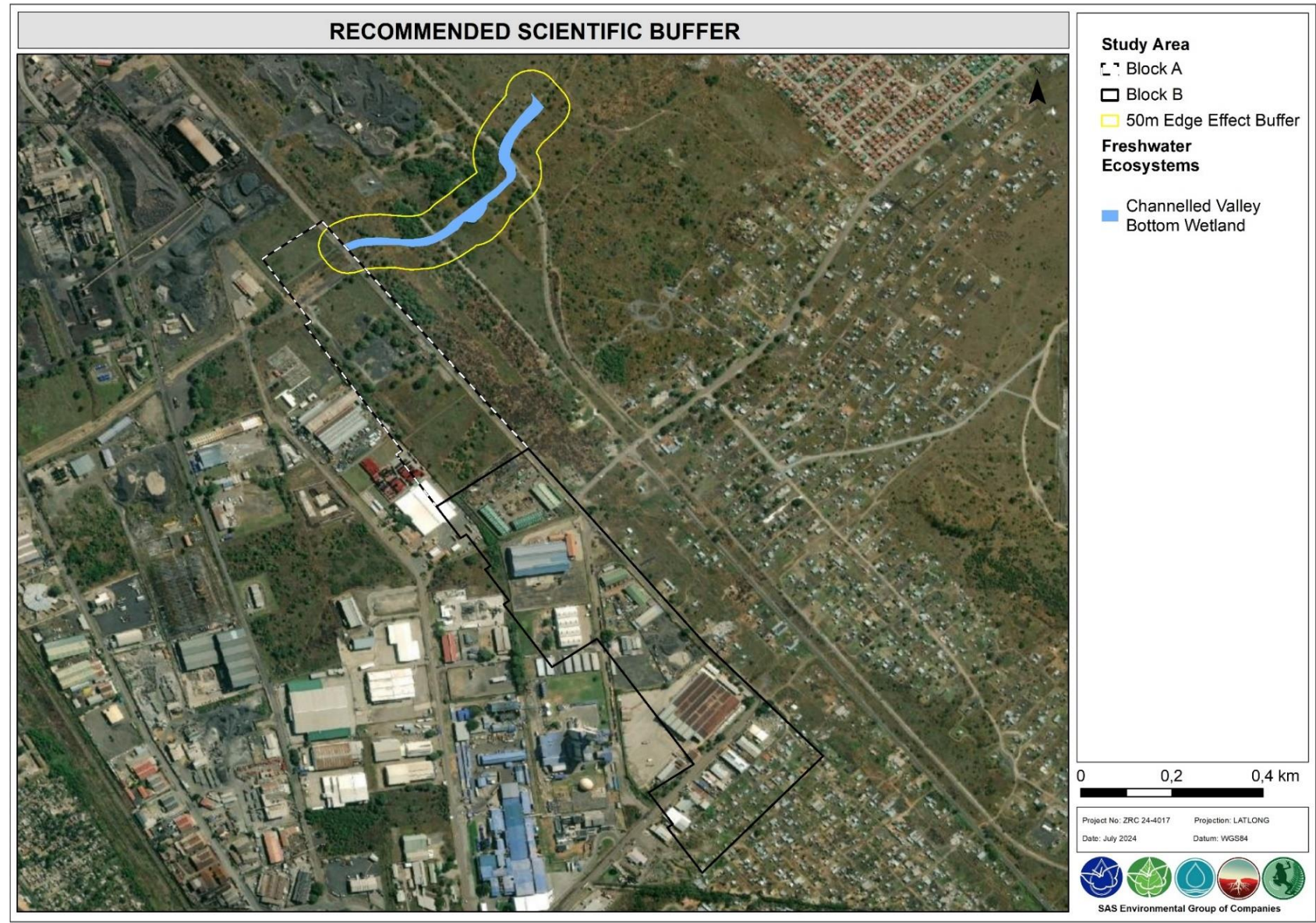


Figure 10: Map depicting the recommended scientific buffer.

8. CONCLUSION AND RECOMMENDATIONS

Although the hydropedological losses are anticipated to be very limited due to the absence of interflow soils and/or soils of significant vadose zone water storage capacity within the development footprint area, the following mitigatory measures and recommendations have been compiled and these include but not limited to:

- The recommendations of the rock engineer report should be adhered to and sufficiently implemented to ensure that underground extraction of ore and related activities does not lead to the destabilisation of the surrounding environment and subsequent potential subsidence of the land and creation of a cone of depression, thus ensuring the functionality of the watercourse throughout all phases of development;
- Groundwater studies should be consulted to understand the static water levels and ensure that the groundwater does not influence the watercourse feature within the expansion area. Recommendations of the groundwater studies should strongly be adhered to.
- All the proposed development activities should remain within demarcated footprint area as far as possible and disturbance of soil profiles to be limited to what is essential with a compact footprint;
- Excavation activities within the watercourse systems must be avoided as far as practically possible; and
- Ensure that the post development runoff does not exceed the pre-development runoff budget;
- Water from diverted clean water areas should be discharged back into the watercourse in an attenuated manner.

The demarcated footprint area for the proposed Kwezi underground mining right expansion is deemed developable from the hydropedological risk management point of view, provided that the above mitigatory measures are implemented.

We trust we have interpreted your requirements correctly. Please do not hesitate to contact us if there are aspects of our proposal that you would like to discuss further.

Yours Faithfully,

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Stephen van Staden