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SPECIALIST REPORT

Soil and hydropedological assessment of the proposed Zola Public Transport Facility development area in Soweto, Gauteng Province

Requested By

Ecotone Freshwater Consultants

Compiled By

Rehab Green Monitoring Consultants CC
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Abbreviated Curriculum Vitae

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Professional career:	1991-2004 Institute for Soil Climate and Water 2004-2022 Principal consultant of Rehab Green Monitoring Consultants cc
Experience:	30 years experience in: - pre-mining soil, hydro-pedological and land capability classification, mapping and impact assessments; - Post-mining rehabilitated soil and land capability assessments; - Pre-mining soil stripping plans and procedures for optimal rehabilitation and post-mining land capability achievements. - Pre- and post-mining soil fertility assessments for re-vegetation and fertilizer application purposes. - GIS surface analyses and map compilations.

Declaration of Independence

I, Piet Steenekamp (ID 680211 5009 08 9), hereby declare that I have no conflict of interest related to the work of this report. Specially, I declare that I have no personal financial interests in the property and/or development being assessed in this report, and that I have no personal or financial connections to the relevant property owners, developers, planners, financiers or consultants of the development. I declare that the opinions expressed in this report are my own and a true reflection of my professional expertise.

Declaration of Professional Registration

I, Piet Steenekamp, hereby declare that I am registered at The South African Council for Natural Scientific Professions (Reg. No. 200032/04) as a Certificated Natural Scientist in terms of section 20(3)(c) of the Natural Scientific Professions Act, 2003 (Act 27 of 2003) in the following field of practice (Schedule 1 of the Act): Soil Science.

P.I. Steenekamp

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1. INTRODUCTION

1.1 Project Location

The proposed Zola Public Transport Facility development area is situated in Soweto, more or less in-between Roodepoort to the North, Lenasia to the south, Johannesburg to the east and Randfontein to the Northwest (Figure 1a).

Figure 1a: Regional setting of Summer Symphony Sand Mine

1.2 Scope of work

Rehab Green Monitoring Consultants cc was appointed by Ecotone Freshwater Consultants (Ecotone) to conduct a soil and hydropedology assessment of the proposed Zola Public Transport Facility development area.

1.3 Study aims and objectives

Based on the scope of work the study objectives were to:

- Conduct a detailed soil assessment of the proposed development site;
- Classify and map soil forms according to the South African Taxonomic Soil Classification System, 1991;
- Identify soil properties related to wetness to enable the delineation of wetland or riparian zones based on guidelines of the Department of Water Affairs, 2003; and
- Group soil types in hydropedological zones based on internal drainage properties.

1.4 Assumptions and limitations

The extent of the study area is provided by Ecotone in electronic kml file format named “D19046 Zola layout wg27.KML”. This location was assessed and is referred to as the soil assessment area and is larger than the proposed development site as indicated on all maps.

2. METHODOLOGY

2.1 Field preparation procedures

Geographic Information System (GIS) software from Esri (Environmental Systems Research Institute) called ArcGIS-ArcMap was used to generate spatial data and to store and process field data for map compilations.

A grid of field observation points were generated across the study area at a density of 50 m x 50 m. The coordinates of the observation points were calculated and loaded on a Geographic Positioning System (GPS) to accurately locate the position of the observation points in the field. The study area and field observation points were superimposed on Google Earth satellite imagery for the compilation of large scale field maps.

2.2 Field and soil classification procedure

The soils were investigated by means of auger holes to a depth of 1500 mm or to refusal. The soils were described and classified according to the South African Taxonomic Soil Classification System (Soil Classification Working Group, 2nd edition 1991). The system of soil classification is explained in Appendix A.

The following procedure was followed to note soil properties and classify soils accordingly:

i) Identify applicable diagnostic horizons by noting the physical properties such as:

- Effective depth (depth of soil suitable for root development);
- Colour (in accordance with Munsell colour chart);
- Texture (refers to the particle size distribution);
- Structure (aggregation of soil particles into structural units);
- Mottling (alterations due to continued exposure to wetness);
- Concretions (cohesion of minerals into hard fragments);
- Leaching (removal of soluble constituents by percolating water);
- Gleying (reduction of ferric oxides under anaerobic conditions, resulting in grey, low chroma soil colours); and
- Illuviation of colloidal matter from one horizon to another, resulting in the development of grey sandy E-horizons and grey clay G-horizons.

ii) Determine the appropriate soil Form and soil Family according to the above properties.

The soil properties that were used to map fairly homogeneous soil types are discussed in Appendix B.

2.3 Wetland and riparian delineation

Wetland and/or riparian zones were delineated according to the practical field procedure for the identification and delineation of wetlands and riparian areas (Department of Water Affair and Forestry, 2005). Three of the four indicators were used in the study to delineate wetland and riparian zones, namely:

- Terrain unit;
- Soil form;
- Soil wetness; and
- Wetland and riparian vegetation (not used).

Further details on the delineation of wetland areas are included in Appendix C.

2.4 Map compilations

The field data was captured in shapefile format (shp) and processed and stored in a Geographic Information System called ArcGIS. The maps are compiled in a map extendable document format (mxd) and exported to Jpeg format. The shapefiles can be exported to a dxf or dwg format for CAD users. The shapefiles, dxf and dwg formats are available on request.

The maps were generated in a projected coordinate system using the longitude of origin (LO) coordinate system based on the 27° East meridian, WG1984 Ellipsoid and Hartebeesthoek 1994 Datum.

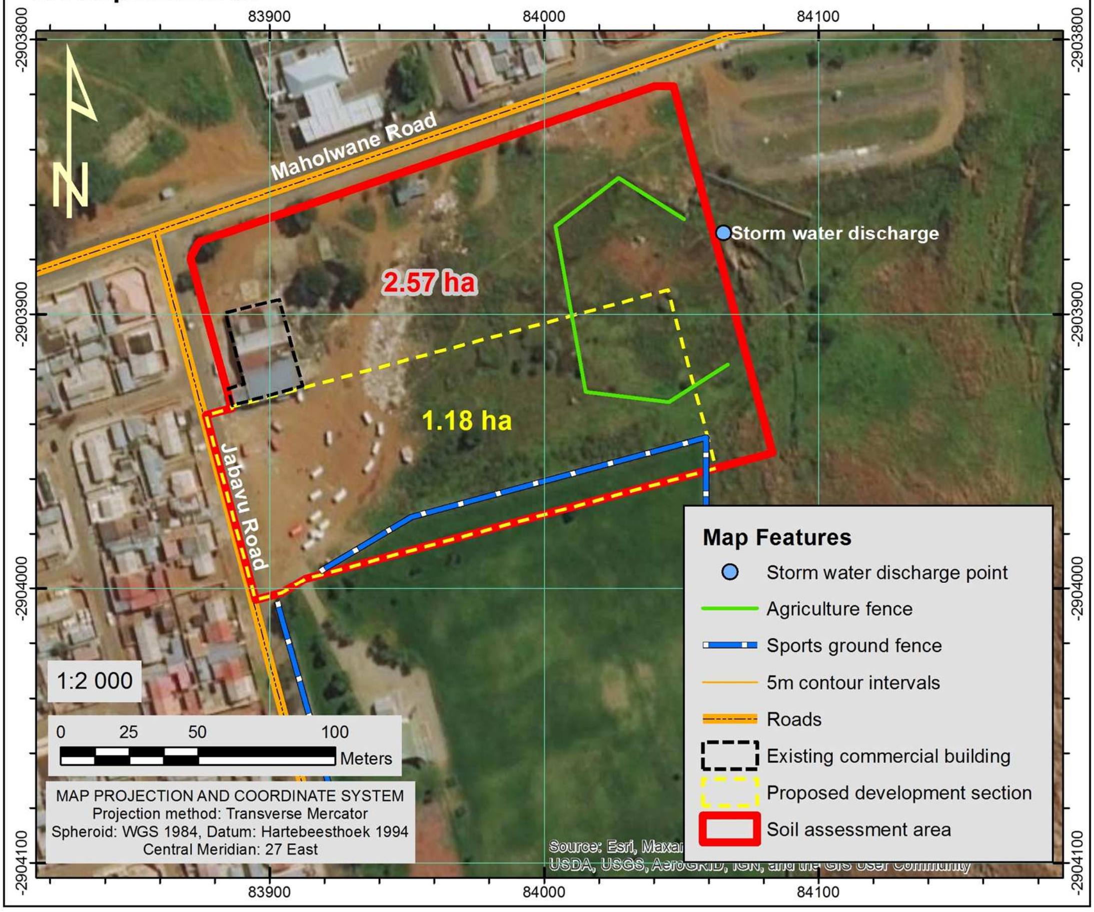
3. SURVEY RESULTS

The field survey was conducted during November 2019.

3.1 Geographic features of the study area

The soil assessment area borders Maholwane Road to the north and Jabavu Road to the west and comprises 2.57 ha (Figure 1b). The proposed development area (dashed yellow line) covers the southern section of the soil assessment area and comprises 1.18 ha. A storm water discharge point is situated on the eastern edge of the soil assessment area. A building utilized for trade and commercial purposes is situated in the northwestern corner, adjacent to Jabavu road. Sports grounds occupy a narrow strip of the southern section of the soil assessment area. A section within the central east of the soil assessment area is utilized for small scale farming/agricultural activities.

Figure 1b: Geographic features of the proposed Zola Public Transport Facility development area

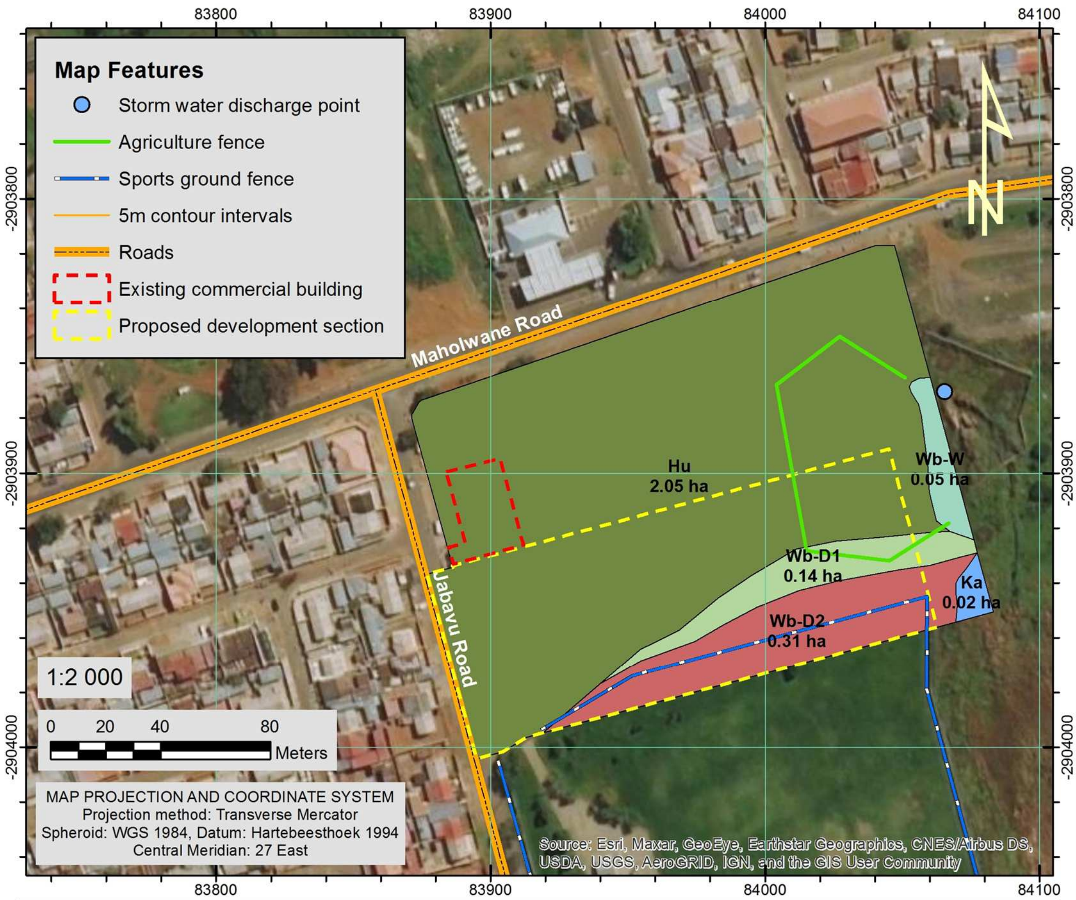


3.2 Dominant soil types

Soil types within the soil assessment area were mapped based on soil information gathered by means of auger observations at a grid density of 50 x 50 meter. A total of 15 auger observations were made at pre-determined and random grid points in order to locate and accurately map soil boundaries.

A total of 5 homogeneous soil units, based on dominant soil form, effective soil depth, internal drainage, terrain unit and slope percentage were identified during field observations and were symbolised as Hu, Wb-D1, Wb-D2, Wb-W and Ka. The 5 homogeneous units are referred to as soil types and are shown in Figure 2, which contains an abbreviated soil legend.

Figure 2: Soil map of the proposed Zola Public Transport Facility development area



ABBREVIATED SOIL LEGEND (for full legend refer to Table 1 of the soil report)

Soil Type Code	Dominant soil form and family & subdominant soil form	Summarized Description of Dominant Soil Forms in terms of effective depth, soil colour, soil texture and terrain unit	Wetland zone	Hydro-pedology zone	Area (ha)
Hu	***Hutton 2100**; Bainsvlei	Deep, well-drained, orange red, sandy loam to sandy clay loam soils underlain by saprolite (highly weathered rock), situated on gentle footslopes (3-5% slope).	Terrestrial	Recharge	2.05
Wb-D1	***Witbank 1000**	Imported soil material consisting of well-drained, reddish brown, orange red and yellow brown soil horizons varying in thickness and texture, mainly sandy loam to sandy clay loam, mostly deeper than 1.5 m, situated gentle footslopes (1-3% slopes).	Terrestrial	Recharge	0.14
Wb-D2	***Witbank 1000**	Imported material consisting of thin constant varying layers of mixed soil, ash and domestic waste, situated on gentle footslopes (1-3% slopes).	Terrestrial	Recharge	0.31
Wb-W	***Witbank 1000**	The upper horizon consists of varying imported soils, overlying greyish brown alluvium at places with signs of wetness and water tables occurred occasionally below 1.0 m that appeared to be caused mainly by a storm water outlet close by.	Temporary Artificial wetland	Interflow	0.05
Ka	***Katspruit 1000**; Kroonstad, Longlands	Dark grey to grey, somewhat poorly to poorly drained, sandy clay loam to clay soils with prominent signs of wetness, situated in a gently sloping valley bottom; Water table at 900 mm.	Seasonal to permanent	Responsive	0.02
* Dominant soil form and family				Total	2.57

A comprehensive soil legend is provided in Table 1, which describe the soils in terms of the following aspects.

- Dominant soil forms and families and subdominant soil forms;
- The estimated clay content of the A, E, G and B horizons;

- A broad description of the dominant soil form and terrain in terms of the effective soil depth, internal drainage, soil colour, soil texture class, terrain unit and average slope percentage range;
- A description of the soil horizon in natural sequence.
- The land capability, wetland and hydropedology zone classification; and
- The area and percentage comprised by each soil type and land class.

Table 1: Detailed soil legend

SOIL LEGEND									
Soil Type Code	**Dominant & subdominant Soil Form and Family**	**% Clay per horizon A, E, G, B**	**Summarized Description of Dominant Soil Forms in terms of effective depth, soil colour, soil texture and terrain unit**	**Erodibility**	**Wetland zone**	**Land Capability**	**Hydro-pedology zone**	**Area (ha)**	**Area (%)**
Hu	***Hutton 2100**; Bainsvlei	A: 16-20 B: 18-24	Deep (1000-1200 mm), well-drained, orange red, sandy loam to sandy clay loam soils underlain by saprolite (highly weathered rock), situated on gentle footslopes (3-5% slope).	Low	Terrestrial	Arable	Recharge	2.05	79.74
Wb-D1	***Witbank 1000**	A: 16-24 B: 16-24	Imported soil material consisting of well-drained, reddish brown, orange red and yellow brown soil horizons varying in thickness and texture, mainly sandy loam to sandy clay loam, mostly deeper than 1.5 m, situated gentle footslopes (1-3% slopes).	Low	Terrestrial	Arable	Recharge	0.14	5.52
Wb-D2	***Witbank 1000**	A: 16-20	Imported material consisting of thin constant varying layers of mixed soil, ash and domestic waste, situated on gentle footslopes (1-3% slopes).	Low	Terrestrial	Wilderness	Recharge	0.31	11.88
Wb-W	***Witbank 1000**	A: 16-20	The upper horizon consists of varying imported soils, overlying greyish brown alluvium at places with signs of wetness and water tables occurred occasionally below 1.0 m that appeared to be caused mainly by a storm water outlet close by.	Moderate	Temporary Artificial	Wetland (Artificial)	Interflow	0.05	2.04
Ka	***Katspruit 1000**; Kroonstad, Longlands	A: 20-30 G: 30-40	Dark grey to grey, somewhat poorly to poorly drained, sandy clay loam to clay soils with prominent signs of wetness, situated in a gently sloping valley bottom; Water table at 900 mm.	Moderate	Seasonal to permanent	Wetland	Responsive	0.02	0.82
*** Dominant soil form and family**							**TOTAL**	**2.57**	**100.0**

3.2.1 Profiles of dominant soil types

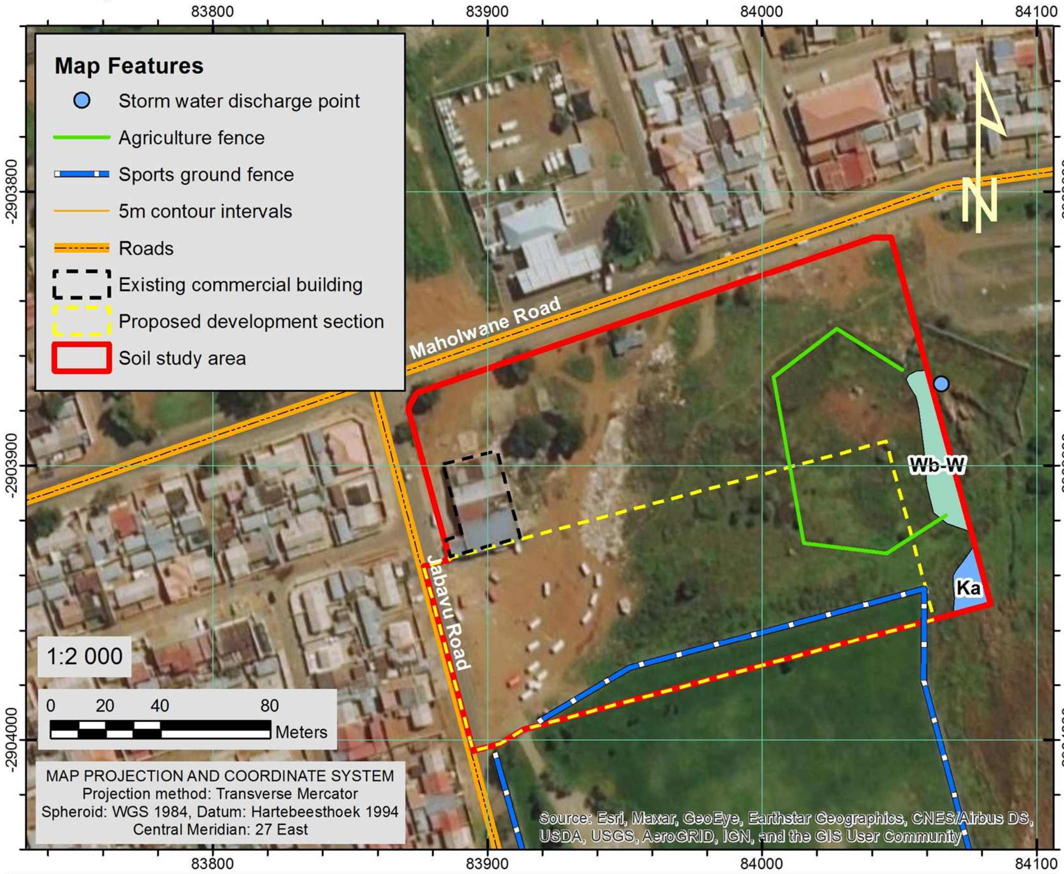
Photos 1-4 show profiles of the dominant soil types. Other profile and site photos are shown in Appendix D.

Photo 1: Soil Type Hu (Auger point D3) Deep, red, well-drained natural soils	**Photo 2: Soil type Wb-D1 (Auger point A4)** Imported material consisting of varying horizons of high quality soil material
	
Photo 3: Soil type Wb-D2 (Aguer point B4) Imported material consisting of material varying form high quality soil material to ash and domestic waste	**Photo 4: Soil type Ka (Auger point B6)** Dark grey to grey, somewhat poorly to poorly drained wetland soils – water table at 900 mm
	

3.3 Wetland delineation and description of wetland mechanism

The extent of wetland zones based on soil types, soil wetness and topography indicators, is shown in Figure 3. Vegetation indicators could not be used due to severe surface and soil disturbances across the entire site.

Figure 3: Wetland delineation map of the proposed Zola Public Transport Facility development area



LEGEND: WETLAND DELINEATION

*Soil Type Code	Wetland zone	Broad Soil Description	Wetland mechanism/driver	Area (ha)
Wb-W	Temporary Artificial wetland	The upper horizon consists of varying imported soils, overlying greyish brown alluvium at places with signs of wetness and water tables occurred occasionally below 1.0 m that appeared to be caused mainly by a storm water outlet close by.	Receive increased surface runoff from the residential area to the north. Receive water from the storm water outlet close by. Due to presence of perched water tables caused by storm water outlet it is expected that some restricted lateral flow occurs within the soil profile above weathered subsoil strata although no clear E-horizons was observed. The zone was dry during the time of the soil assessment. Considering that the assessment was conducted in the driest time of the year it is expected that the state of wetness can increase significantly during mid-season.	0.05
Ka	Seasonal to permanent	Dark grey to grey, somewhat poorly to poorly drained, sandy clay loam to clay soils in a gently sloping valley bottom; Water table at 900 mm.	Receive increased surface runoff mainly via the storm water outlet. Receive probably water via the soil profile from soil type Wb-W of which the source is the storm water outlet. Receive water via exfiltration (return flow) from the perched aquifer below during wet periods.	0.02
*See soil map, Figure 2			**Total**	**0.07**

Table 2 categorizes the wetland related soil types in 2 wetland zones namely: temporary artificial and seasonal to permanent zones and also provides a description of the wetland mechanism/driver.

Table 2: Wetland zones

LEGEND: WETLAND DELINEATION				
***Soil Type Code**	**Wetland zone**	**Broad Soil Description**	**Wetland mechanism/driver**	**Area (ha)**
Wb-W	Temporary Artificial wetland	The upper horizon consists of varying imported soils, overlying greyish brown alluvium at places with signs of wetness and water tables occurred occasionally below 1.0 m that appeared to be caused mainly by a storm water outlet close by.	Receive increased surface runoff from the residential area to the north. Receive water from the storm water outlet close by. Due to presence of perched water tables caused by storm water outlet it is expected that some restricted lateral flow occurs within the soil profile above weathered subsoil strata although no clear E-horizons was observed. The zone was dry during the time of the soil assessment. Considering that the assessment was conducted in the driest time of the year it is expected that the state of wetness can increase significantly during mid-season.	0.05
Ka	Seasonal to permanent	Dark grey to grey, somewhat poorly to poorly drained, sandy clay loam to clay soils in a gently sloping valley bottom; Water table at 900 mm.	Receive increased surface runoff mainly via the storm water outlet. Receive probably water via the soil profile from soil type Wb-W of which the source is the storm water outlet. Receive water via exfiltration (return flow) from the perched aquifer below during wet periods.	0.02
*See soil map, Figure 2			**Total**	**0.07**

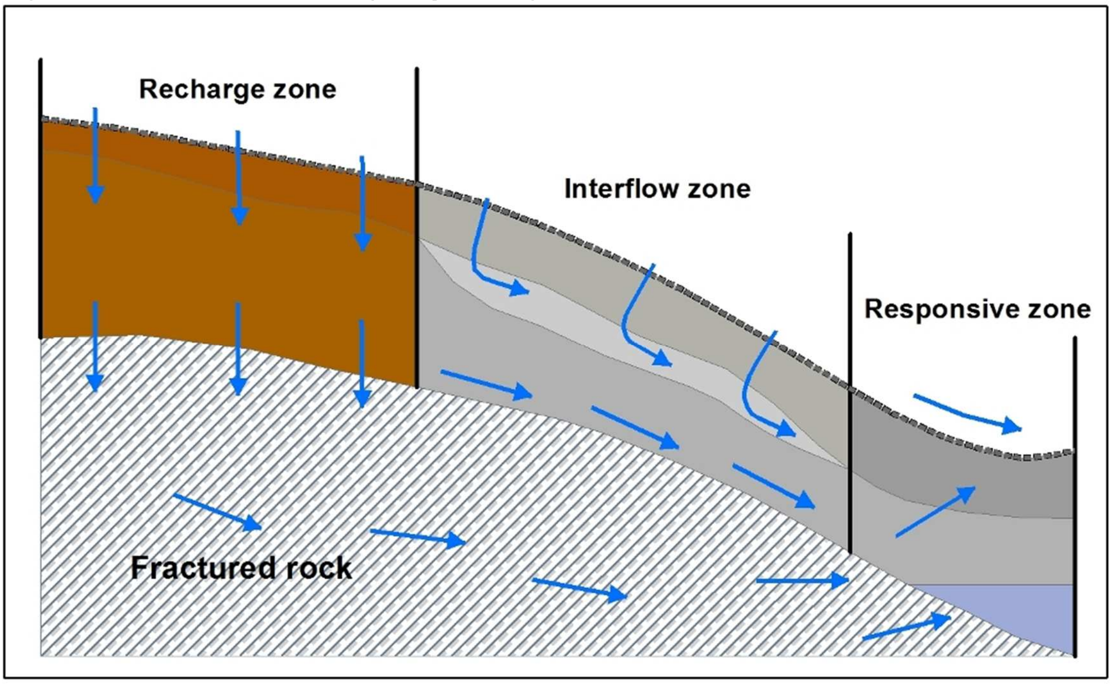
4. HYDROPEDOLOGICAL ASSESSMENT

4.1 Basics of hydropedology

The hydropedological behaviour of soils can be grouped into the following three hydropedological zones as illustrated in Figure 4 and summarised in Table 3:

- *Recharge zone* characterised by vertical infiltration through the soil profile and weathered subsoil strata and lateral flow at the bedrock interface during the rainy season;
- *Interflow zone* characterised by lateral flow in higher permeable layer(s) in the soil profile underlain by lower permeable soil/subsoil material; and
- *Responsive zone* characterised by saturated and near saturated conditions of the soil profile for most of the year and exfiltration (return flow) of upslope interflow flow during the rainy season.

Figure 4: Zones based on hydropedological behaviour[1]



Note 1: Figure presented by van Tol, le Roux and Lorentz, 2017.

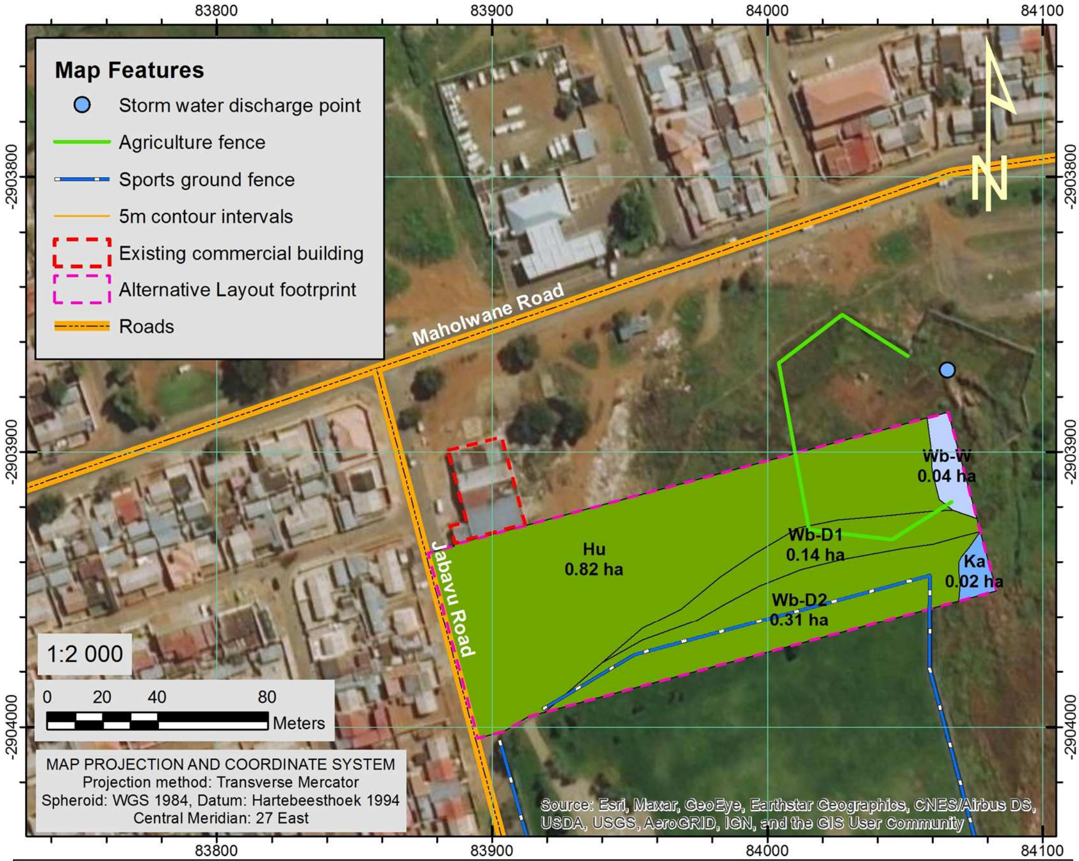
Table 3: Hydropedological zones

Hydro-pedological zone	Hydropedological behaviour / dominant flow mechanism				Wetland system
	Soil profile	Vadose zone *(zone between ground surface and groundwater table)*			
		Weathered subsoil strata	Bedrock	Perched aquifer	
Recharge	High surface infiltration Vertical infiltration through well-drained soil profile	Vertical infiltration through weathered subsoil strata	Lateral flow of deep infiltration above low permeable / impermeable bedrock	Perched aquifer develops above bedrock during or after prolonged wet periods	Terrestrial
Interflow	Vertical infiltration through surface horizon Lateral flow in high permeable E-horizon (2nd soil horizon) Restricted vertical flow through lower permeable 3rd soil horizon (G- or B_2 horizon) *or* fluctuating water table in 3rd soil horizon (soft plinthic)	Restricted vertical flow through low permeable subsoil strata	Lateral flow of deep drainage and lateral flows from upslope soils above low permeable / impermeable bedrock	Thicker perched aquifer develops into weathered subsoil strata during wet season with additional recharge from upslope soil and/or subsoil weathered strata	Temporary Seasonal
Responsive	Reduced infiltration into soil and exfiltration (return flow) of up-gradient perched aquifer during wet periods Restricted vertical infiltration through low permeable subsoil	Restricted vertical flow through low permeable subsoil strata Strata saturated or near saturated throughout year	Lateral flow into ephemeral stream and/or increased surface exfiltration (return flow) with shallow bedrock	Relative shallow perched aquifer during dry season Perched aquifer develops to ground surface and exfiltrate (return flow) during wet periods	Permanent

4.2 Hydropedological zones and flow pathways within the Alternative Layout footprint (not preferred footprint option)

Soil types as described on the detailed soils map (Figure 2), were grouped according to their hydropedology as a recharge, interflow or responsive soil. Figure 5 shows the hydropedological zones and associated soil types within the **Alternative Layout footprint (not preferred option)** and contains an abbreviated legend.

Figure 5: Hydropedological zones and water flow pathways within the Alternative Layout Footprint (not preferred option).



Abbreviated legend: Flow pathways of soil types within Hydropedological zones (See Table 4 in report)				
Hydropedological zones	**Soil Type Code**	**Dominant Soil Form Family**	**Wetness indicators (wetness within 500 mm)**	**Water flow pathways**
Recharge soils	**Hu**	***Hutton 2100**; Bainsvlei	Well-drained profile - no signs of wetness	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata
	Wb-D1	***Witbank 1000**	Well-drained profile - no signs of wetness	
	Wb-D2	***Witbank 1000**	Well-drained profile - no signs of wetness	
Interflow soils (artificial source)	**Wb-W**	***Witbank 1000**	Grey soil matrix colours in some horizons and occasional perched water tables in the lower soil profiles	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata. Due to presence of perched water tables caused by storm water outlet it is expected that some restricted lateral flow occurs within the soil profile above weathered subsoil strata although no clear E-horizons was observed.
Responsive soils	**Ka**	***Katspruit 1000**; Kroonstad, Longlands	Dark grey to grey soil matrix; Common mottling in A and G-horizons.	Surface runoff into ephemeral stream; Vertical through surface soil horizon and restricted infiltration in G-horizon to perched aquifer in weathered strata above bedrock; Exfiltration during wet periods.

*Dominant soil form and family

Table 4 serves as a full-length legend for Figure 5, which summarizes the soil types within the 3 hydropedological zones that intersect the Alternative Layout footprint. This footprint intersects the wetland and wetland buffer zones.

Table 4: Hydropedological zones and water flow pathways within the Alternative Layout footprint (not preferred option)

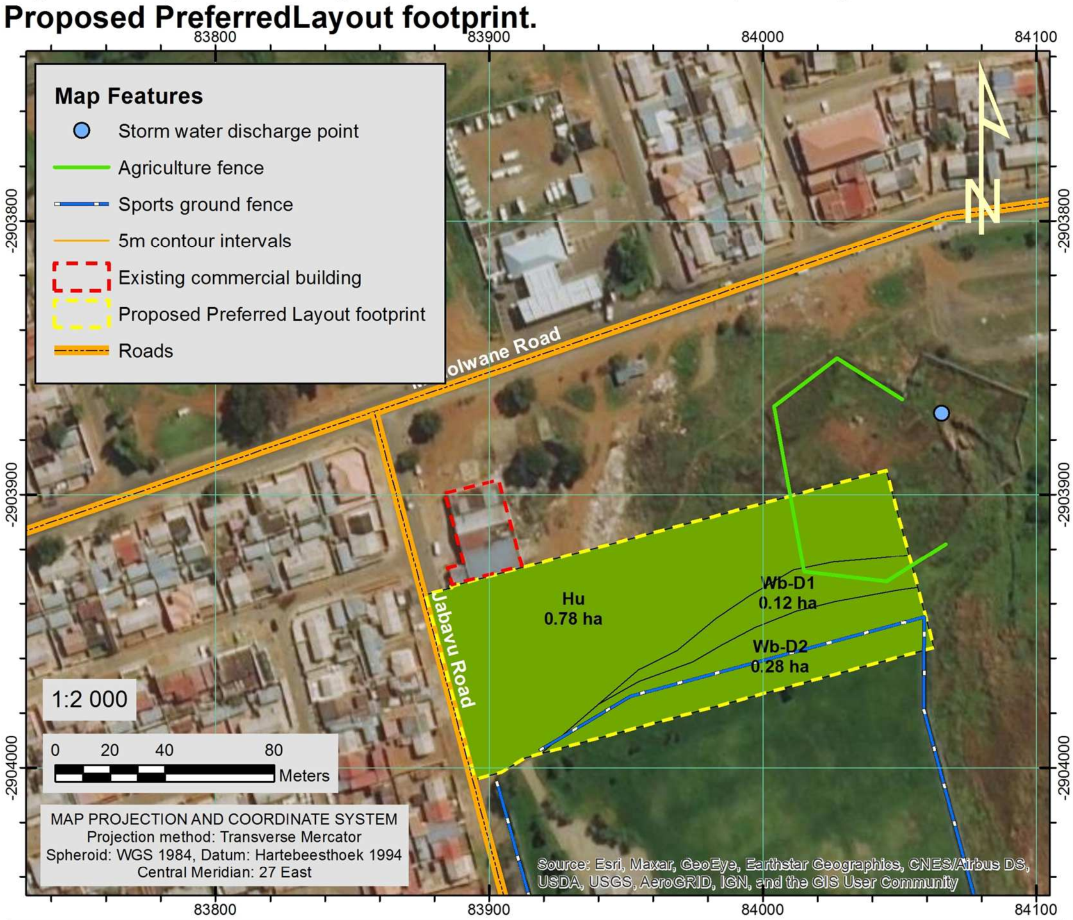
Legend: Flow pathways of soil types within Hydropedological zones						
Hydropedological zones	**Soil Type Code**	**Dominant & subdominant Soil Form and Family**	**Summarized description of dominant soil type, effective depth, colour, texture, internal drainage, terrain and slope percentage range**	**Wetland/Terrestrial zone**	**Wetness indicators (wetness within 500 mm)**	**Water flow pathways**
Recharge soils	**Hu**	***Hutton 2100**; Bainsvlei	Deep (1000-1200 mm), well-drained, orange red, sandy loam to sandy clay loam soils underlain by saprolite (highly weathered rock), situated on gentle footslopes (3-5% slope).	Terrestrial	Well-d rained profile - no signs of wetness	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata
	Wb-D1	***Witbank 1000**	Imported soil material consisting of well-drained, reddish brown, orange red and yellow brown soil horizons varying in thickness and texture, mainly sandy loam to sandy clay loam, mostly deeper than 1.5 m, situated gentle footslopes (1-3% slopes).	Terrestrial	Well-d rained profile - no signs of wetness	
	Wb-D2	***Witbank 1000**	Imported material consisting of thin constant varying layers of mixed soil, ash and domestic waste, situated on gentle footslopes (1-3% slopes).	Terrestrial	Well-d rained profile - no signs of wetness	
Interflow soils (artificial source)	**Wb-W**	***Witbank 1000**	The upper horizon consists of varying imported soils, overlying greyish brown alluvium at places with signs of wetness and water tables occurred occasionally below 1.0 m that appeared to be caused mainly by a storm water outlet close by.	Temporary artificial wetland	Grey soil matrix colours in some horizons and occasional perched water tables in the lower soil profiles	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata. Due to presence of perched water tables caused by storm water outlet it is expected that some restricted lateral flow occurs within the soil profile above weathered subsoil strata although no clear E-horizons was observed.
Responsive soils	**Ka**	***Katspruit 1000**; Kroonstad, Longlands	Dark grey to grey, somewhat poorly to poorly drained, sandy clay loam to clay soils with prominent signs of wetness, situated in a gently sloping valley bottom; Water table at 900 mm.	Seasonal to permanent Wetland	Dark grey to grey soil matrix; Common mottling in A and G-horizons.	Surface runoff into ephemeral stream; Vertical through surface soil horizon and restricted infiltration in G-horizon to perched aquifer in weathered strata above bedrock; Exfiltration during wet periods.

*Dominant soil form and family

4.3 Hydropedological zones and flow pathways within the Proposed Preferred Layout footprint (preferred footprint option)

Figure 6 shows the hydropedological zones and associated soil types within the **Proposed Preferred footprint (preferred option)** and contains an abbreviated legend. This footprint doesn’t intersect the wetland and is outside the 32m wetland buffer zone.

Figure 6: Hydropedological zones and water flow pathways within the Proposed PreferredLayout footprint.



Abbreviated legend: Flow pathways of soil types within Hydropedological zones (See Table 4 in report)				
Hydropedological zones	**Soil Type Code**	**Dominant Soil Form Family**	**Wetness indicators (wetness within 500 mm)**	**Water flow pathways**
Recharge soils	**Hu**	***Hutton 2100**; Bainsvlei	Well-d rained profile - no signs of wetness	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata
	Wb-D1	***Witbank 1000**	Well-d rained profile - no signs of wetness	
	Wb-D2	***Witbank 1000**	Well-d rained profile - no signs of wetness	
*Dominant soil form and family				

Table 5 serves as a full-length legend for Figure 6, which summarizes the soil types within the 1 hydropedological zone that intersect Proposed Preferred Layout footprint. This footprint does not intersect the wetland.

Table 5: Hydropedological zones and water flow pathways within the Proposed Preferred Layout footprint (preferred option)

Legend: Flow pathways of soil types within Hydropedological zones						
Hydropedological zones	**Soil Type Code**	**Dominant & subdominant Soil Form and Family**	**Summarized description of dominant soil type, effective depth, colour, texture, internal drainage, terrain and slope percentage range**	**Wetland/Terrestrial zone**	**Wetness indicators (wetness within 500 mm)**	**Water flow pathways**
Recharge soils	**Hu**	***Hutton 2100**; Bainsvlei	Deep (1000-1200 mm), well-drained, orange red, sandy loam to sandy clay loam soils underlain by saprolite (highly weathered rock), situated on gentle footslopes (3-5% slope).	Terrestrial	Well-d rained profile - no signs of wetness	Mainly vertical through soil profile and weathered subsoil strata to flow limiting bedrock. Lateral flow at interface of bedrock and weathered subsoil strata
	Wb-D1	***Witbank 1000**	Imported soil material consisting of well-drained, reddish brown, orange red and yellow brown soil horizons varying in thickness and texture, mainly sandy loam to sandy clay loam, mostly deeper than 1.5 m, situated gentle footslopes (1-3% slopes).	Terrestrial	Well-d rained profile - no signs of wetness	
	Wb-D2	***Witbank 1000**	Imported material consisting of thin constant varying layers of mixed soil, ash and domestic waste, situated on gentle footslopes (1-3% slopes).	Terrestrial	Well-d rained profile - no signs of wetness	
*Dominant soil form and family						

5. IMPACT ON SOIL AND HYDROPEDOLOGY

5.1 Impact assessment footprints

The impact on soil and hydropedology is assessed based on 2 footprint options referred to as:

- Alternative Layout footprint (not preferred). This layout intersects the wetland buffer zones and wetland (Figure 7).
- Proposed Preferred Layout footprint. This layout plan doesn't intersect the wetland and is outside the 32m wetland buffer zone (Figure 8).

The 2 footprints are shown in Figures 7 and 8.

Figure 7: Alternative layout plan (not preferred development proposal)

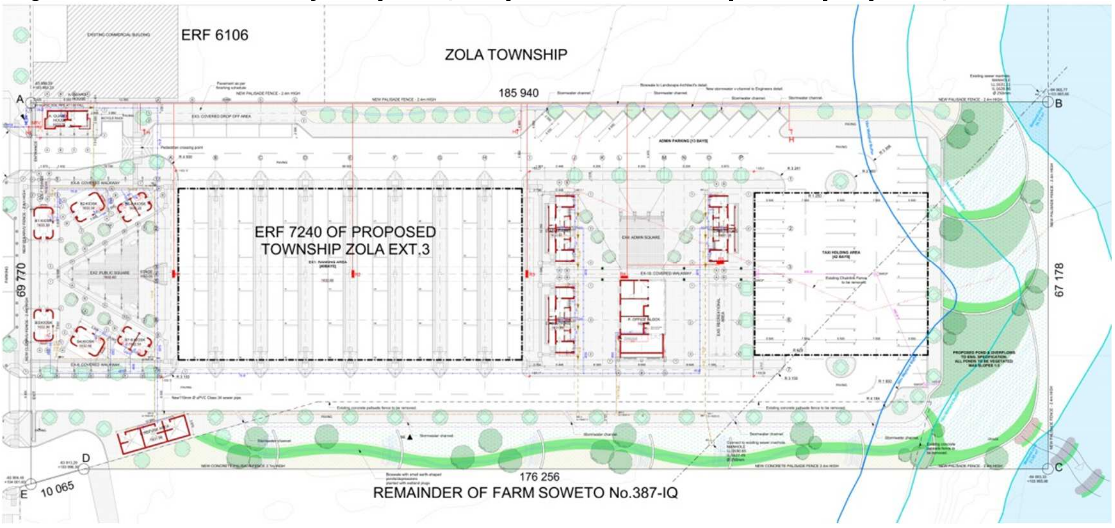
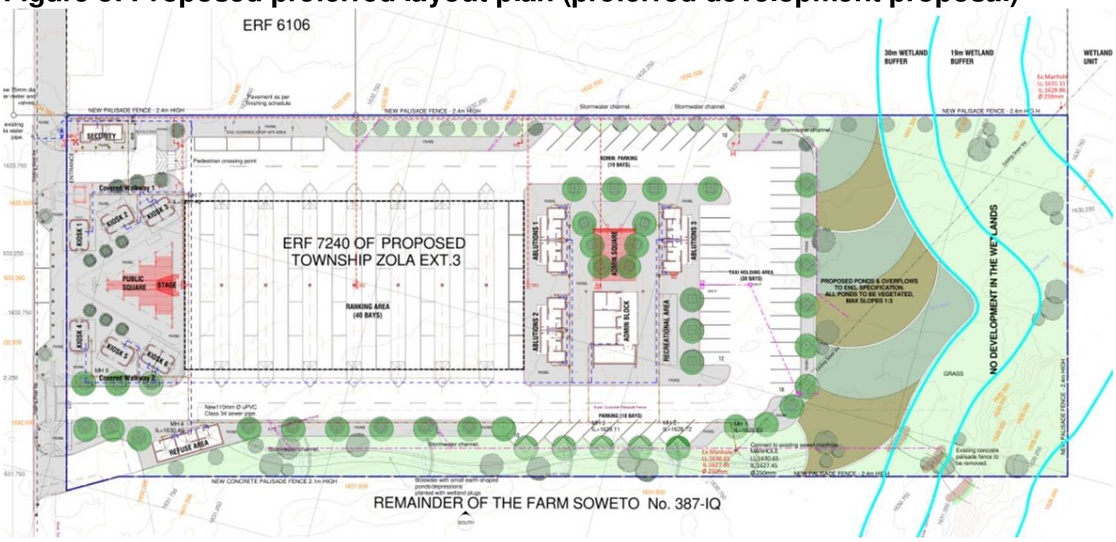


Figure 8: Proposed preferred layout plan (preferred development proposal)



5.2 Impact assessment rating of soil and hydropedology

The criteria and ratings used for the impact assessment are provided in Appendix E.

Table 6: Impact assessment and rating – Alternative Layout Plan (not preferred – this footprint intersect the wetland)

ACTIVITY: Construction of a transport facility (taxi rank).							
Nature of the impact	**Significance of potential impact WITHOUT mitigation**			**Mitigation Measures**	**Significance WITH mitigation**		
Soil - Complete cease of the soil's productive capability due to the soil surface being covered by concrete, tar and paving. The soil's productive capability will not be destroyed but will cease permanently or until the structure is removed completely.	**Extent**	Site	1	The reality is that wherever natural soils are covered by concrete, tar or paving the soil's productive capability will cease. This is an impact that is unavoidable in expanding urban areas. Within larger developments the soil's productive capability in-between structures can be preserved, but with a single structure there are no mitigation measures.	**Extent**	Site	1
	Duration	Permanent	5		**Duration**	Permanent	5
	Intensity	High	8		**Intensity**	High	8
	Probability	Definite	5		**Probability**	Definite	5
	Significance	**High**	**70**		**Significance**	**High**	**70**
	Status	Negative			**Status**	Negative	
	Confidence	High			**Confidence**	High	
Reversibility	The impact can be reversed by removing the structure at the end of its lifespan.						
Cumulative impact	The cumulative impact is certainly high since there is a high development rate in the country and soils are covered by structures everywhere.						
Irreplaceable loss of resource	The soil resource underneath structures is not lost although the productive capability will remain ceased until the structures are removed.						
Residual risk	There are no expected residual risks.						
Nature of the impact	**Significance of potential impact WITHOUT mitigation**			**Mitigation Measures**	**Significance WITH mitigation**		
Hydropedology – this footprint intersect mainly the recharge hydropedological zone, but also small sections of the interflow and responsive zones. Structures that are erected within the interflow zone may disturb the flow path and causes a minor reduction of water quantities in the nearby wetlands.	**Extent**	Site	1	The interflow zone can be in-filled. If construction of foundations takes place above the flow path it will not be disturbed or damaged and water quantities in the wetland will probably not be influenced.	**Extent**	Site	1
	Duration	Permanent	5		**Duration**	Permanent	5
	Intensity	Medium	6		**Intensity**	Low	4
	Probability	High proba	4		**Probability**	Definite	2
	Significance	**Medium**	**48**		**Significance**	**Low**	**20**
	Status	Negative			**Status**	Negative	
	Confidence	High			**Confidence**	High	
Reversibility	If the flow path within the soil profile is destroyed during construction then the impact cannot be reversed.						
Cumulative impact	The cumulative impact is probably low since most developments are placed outside of wetland systems.						
Irreplaceable loss of resource	The disturbance of a flow path can in some way be seen as loss of a resource.						
Residual risk	There are no expected residual risks.						

Table 7: Impact assessment and rating – Proposed Preferred Layout Plan (this footprint does not intersect the wetland or buffer zones)

ACTIVITY: Construction of a transport facility (taxi rank).							
Nature of the impact	**Significance of potential impact WITHOUT mitigation**			**Mitigation Measures**	**Significance WITH mitigation**		
Soil - Complete cease of the soil's productive capability due to the soil surface being covered by concrete, tar and paving. The soil's productive capability will not be destroyed but will cease permanently or until the structure is removed completely.	**Extent**	Site	1	The reality is that wherever natural soils are covered by concrete, tar or paving the soil's productive capability will cease. This is an impact that is unavoidable in expanding urban areas. Within larger developments the soil's productive capability in-between structures can be preserved, but with a single structure there are no mitigation measures.	**Extent**	Site	1
	Duration	Permanent	5		**Duration**	Permanent	5
	Intensity	High	8		**Intensity**	High	8
	Probability	Definite	5		**Probability**	Definite	5
	Significance	**High**	**70**		**Significance**	**High**	**70**
	Status	Negative			**Status**	Negative	
	Confidence	High			**Confidence**	High	
Reversibility	The impact can be reversed by removing the structure at the end of its lifespan.						
Cumulative impact	The cumulative impact is certainly high since there is a high development rate in the country and soils are covered by structures everywhere.						
Irreplaceable loss of resource	The soil resource underneath structures is not lost although the productive capability will remain ceased until the structures are removed.						
Residual risk	There are no expected residual risks.						
Nature of the impact	**Significance of potential impact WITHOUT mitigation**			**Mitigation Measures**	**Significance WITH mitigation**		
Hydropedology – this footprint intersect only the recharge hydropedological zone and not the interflow or responsive zones. Water will not infiltrate the soil at the structure footprint but will infiltrate the soil after being channelled off the footprint or it may be channelled directly into the nearby wetland. It will not cause a reduction of water quantities in the nearby wetlands.	**Extent**	Site	1	There are hardly any impact and therefore no mitigation measures.	**Extent**	Site	1
	Duration	Permanent	1		**Duration**	Permanent	1
	Intensity	Minor	2		**Intensity**	Minor	2
	Probability	Improbable	1		**Probability**	Improbable	1
	Significance	**Low**	**4**		**Significance**	**Low**	**4**
	Status	Negative			**Status**	Negative	
	Confidence	High			**Confidence**	High	
Reversibility	There are no impacts that can be reversed.						
Cumulative impact	There are no impacts that accumulate.						
Irreplaceable loss of resource	No loss of a resource.						
Residual risk	There are no residual risks.						

6. CONCLUSION

6.1 Soils and hydropedology – Alternative Layout footprint (not preferred option)

The majority of the Alternative Layout footprint is occupied by red well-drained soils of the Hutton form (soil type Hu) that were classified as a recharge hydropedoligical zone and don't contribute to water quantities in the nearby wetland via the soil profile.

Soil types Wb-D1 and Wb-D2 consist of imported material that varies from high quality soil material to ash and domestic waste. These soil types were classified as a recharge hydropedoligical zone and don't contribute to water quantities in the nearby wetland via the soil profile.

Soil type Wb-W consists of varying layers of imported material overlying alluvium in which slight perched water tables occurred in the lower soil profile (below 1m). The source of the water appears to originate mainly from a storm water outlet nearby, although some water may be natural seepage. Soil type Wb-W was classified as a temporary artificial wetland. Since perched water tables were found it is assumed that there will probably be some lateral flow towards the wetland and it was therefore classified as an interflow zone, although the majority of water appears to originates from an artificial source.

Soil type Ka occupies a very small section in the southeastern corner of the Alternative Layout footprint and is dominated by greyish, mottled, poorly drained soils of the Katspruit form and was classified as a seasonal to permanent wetland zone and responsive hydropedological zone. A prominent water table occurred at 900 mm. The zone contributes water to the wetland via exfiltration (return flow) from the perched aquifer underneath during wet periods.

6.2 Impact at the Alternative Layout footprint

The impact on soils within this footprint was rated as high, since the soils will be covered by concrete, tar and paving and the soil's productive capability will subsequently cease permanently or at least until the structure is removed completely. Since there are no effective mitigation measures the impact rating after mitigation remains the same.

The impact on hydropedology was rated medium without mitigation and low with mitigation.

6.3 Soils and hydropedology – Proposed Preferred footprint (preferred option)

The majority of the Proposed Preferred Layout footprint is occupied by soil type Hu and the remainder by soil types Wb-D1 and Wb-D2, which were all classified as recharge zones that do not contribute to water quantities in the nearby wetland.

6.4 Impact at the Proposed Preferred Layout footprint

The impact on soils within this footprint was rated as high, the same as in the Alternative Layout footprint.

However, the impact on hydrogeology was much lower and was rated as low prior and after mitigation.

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APPENDIX A
SOIL CLASSIFICATION SYSTEM

The classification system categorizes soil types in an upper soil Form level which is subdivided into a number of lower Family levels. Each soil Form (higher level) is defined by a unique vertical sequence of soil horizons with specific defined properties. The soil Families (lower level) are a subdivision of the soil Form (higher level), differentiated on the basis of specific characteristics such as leaching status, calcareousness, structure types and sizes etc.

In this way, standardised soil identification and communication is allowed by use of soil Form names and family numbers or names e.g. Hutton 2100 or Hutton Hayfield. The soil Form and soil Family together are referred to as soil types.

The soil Forms are indicated by the name and the Family by its appropriate number e.g. Hutton 2100. The soil Form and Family are then symbolized e.g. Hu and referred to as soil type Hu. The soil Form and Family are often further categorized based on effective soil depth, terrain unit and slope and a numerical number is added to the symbol e.g. Hu1. For example, where the Hutton 2100 soil Form and Family occurs at an effective depth of 900-1200 mm, it is symbolized and referred to as soil type Hu1, and where this soil Form and Family occurs at an effective depth of 600-900 mm it is symbolized and referred to as soil type Hu2.

APPENDIX B
SOIL PROPERTIES AND CHARACTERISTICS

Various terms in the soil legend are used to describe a series of soil properties and characteristics such as the dominant soil Form and Family, effective soil depth, internal drainage, and clay content per soil horizon and texture class.

1. Effective soil depth

Effective soil depth can be considered as the depth freely permeable to plant roots and water. Effective soil depth categories used in the soil legend are as follows:

Very shallow	< 300mm
Shallow	300-600 mm
Moderately deep	600-900 mm
Deep	900-1500 mm
Very deep	> 1500 mm

2. Internal drainage

Internal drainage is the flow of water (annual precipitation) through the soil profile. Soils with the ability to drain annual precipitation though the profile without waterlogged periods within certain parts of the profile are called **well-drained** soils. Soils which lack this ability will display properties indicating temporary to permanent water logged conditions in parts of the soil profile in the form of mottling, leaching or gleying.

Moderately well-drained soils mostly display impeded internal drainage in the lower profile e.g. soft plinthic horizons, which is the result of periodically fluctuating water tables which are characterized by mottling and accumulation of iron and manganese oxides.

Imperfectly drained soils mostly display impeded internal drainage in the upper and lower parts of the profile e.g. E and plinthic horizons, which is the result of periodic lateral flow of water in the profile and fluctuating water tables. Such soils are characterized by grey, leached, sandy horizons and mottled plinthic horizons.

Poorly drained soils mostly display impeded internal drainage in the upper and lower parts of the soil profile e.g. E, plinthic and G-horizons and are the result of long term to permanent wetness in the soil profile, which is characterized by grey, leached, sandy horizons, mottled plinthic horizons and gleyed clay horizons.

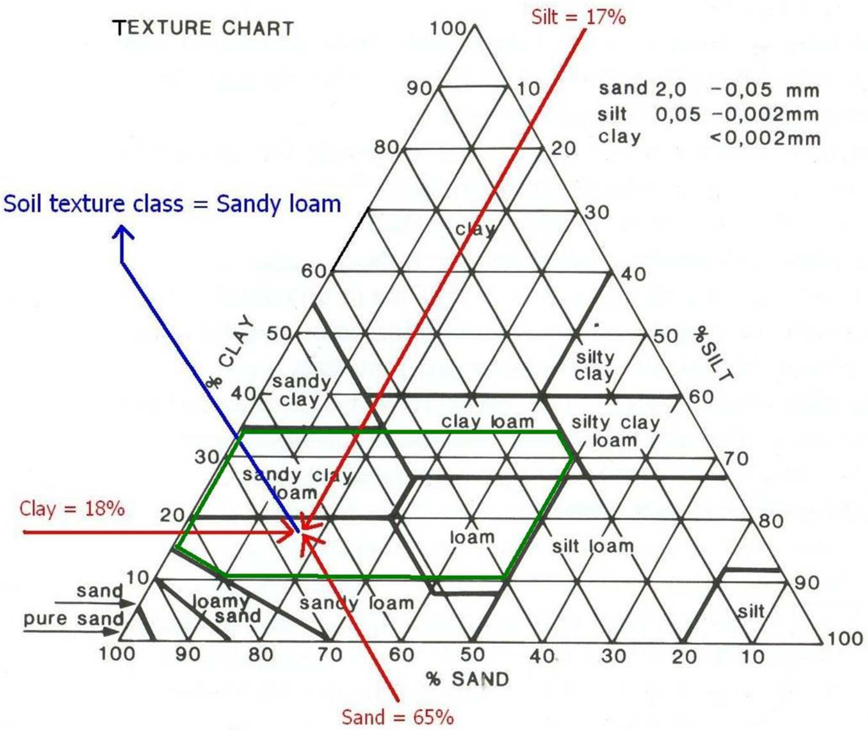
3. Texture class

Soil texture refers to the relative proportions of the various particle size separates in the soil. Particle sizes are defined in the following **fractions**.

Sand – (2.0 – 0.05 mm)
Silt – (0.05 – 0.002 mm)
Clay – (< 0.002 mm)

The relative proportions of these 3 fractions (as illustrated by the red arrows in Figure B1) determines 1 of 12 soil texture classes e.g. sandy loam, loam, sandy clay loam etc. The different texture class zones are demarcated by the thick black lines in the diagram. The green zone can be used as a guideline for moderate to high agricultural potential, but needs to be evaluated together with other soil properties.

Figure B1: Soil texture chart



APPENDIX C
WETLAND DELINEATION

1. Legal framework

In order to determine the existence and extent of a wetland in the proposed mining area the legal framework on what classifies as a wetland should be applied. The National Water Act, 1998 (Act 36 of 1998), (NWA), includes a wetland in the definition of a watercourse. A watercourse is:

- *"a river or spring;*
- *a natural channel in which water flows regularly or intermittently;*
- *a wetland, lake or dam 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."*

A wetland is then further defined by the NWA as *"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".*

Based on the above definition, the Department of Water Affairs and Forestry (DWAF), now the Department of Water Affairs (DWA), published a set of guidelines describing field indicators and methods for determining whether an area is a wetland or riparian area, and for finding its boundaries (DWAF, 2005). These guidelines state that wetlands must have one or more of the following attributes:

- *Wetland (Hydromorphic) soils* that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of *water loving plants (hydrophytes)*; and
- A *high water table* that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.

Based on the NWA definition of a wetland, four indicators were identified within the DWAF (2005) guidelines to assist in identifying wetland areas:

- *Terrain Unit Indicator*. The topography of the area is usually used to determine where in the landscape the wetland is likely to occur.
- *Soil Form Indicator*. Certain soil forms, as defined by the Soil Classification Working Group (1991), are associated with prolonged and frequent saturation.
- *Soil Wetness Indicator*. The soil wetness indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- *Vegetation Indicator*. The vegetation indicator identifies hydrophilic vegetation associated with frequently saturated soils.

2. Processes in wetland soils and associated properties

The following processes normally take place under anaerobic/saturated or so-called wetland conditions:

- Mottling (localized colouring and alterations due to continued exposure to wetness);
- Concretions (accumulation and cohesion of minerals into hard fragments).
- Leaching (removal of soluble constituents by percolating water);
- Gleying (reduction of ferric oxides under anaerobic conditions resulting in grey, low chroma soil colours); and
- Illuviation of colloidal mater from one horizon to another, resulting in the development of grey sandy E-horizons and grey clay G-horizons.

These processes usually result in soil properties which provide undisputable evidence of temporary to permanent wetness such as:

Dark grey coloured A-horizons

The A-horizon is the upper 200-300 mm of the soil profile and is usually defined by a slightly darker colour due to a greater or lesser amount of humified organic matter. The dark grey A-horizon is common to almost all the soils found in permanent and seasonal zones. The dark grey colour usually appears only in the moist state and rapidly fades in to a plain grey colour when it dries out. The dark appearance is due to higher organic carbon content which builds up under the long term moist conditions in a wetland system. The carbon and also fine organic matter loses its dark colour in the dry state and the grey colour of the soil particles becomes prominent. The grey soil colour is the result of the removal of soluble constituents (iron oxides, silicate clay) by percolating water. The dark grey A-horizon is common in permanent, seasonal and temporary wetland zones.

Grey to pale grey E-horizons

The E-horizon underlies the A-horizon, having a lower content of colloidal matter (clay, sesquioxides, organic matter) usually reflected by a pale colour and a relative accumulation of quartz and/or other resistant minerals of sand or silt sizes. The E-horizon develops under high lateral flow (permanent or periodic) of water in the soil profile, which removes some colloidal matter to the lower soil profile and some further down the wetland system. The E-horizon is thus the flow path for shallow groundwater in the wetland zone. The grey and pale grey E-horizon is common in permanent and seasonal wetland zones and less common in temporary zones.

Yellowish grey E-horizons

The colour of the E-horizon reflects the intensity of removal of colloidal matter from the horizon. This results in the phenomenon that some E-horizons have a yellowish colour in the moist state but become grey in the dry state. The yellowish colour in the moist state is due to an incomplete covering of the mineral soil particle by ferric oxides and indicates a less leached state and less anaerobic (saturated conditions) conditions. The yellowish E-horizons are therefore strongly related to temporary wetland zones and occur less in seasonal or permanent wetland zones.

Plinthic horizons

Plinthic horizons are characterised by localization and accumulation of iron and manganese oxides under conditions of a fluctuating water table, resulting in distinct reddish brown, yellowish brown and/or black mottles, with or without hardening to form sesquioxide concretions. Plinthic horizons are the result of fluctuating water tables which implies wetter and dryer phases and are therefore found commonly in seasonal and temporary wetland zones and less in permanent wetland zones.

G-horizons

Gleying is the process of reduction of ferric oxides and hydrated oxides under anaerobic conditions, resulting in grey, low chroma matrix colours. This usually goes along with clay illuviation from the upper horizon which results in a grey clay horizon and is called a G-horizon. G-horizons are commonly found in permanent wetland zones, occasionally in seasonal zones and rarely in temporary wetland zones.

APPENDIX D
SOIL PROFILE AND SITE PHOTOS

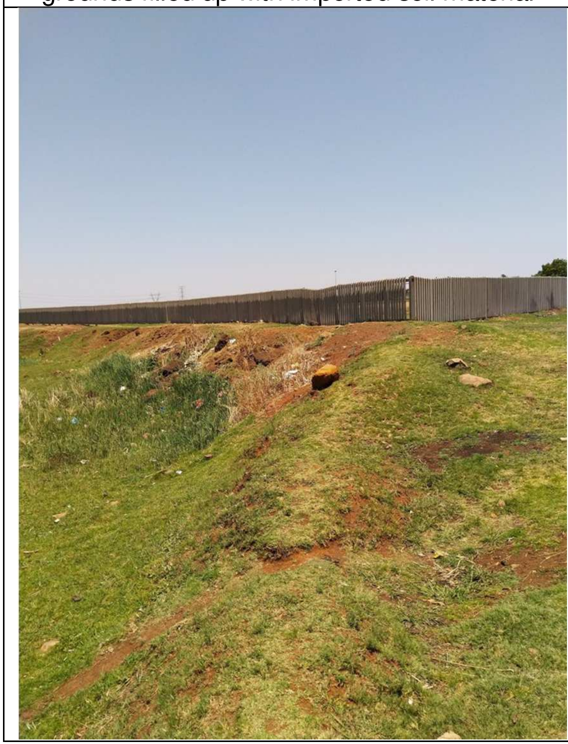
Photo 5: Soil Type Wb-W (Auger point D5) Varying layers of imported material with slight water table occurring in lower soil profile	**Photo 6: Soil type Wb-D1 (Auger point B3)** Imported material consisting of varying horizons of high quality soil material
	
Photo 7: Northeastern corner of the sports grounds filled up with imported soil material	**Photo 8:** Disturbed site surface
	

Photo 9: Vegetation at storm water outlet situate on the eastern edge of the soil study area	**Photo 10: Soil type Wb-D2 (Aguer point B5)** Imported material consisting of material varying form high quality soil material to ash and domestic waste
	

APPENDIX E – IMPACT ASSESSMENT CRITERIA AND RATING

Extent of the Impact: **(1) Site** (i.e. extending only as far as the development boundary of the site area), **(2) Local/Surrounds** (i.e. the area and its immediate surroundings within 5km of the site), **(3) Municipal** (i.e. Local Municipality), **(4) Provincial** (i.e. the relevant province - Gauteng/Limpopo/North-West/Western Cape/KZN/Free State/Eastern Cape/Mpumalanga/Northern Cape), **(5) National** (i.e. South Africa), or **(6) International** (i.e. Africa, Europe, USA etc).	**Duration of the Impact:** **(1) Immediate** (>1year), **(2) Short term** (1-5 years), **(3) Medium term** (6-15 years), **(4) Long term** (16-30 years and/or the impact will cease after the operational life span of the project), or **(5) Permanent** (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/Intensity: **(0) None** (where the aspect will have no impact on the environment, **(2) Minor** (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected), **(4) Low** (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected), **(6) Moderate/Medium** (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way), **(8) High** (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or **(10) Very High** / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease.	**Probability of occurrence:** **(0) None** (the impact will not occur), **(1) Improbable** (low likelihood – the possibility of the impact materializing is very low as a result of design, historic experience, or implementation of adequate corrective actions), **(2) Low Probability** (there is a possibility that the impact will occur), **(3) Medium Probability** (distinct possibility – the impact may occur), **(4) High Probability** (it is most likely that the impact will occur), or **(5) Definite** / I don't know (the impact will occur regardless of the implementation of any prevention measures and/or corrective actions, or you don't know what the probability will be based on too little published information).
Status of the Impact: • Negative Effect (i.e. at a "cost" of the environment), • Positive Effect, (i.e. a "benefit" to the environment), or • Neutral effect on the environment. The impacts are to be assessed in terms of their effect on the project and the environment.	**Degree of confidence in predictions:** The environmental consultant &/or any relevant specialists should state what degree of confidence (**low, medium or high**) is there in the predictions based on the available information and level of knowledge and expertise.

<u>Significance of the Impact:</u>

Based on the information contained in the points above, the potential impacts are assigned as significance weighting (S). This weighting is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and Magnitude (M) and multiplying this sum by the probability (P) of the Impact.

S = (E+D+M) P

(0) **No significance:** (The impacts do not influence the proposed development and/or environment in any way),
(<30) **Low:** (The impacts will have a minor influence on the proposed development and/or environment i.e. where this impact would not have a direct influence on the decision to develop in the area. These impacts could possibly require some attention to modification of the project design where possible, or alternative mitigation.
(30-60) **Moderate/Medium**: (The impacts will have a moderate influence on the proposed development and/or environment. The impact can be ameliorated by a modification in the project design or implementation of effective mitigation measures i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated).
(>60) **High**: (i.e where the impact must have an influence on the decision process to develop in the area. The impacts will be likely to have the "no-go" implication on the development or portions of the development regardless of any mitigation measures that could be implemented. This level of significance must be well motivated.