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Hydrogeological Investigation – Proposed Emdemi Public Transport Facility

Report

Version – 1

14 December 2021

Urban Innovate

GCS Project Number: 19-1075

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Hydrogeological Investigation – Proposed Emdemi Public Transport Facility

Urban Innovate

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ACRONYMS

AH	Auger Hole
BH	Borehole
DRO	Diesel Range Organics
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
GRDM	Groundwater Resource Directed Measures
GRO	Gasoline Range Organics
MAMSL	Metres above mean sea level
M BGL	Meters below ground level
NEMWA	National Environmental Management Waste Act
NGA	National Groundwater Archive
PID	Photo Ioniser Detector
PPM	Parts per million
SANAS	South African National Accreditation System
SANS	South African National Standard
SVS	Soil Vapour Survey
SWL	Static Water Level
TDS	Total Dissolved Solids
WGS	World Geodetic System

EXECUTIVE SUMMARY

GCS Water and Environment (Pty) Ltd (GCS) was contracted by Pierre Joubert Landscape Architect & Environmental Planner on behalf of Urban Innovate to conduct a Hydrogeological investigation for the development of a proposed transport facility referred to as Emdeni/Zola Transport facility located on a part of the remainder of farm Soweto 387 I.Q located in Soweto, Gauteng Province (the site).

The site is undeveloped and is situated within a mixed commercial and residential land use setting. There is informal agricultural activity taking place adjacently north-east of the proposed site location, whilst the western portion of the site is being used as an informal parking lot by local minibus taxi's.

Soil augering was conducted within and adjacent to the boundaries of the proposed development layout to determine the presence and/or absence of shallow groundwater levels and to provide baseline contaminant concentrations before the development.

Groundwater seepage was encountered during the completion of auger holes AH2, AH3 and AH5 on 30th October 2019 at depths ranging between 0.8 and 3.9 m bgl. Static water levels (SWLs) measured on 1st November 2019 ranged between 0.5 and 2.92 m bgl. Topographical survey results of the well and groundwater elevations indicated that the groundwater flow direction is towards the south-south-west and emulates the regional topography.

Groundwater samples were collected from auger holes AH2, AH3 and AH5 and were submitted for laboratory results that indicated the following:

- The detected concentrations of chloride, ammonia and mercury exceeded the SANS drinking water standards; and
- Slightly elevated concentrations of GRO C_6-C_{10} were detected in the groundwater samples collected from auger holes AH3 and AH5 and exceeded the applicable USEPA drinking water standards. The source of the hydrocarbon concentrations detected in the groundwater from AH3 and AH5 is most likely from an upgradient and off-site source.

During the operational phase of the proposed development, impacts to the soil and groundwater environment may result from the release of potentially impacted stormwater into the adjacent stream or from faulty stormwater infrastructure, leaking vehicles and the on-site sewer system. From a review of the updated project scope, a series of ecological attenuation dams will be constructed that would serve to reduce potentially hazardous substances (both non-aqueous phase liquids as well as dissolved phase contaminants) present in surface run-off. Also included in the design is a 30m wetland buffer to reduce the probability of potentially hazardous substances from reaching the wetland. Further mitigation measures would include the implementation of the groundwater monitoring program for the site and surrounding area whereby the attenuation dam water and adjacent streams are monitored and sampled regularly.

GCS recommends the following:

- Stormwater from the attenuation dams should be sampled regularly to ensure that no unacceptable contamination is released into the associated wetland. Samples should also be collected down- and up-gradient of the attenuation dam to assess the impact the dam has on the water quality in comparison to in-situ (up-stream) conditions;
- Groundwater monitoring should be conducted on a bi-annual basis for inorganic and hydrocarbon constituents and a trend analysis should be compiled to ensure the facility does not have any detrimental effect on the groundwater environment;
- The groundwater monitoring plan should commence once the site is operational.

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1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) was contracted by Pierre Joubert Landscape Architect & Environmental Planner on behalf of Urban Innovate to conduct a Hydrogeological investigation for the development of a proposed transport facility referred to as Emdeni/Zola Transport facility located on a part of the remainder of farm Soweto 387 I.Q located in Soweto, Gauteng Province (the site). This report details the findings of the hydrogeological investigation undertaken at the site on 30 October and 1 November 2019 and includes an update of the impact assessment due to the redesign of the proposed development layout.

2 SCOPE OF WORK

The scope of work for the Phase I investigation conducted at the site included the following:

- Initial site inspection;
- Data review of previous study and reports conducted if available;
- Identify any sensitive areas (e.g. wetlands, streams etc.) within a 1km radius of the site through a desktop study review;
- Conduct a hydrocensus within the vicinity of the site;
- Soil vapour survey through the advancement of hand augered soil bores;
- Collection of representative groundwater samples from the auger holes;
- Inspection for visible spillages on-site;
- Obtain water level measurements within the auger holes;
- Identify potential pathways and receptors;
- Impact assessment describing the potential impact of the facility and its activities on the natural environment; and
- Reporting.

3 METHODOLOGY

3.1 Hydrocensus

A hydrocensus was conducted within the general vicinity of the site to identify existing groundwater users. The hydrocensus survey included a drive by survey of properties located in the vicinity of the site and interviewing local site contacts on the likely presence of boreholes in the general area.

3.2 Soil vapour survey

A soil vapour survey utilising shallow drilled hand augered soil bores and a hand-held PID was carried out to identify the extent of any shallow subsoil hydrocarbon vapours. Auger holes were drilled utilising a Johnson hand auger. The auger holes were profiled and evidence of contamination from the seepage zones and olfactory observations were recorded. Soil vapour readings were also recorded during the auger process with the aid of a PID. Soil vapour logs were taken at 1 meter (m) intervals.

3.3 Groundwater investigation

During the site assessment, information was collected on the current groundwater conditions at the site. Groundwater samples were collected from seepage encountered during augering and analysed for chemicals of concern. The water samples were submitted for the following analysis:

- Inorganic compounds: alkalinity; calcium; magnesium; chromium (hexavalent and total); cyanide; sulphate; lead; nitrate; phenolic compounds; potassium; free and saline ammonia; boron; cadmium; mercury; sodium; chloride; chemical oxygen demand; and
- Hydrocarbon compounds: TPH C_6-C_{10}, C_{10}-C_{28}, C_{28}-C_{40}.

3.4 Impact assessment

The groundwater impact assessment was conducted with available site information to determine the impact of the proposed and alternative development on the hydrogeological environment.

4 SITE DESCRIPTION

4.1 Locality

The site is located at Ntshunyana street (Refer to Figure 5-3), Zola Extension 3, Soweto in Gauteng Province which falls under the jurisdiction of the City of Johannesburg Municipality.

4.2 Site details

The site is situated within a mixed commercial and residential land use setting at coordinates -26.242109°; 27.840545°. Johannesburg Development Agency (JDA) is planning to build a public transport facility at the currently vacant site. There is informal agricultural activity taking place adjacently north-east of the proposed site location, whilst the western portion of the site is being used as an informal parking lot by minibus taxi's.

Based on documents supplied by the Client, the following proposed infrastructure will be present on-site after construction is completed:

- Taxi holding bays;
- Ranking bays;
- Admin parking bays;
- Drop off bays;
- Trading kiosks;
- Ablution blocks;
- Security office;
- Administration block; and
- A series of retention ponds, attenuation dams and bioswales.

4.3 Neighboring land survey

A neighbouring land survey was conducted for the site in order to prepare a list of adjacent land use as detailed in Table 4-1. An aerial photograph depicting the general surrounding land use properties is presented in Figure 5-3.

Table 4-1: Neighbouring land use

Locality	Land Use
North	Commercial buildings to the north-west, vacant land to the north, followed by a retail filling station (Engen Ma-Africa), and an informal vegetable garden to the north-east (partially on-site), followed by residential properties.
East	Non-perennial streams and wetland from east-north-east to east-south-east.

Locality	Land Use
South	A commercial building to the south-south-west, sports field to the south and wetland to the south-south-east.
West	Residential properties from west-north-west to west-south-west.

Off-site potential sources of hydrocarbon contamination are present north of the site (Engen Ma-Africa), whilst sensitive environmental receptors are present in the form of a wetland and various non-perennial streams located adjacently east of the site.

5 ENVIRONMENTAL SETTING

5.1 Topography

The site is located at an elevation of approximately 1,634 mamsl (meters above mean sea level) according to the 1:50 000 topographical map (2627BB). The topography at and near the site slopes gently in a south-easterly direction. Regionally however the site slopes towards the south-south-west. The groundwater flow was expected to emulate the regional topography in a south-south-westerly direction. The results of the hydrogeological investigation confirm that locally groundwater flow is towards the south-south westerly direction.

5.2 Hydrology

The surface water features identified from the 1:50 000 topographical map, as well as the latest Google Earth Imagery (2019/7/5), have been tabulated below in Table 5-1.

Table 5-1: Hydrological features near the site

Hydrological Feature	Distance from the site (m)	Direction
Unnamed non-perennial stream	15	East and down-gradient of the site.
Wetland (fed by various non-perennial streams)	15	East and down-gradient of the site.

5.3 Geology

According to the 1:250 000, Geological Series map of South Africa, (Sheet 2626, West Rand) the site is underlain by basaltic lava, agglomerate and tuff of the Klipsrivier Group from the Randian age (refer to Figure 5-2). The general conditions encountered during augering consisted of reddish and light brown shades of silty sand and clay with rock inclusions.

5.4 Hydrogeology

No registered NGA (National Groundwater Archive) boreholes were located within a 1km radius of the site. According to the 1:500 000 Hydrogeological map series 2526 Johannesburg (Barnard and Baran, 1999), the site is underlain by an intergranular and fractured aquifer with an average borehole yield ranging from 0.5 to 2.0L/s. Groundwater quality in the area is expected to be good with electrical conductivity values ranging between 0-70 mS/m.

The aquifer vulnerability and classification maps of South Africa classify the underlying aquifer as minor, intergranular and fractured aquifer with a moderate vulnerability to contamination from surface activities.

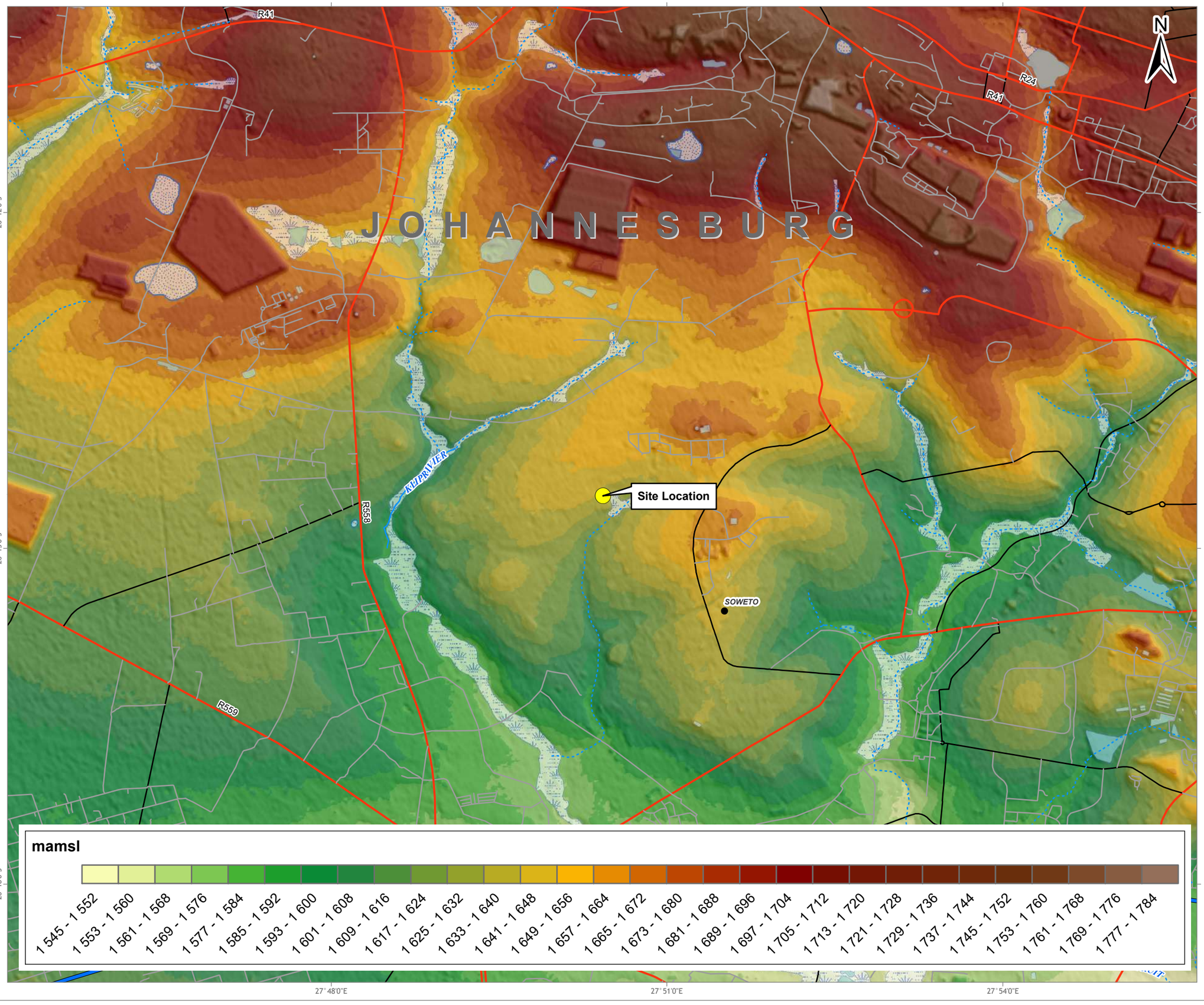
5.5 Quaternary catchment

Data from relevant hydrogeological databases including, the Groundwater Resource Directed Measures (GRDM), was obtained from the Department of Water and Sanitation. The site area falls within quaternary catchment: C22A, as indicated in Table 5-2. Although the average regional groundwater level for the catchment is 21.1 m bgl, at and near the site shallow groundwater levels are present at less than 4 m bgl.

Table 5-2: Summarized quaternary catchment information (GRDM, 2013)

Quaternary Catchment	Total Area (km^2)	Recharge (mm/a)	Rainfall (mm/a)	Average groundwater level (m bgl)
C22A	548.4	31.5	695	21.1

FIGURE 5-1: TOPOGRAPHY MAP



LEGEND

- Major Towns
- Site Location

Rivers and Streams

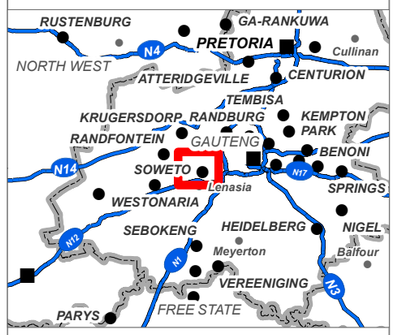
- Non-Perennial
- Perennial

Road Network

- National Route
- Main Road
- Secondary Road
- Streets

Inland Water

- Dams and lakes
- Reservoirs and water tanks
- Marsh and swamps
- Non-perennial pans



Data Sources:
ALOS World 3D - 30m (AW3D30) ©JAXA
Data supplied by Specialist (J Muller)

0 1.5 3 Kilometers

SCALE: 1:60 000

FIGURE NO.:	-	MAP NUMBER:	19-1075-02
DRAWN BY:	A LOVE GIS TECHNICIAN	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	4 NOVEMBER 2019
PROJECT: CLIENT:	EMDENI PUBLIC TRANSPORT FACILITY PIERRE JOUBERT PROFESSIONAL LANDSCAPE ARCHITECT & ENVIRONMENTAL CONSULTANT		

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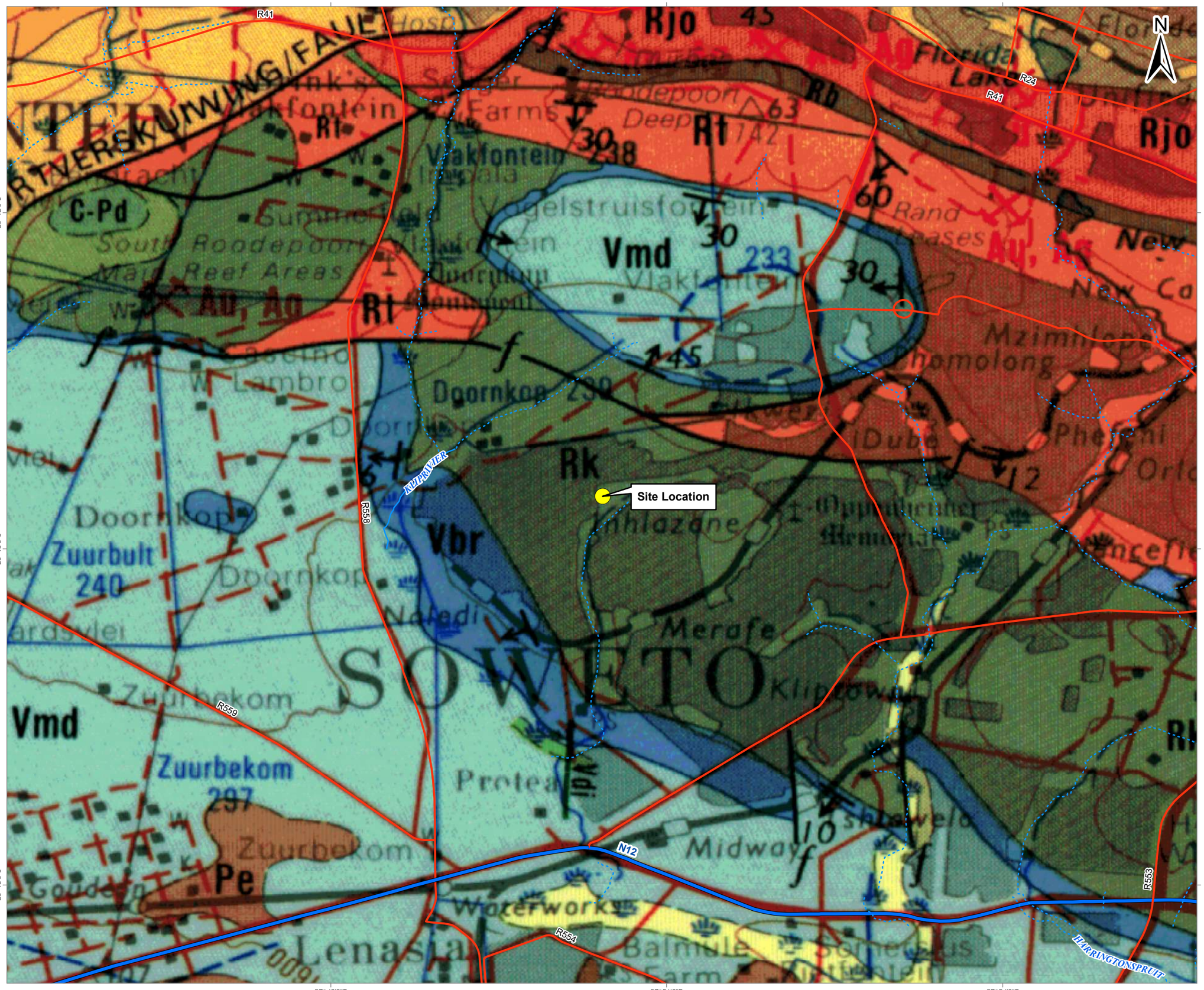
FIGURE 5-2: GEOLOGY MAP



LEGEND

- Site Location

Rivers and Streams

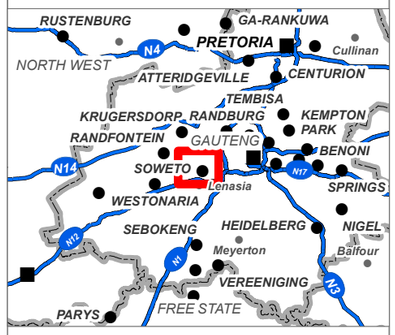
- Non-Perennial
- Perennial

Road Network

- National Route
- Main Road

Lithology

- Alluvium
- C-Pd — Diamictite, shale
- Vmd — Dolomite, chert and remnants of chert breccia of the Rooihoogte Formation
- Vbr — Quartzite, conglomerate, shale
- Rk — Basaltic lava, agglomerate tuff
- Rt — Quartzite, conglomerate, shale
- Rjo / Rb — Quartzite, conglomerate
- Rj — Shale, quartzite, conglomerate, amygdaloidal lava



Data Sources:
Council for Geoscience
1:250 000 Geological Series: 2626
Data supplied by Specialist (J Muller)

0 — 1.5 — 3 Kilometers

SCALE:	1:60 000		
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DRAWN BY:	A LOVE GIS TECHNICIAN	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	4 NOVEMBER 2019
PROJECT:	EMDENI PUBLIC TRANSPORT FACILITY		
CLIENT:	PIERRE JOUBERT PROFESSIONAL LANDSCAPE ARCHITECT & ENVIRONMENTAL CONSULTANT		

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FIGURE 5-3: AERIAL MAP

LEGEND

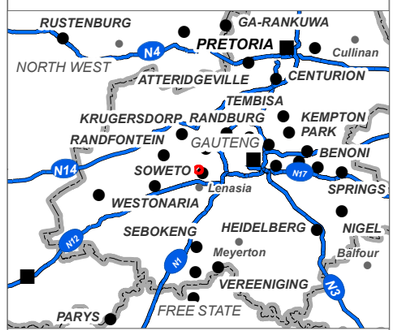
Site Location

Rivers and Streams

Non-Perennial

Inland Water

Marsh and swamps



Data Sources:
ALOS World 3D - 30m (AW3D30) ©JAXA
Data supplied by Specialist (J Muller)

0 75 150 Meters

SCALE: 1:2 933

FIGURE NO.:	-	MAP NUMBER:	19-1075-04
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DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	4 NOVEMBER 2019
PROJECT:	EMDENI PUBLIC TRANSPORT FACILITY		
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6 DETAILED SITE INVESTIGATION

A hydrogeological investigation was conducted at the site on the 30th October 2019 and 1st November 2019. The investigation entailed a site walkover, hydrocensus, soil augering, groundwater sampling and topographical surveying of the soil bore locations.

6.1 Site reconnaissance and housekeeping

The site walkover was carried out to locate any visible contamination or contamination sources within the footprint of the site.

The general site conditions are indicative of poor housekeeping with construction and consumable waste present in the western portion of the site (refer to Appendix A – Photographic Log). Consumable waste was also present within the non-perennial stream located to the east. Parts of the site is also used as an informal taxi rank with numerous vehicles parked on-site during the site assessment.

6.2 Hydrocensus

During the hydrocensus, properties within the vicinity of the site were visited. No borehole users were identified.

6.3 Soil vapour survey

6.3.1 Soil augering

As part of the soil vapour survey, soil augering was conducted within and adjacent to the boundaries of the proposed development layout to determine the presence and/or absence of contamination. The PID measurements consisted of collecting headspace readings from soil collected during augering at 1.0 meter intervals. The soil characteristics obtained during augering have been compiled in Appendix B. The auger hole descriptions are summarised in Table 6-1.

Table 6-1: Auger hole description summery

Auger Hole ID	Co-ordinates		Depth (m bgl)	Comments
	S	E		
AH1	-26.242176	27.841101	2.3	Located east of the proposed office block and recreational area.
AH2	-26.242017	27.841432	1.2	Located north of the proposed attenuation facility.
AH3	-26.241772	27.840845	2.4	Located north of the proposed admin square and north-eastern ablution area.
AH4	-26.241964	27.840845	1.2	Located centrally, north of the proposed north-western ablution area.

Auger Hole ID	Co-ordinates		Depth (m bgl)	Comments
	S	E		
AH5	-26.242279	27.840553	4.2	Located west of the proposed office block and south-western ablution area.

(m bgl) meters below ground level

The soil was screened for volatile vapours at interval depths as specified in Table 6-2. The soil PID measurements were taken by sampling the in-situ profile and placing the soil sample in a zip-locking bag which was sealed and left in the sun for a few minutes. The nozzle of the Mini Rae 3000 was inserted in the bag and readings were recorded. The localities of the auger hole positions are presented in Figure 6-1.

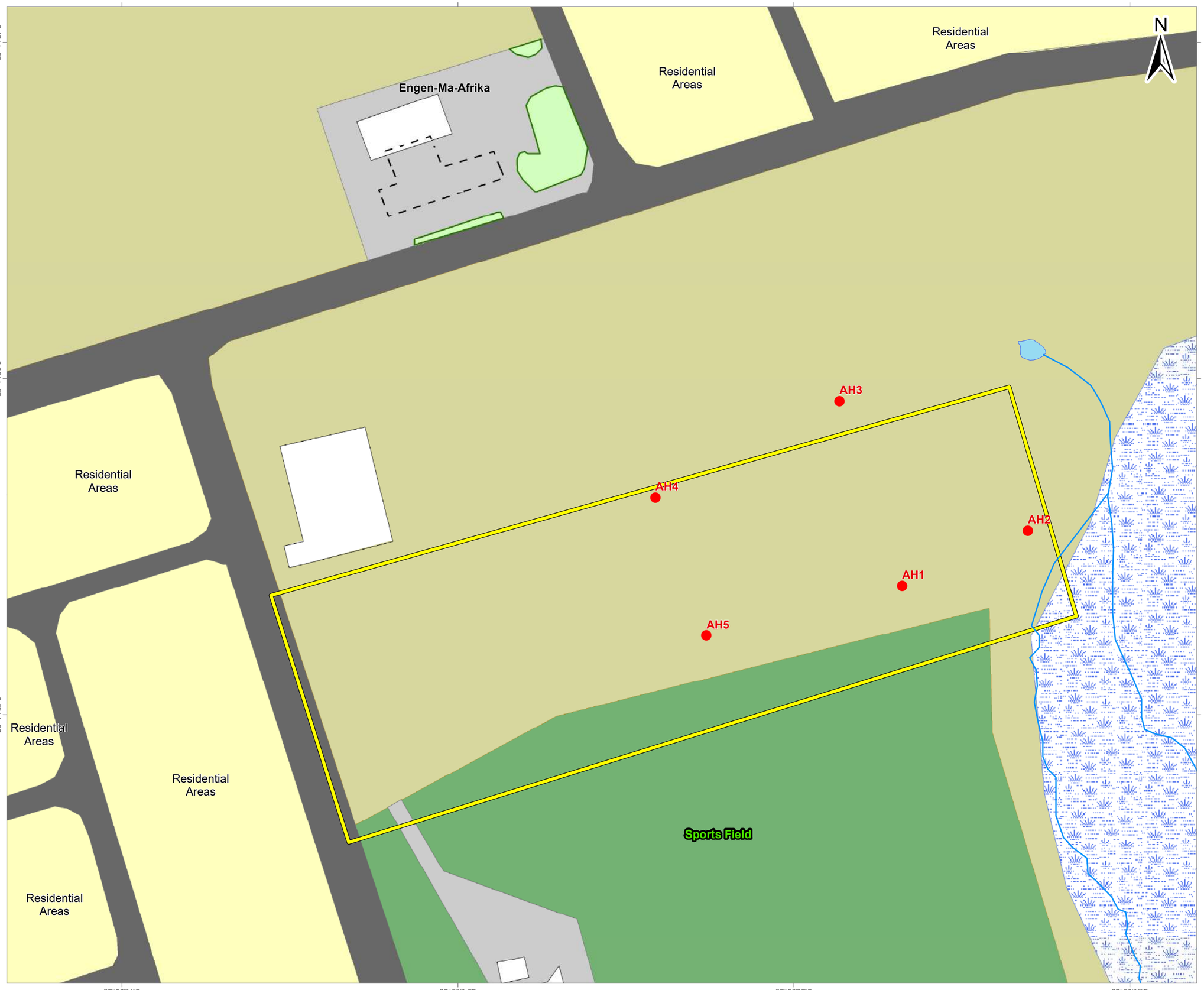
Table 6-2: VOC readings (ppm) recorded during soil augering

Depth (m)	AH1	AH2	AH3	AH4	AH5
1.0	0	0	0	0	0
1.2	-	0	-	0	-
2.0	1.1	-	0	-	0
2.3	0.7	-	-	-	-
2.4	-	-	0	-	-
3.0	-	-	-	-	0
3.7	-	-	-	-	23.1
3.8	-	-	-	-	27.7
4.0	-	-	-	-	86.3

VOC exceeding 100 ppm

The measured VOC readings in all auger holes ranged between 0.0 and 86.3 ppm. Slight hydrocarbon odours and slightly elevated VOC readings were recorded from the soil arisings of auger hole AH5 from 3.8 to 4.2 m bgl.

FIGURE 6-1: SITE LAYOUT

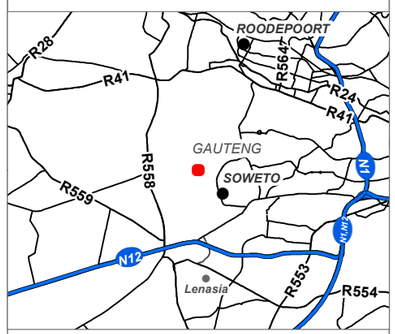


LEGEND

- Augerhole
- River/ Stream
- Site Boundary
- Canopy
- Residential Areas
- Building
- Grass Embankment
- Parking
- Road
- Open Ground
- Sports Field

Inland Water

- Marsh and swamps
- Dam



Data Sources:
Layout digitized from Google Earth™ mapping service: 2019
Imagery Date: 13\05\2019
Data supplied by Specialist (J Muller)

0 25 50 Meters

SCALE: 1:1 000

FIGURE NO.:	-	MAP NUMBER:	19-1075-01
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DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	1 NOVEMBER 2019
PROJECT:	EMDENI PUBLIC TRANSPORT FACILITY		
CLIENT:	PIERRE JOUBERT PROFESSIONAL LANDSCAPE ARCHITECT & ENVIRONMENTAL CONSULTANT		

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6.4 Groundwater investigation

During the investigation on 30th October 2019, groundwater seepage was encountered during the advancement of auger holes AH2, AH3 and AH5. Details of the static water levels (SWL) measured on 1st November 2019 are provided in Table 6-3.

Table 6-3: Groundwater details

MW ID / SANS	Water Strike (m bgl)	SWL (m bgl)	Soil Bore Depth (m bgl)	Comments
AH2	0.80	0.50	1.20	Sample light brown with high sediment load. No odour noted.
AH3	2.10	1.85	2.40	Sample light brown with high sediment load. No odour noted.
AH5	3.90	2.92	4.20	Sample light brown with high sediment load. Slight hydrocarbon odour noted.

Note:
SANS - South African National Standards
m bgl - meters below ground level

6.4.1 Site levelling

The surveying of the topographical coordinates and elevations of the completed auger holes were undertaken by GCS using a dumpy level. The results of the survey are presented in Table 6-4.

Table 6-4: Site levelling

Monitoring Borehole	Relative Site Level (m amsl)	Groundwater Level	Relative Groundwater Elevation (m amsl)
AH1	1631.63	Dry	NA
AH2	1630.04	0.50	1629.54
AH3	1632.05	1.85	1630.20
AH4	1632.93	Dry	NA
AH5	1631.71	2.92	1628.79

NA – Not applicable

6.4.2 Groundwater flow direction

The groundwater level data from auger holes AH2, AH3 and AH5 were used to determine the groundwater flow direction. The groundwater level contour map is presented in Figure 6-3. From the figure, the groundwater on-site flows towards the south-south-west.

The groundwater hydraulic gradient on-site was calculated to be 0.19 in a south-south-westerly direction. The calculated gradient assumes that the subsurface conditions are homogeneous throughout the site.

A weak (R^2= 0.0148) degree of correlation exists between groundwater level elevation and surface elevation at the site as is illustrated in Figure 6-2, indicating that the groundwater flow direction deviates from the site surface topography at a local scale.

Furthermore, it would appear that groundwater flow at the site emulates the regional topography (sloping towards the south-south-west). It should be noted that the wetland also drains in a south-south-west direction as observed from the wetland outlet located further down-gradient of the site.

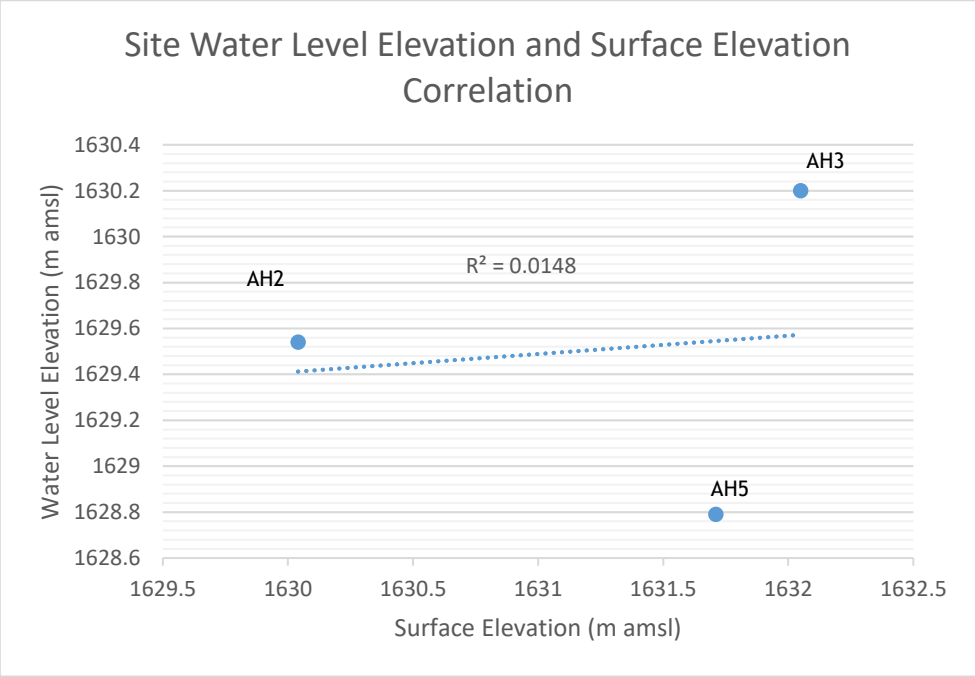


Figure 6-2: Water level correlation with surface elevation

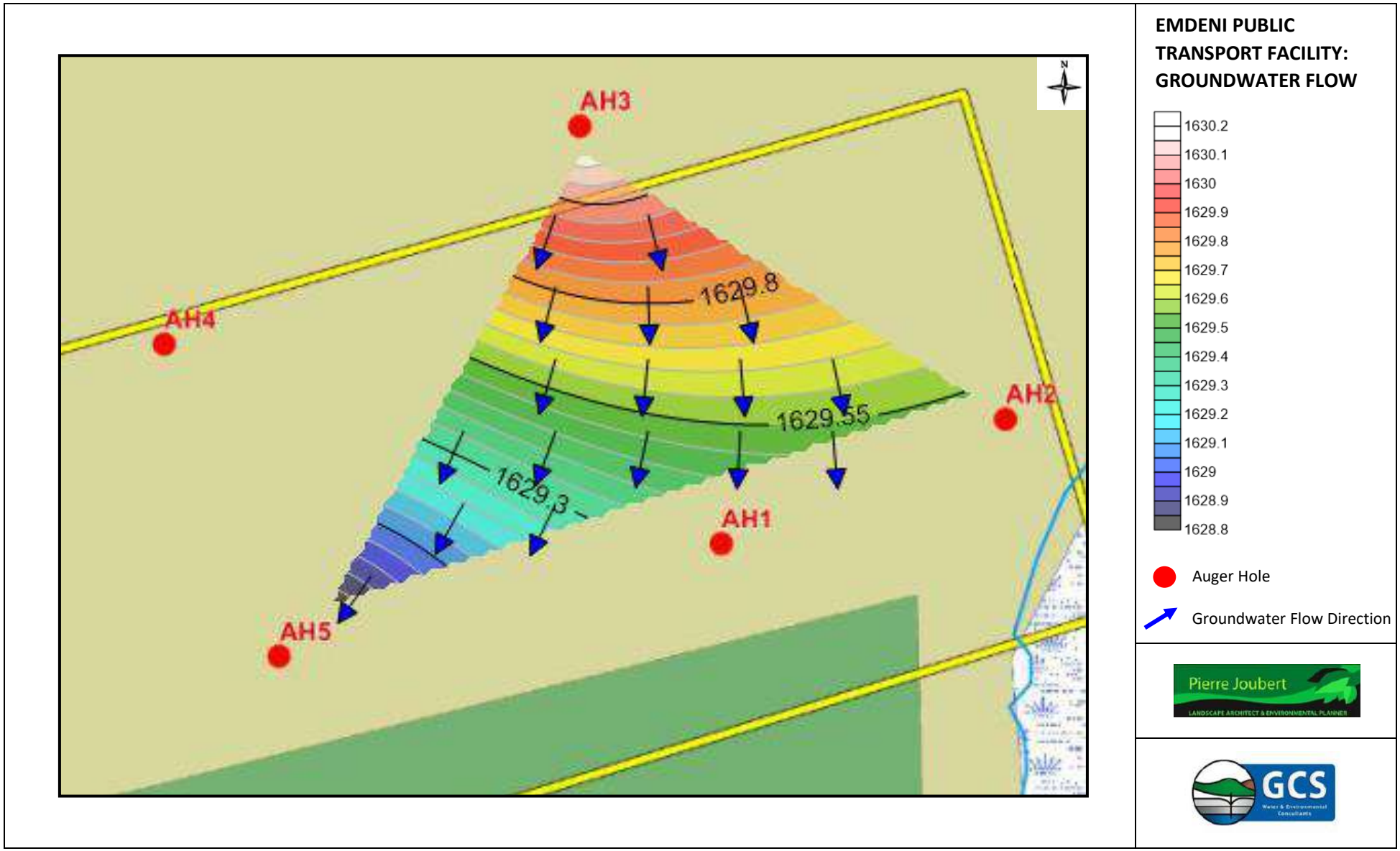


Figure 6-2: Groundwater flow direction contours

7 GROUNDWATER SAMPLING & ANALYSES

7.1 Inorganic groundwater analysis

Groundwater samples were collected from auger holes AH2, AH3 and AH5. The laboratory results obtained for the inorganic parameters and phenols are presented in Table 7-1 and were screened against the SANS 241-1:2015 drinking water standards (SABS, 2015). The laboratory results are presented in Appendix C.

Table 7-1: Groundwater laboratory results - Inorganics

Determinant (mg/l)	SANS 241-1:2015	AH2	AH3	AH5
General Parameters				
pH	>5 to <9.7	7.0	6.78	7.0
Chemical Oxygen Demand	NS	11	17	47
Electrical Conductivity (µS/m)	1,700	545	598	1,055
Total dissolved solids	1,200	270	293	531
P-Alkalinity $CaCO_3$	NS	<0.6	<0.6	<0.6
M-Alkalinity $CaCO_3$	NS	182	99	235
Macro Determinants				
Nitrate, NO_3	11	<0.5	10.51	1.54
Chloride, Cl	300	25.28	47.31	105.02
Sulphate, SO_4	Acute health: 500 Aesthetic: 250	61.85	62.82	106.77
Sodium, Na	200	23.12	24.43	33.6
Ammonia as N	< 1 (ideal)	0.46	<0.02	0.12
Micro Determinants				
Boron, B	2.4	<0.5	<0.5	<0.5
Calcium, Ca	NS	44.24	47.72	80.35
Cadmium, Cd	0.003	<0.05	<0.05	<0.05
Chromium, Cr	0.05	<0.05	<0.05	<0.05
Chromium (VI)	NS	<0.05	<0.05	<0.05
Potassium, K	NS	1.7	2.25	9.03
Lead, Pb	0.01	<0.1	<0.1	<0.1
Magnesium, Mg	NS	24.37	29.63	60.15
Total Cyanide, CN	NS	0.07	<0.07	0.21
Mercury. Hg	0.001 (ideal)	**0.008**	**0.015**	**0.007**
Organic Determinants				
Phenolic Compounds	Aesthetic: 0.01	<0.01	<0.01	<0.01

***Exceeding the SANS standards**

7.1.1 General parameters

None of the general parameters exceeded the SANS drinking water standards. The chemical oxygen demand (COD) concentrations ranged between 11 and 47 mg/l. COD is the amount of oxygen consumed to chemically oxidize organic water contaminants to inorganic end products and is generally used to monitor water treatment plant efficiency. Time-series data for COD at the site will aid in monitoring the discharge from the proposed attenuation dam (as detailed in Section 9).

7.1.2 Macro determinants

All the targeted macro determinants were below the SANS screening criteria.

7.1.3 Micro determinants

The concentrations of mercury detected in the groundwater samples exceeded the SANS drinking water standards. The source of elevated mercury is not known and is expected to be anthropogenic. If reducing groundwater conditions are created, organic and inorganic mercury may be reduced to alkylated forms of mercury, which is its most toxic form (Wuana and Okieimen, 2011).

The remainder of the targeted micro determinants were below the SANS drinking water standards.

7.1.4 Organic determinants

The concentrations of phenolic compounds were below laboratory method detection limits in all groundwater samples.

7.2 Hydrocarbon groundwater analysis

Groundwater samples were collected from auger holes AH2, AH3 and AH5 and transported to UIS Organic laboratory located in Centurion for hydrocarbon analysis. The chemistry results obtained for volatile petroleum hydrocarbons (TPH C_6-C_{40}) are presented in Table 7-2. The laboratory results are presented in Appendix C.

Table 7-2: Groundwater laboratory results – hydrocarbons

Chemical	Sample Location			Risk-Based Screening Values				
				USEPA(a)	CRC HSL (b)			
					Residential	Residential	Commercial/Industrial	Commercial/Industrial
	AH2	AH3	AH5	Drinking Water	Depth to GW 2 to <4m	Depth to GW 4 to <8m	Depth to GW 2 to <4m	Depth to GW 4 to <8m
GRO C6-C10	<10	**47**	**36**	33	980	1,000	4,900	5,100
DRO C10-C28	<382	<382	<382	5.5	1,100	1,100	6,200	6,300
DRO C28-C40	<382	<382	<382	800	NV	NV	NV	NV

Table Notes:

All values stated in µg/l

Values in bold exceeds a screening value while values in bold red exceed two or more screening levels

(a) United States Environmental Protection Agency (US EPA) risk based screening levels (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables). All screening values stipulated for TPH Aromatic fractions

(b) CRC for Contamination Assessment and Remediation of the Environment technical report No 10 – Health screening levels for petroleum hydrocarbons in soil and groundwater Summary, September 2011. Stated values for SAND matrix

NV – No Risk Based Screening specified

AH2: All targeted hydrocarbon compounds were below analytical method detection limits in the groundwater sample collected from auger hole AH2.

AH3 & AH5: Slightly elevated concentrations of GRO C_6-C_{10} were detected in the groundwater samples and exceeded the applicable USEPA drinking water standards.

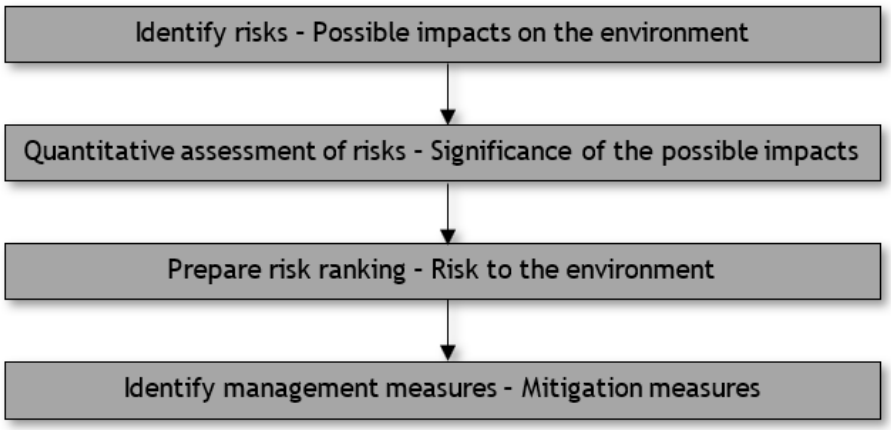
The source of the hydrocarbon concentrations detected in the groundwater from AH3 and AH5 is from upgradient sources as the site is largely undeveloped. An upgradient and potential source of hydrocarbons include the Engen Ma-Africa filling station located to the north of the site.

None of the targeted hydrocarbon compounds exceeded the applicable CRC HSL indoor air inhalation screening criteria. Consequently, based on current chemical data, there would be no risk to commercial employees working in the proposed on-site buildings from the accumulation of hydrocarbon vapours from impacted groundwater at the sampled points.

8 IMPACT ASSESSMENT

To ensure uniformity, the assessment of potential hydrogeological impacts were addressed in a standard manner so that a wide range of impacts is comparable. Each impact identified was assessed in terms of probability (likelihood of occurring), scale (spatial scale), magnitude (severity) and duration (temporal scale). To enable a scientific approach to the determination of the environmental significance (importance), a numerical value was linked to each rating scale.

The following process was followed:



The following criteria was applied to the impact assessment:

Occurrence

- Probability of occurrence (how likely is it that the impact may occur?); and
- Duration of occurrence (how long may impact last?);

Severity

- Magnitude (severity) of impact (will the impact be of high, moderate or low severity?); and
- Scale/extent of impact (will the impact affect the national, regional or local environment, or only that of the site?);

Status of impact

- +: Positive impact;
- -: Negative impact; and
- N: Neutral (no impact).

To assess each of these factors for each impact, the following ranking scales were used:

Status of Impact	
+: Positive (A benefit to the receiving environment)	
N: Neutral (No cost or benefit to the receiving environment)	
-: Negative (A cost to the receiving environment)	
Magnitude: =M	***Duration: =D***
10: Very high/don't know	5: Permanent
8: High	4: Long-term (ceases with the operational life)
6: Moderate	3: Medium-term (5-15 years)
4: Low	2: Short-term (0-5 years)
2: Minor	1: Immediate
0: Not applicable/none/negligible	0: Not applicable/none/negligible
Scale: =S	***Probability: =P***
5: International	5: Definite/don't know
4: National	4: Highly probable
3: Regional	3: Medium probability
2: Local	2: Low probability
1: Site only	1: Improbable
0: Not applicable/none/negligible	0: Not applicable/none/negligible

Once the above factors have been ranked for each impact, the environmental significance of each was assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value that can be achieved is 100 Significance Points (SP). Environmental effects were rated as follows:

Significance	*Environmental Significance Points*	*Colour Code*
High (positive)	>60	H
Medium (positive)	30 to 60	M
Low (positive)	<30	L
Neutral	0	N
Low (negative)	>-30	L
Medium (negative)	-30 to -60	M
High (negative)	<-60	H

This ranking system was used to evaluate impacts associated with the nature of the development and have been detailed in the following sections.

8.1 Potential Impacts Identified During the Construction Phase

8.1.1 Proposed development

During the construction phase of the proposed development, hydrocarbon contamination is possible due to the presence of heavy machinery on-site. Spillages may occur which may impact both the soil and groundwater environment. The impacts are costly and difficult to clean up, however, only small amounts are envisaged to be stored on site. The magnitude of said impacts are however of lesser significance given that hydrocarbon contamination has already been identified within the groundwater on-site (as indicated in Table 7-2).

A 30m buffer has been put in place between the development and the nearest wetland to prevent contamination of the wetland should shallow groundwater be exposed during excavation works. The probability of hydrocarbon impacted groundwater reaching the wetland therefore decreases.

Table 8-1 tabulates the impact of hydrocarbon contamination on-site and the impacts on the soil and groundwater environment. The score of 40 and 42 points results in a medium negative impact.

Table 8-1: Groundwater impact during construction phase of the proposed development - before mitigation measures

Impact description	Unmitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Hydrocarbon contamination associated with heavy machinery on site	Moderate	Short-term	Local	Medium probability	-	-
Score	6	2	2	3	30	**Medium**
Pathway between on-site in-situ hydrocarbon contamination associated with groundwater and off-site streams.	Very high	Short-term	Local	Medium probability	-	-
Score	10	2	2	3	42	**Medium**

Table 8-2 tabulates the impact of hydrocarbon contamination on site and the impacts on the soil and groundwater environment with mitigation measures in place. The mitigation measures would include containing the contaminated groundwater within the appropriate areas and preventing such water from entering the wetland and associated streams. In addition, ensure clean up protocols are in place and followed.

Additionally, the municipality should be informed that up-gradient activities are affecting the groundwater quality at the site prior to construction. The score of 20 points results in a negative low impact for hydrocarbon contamination associated with heavy machinery, whilst the score of 28 points results in a negative low impact for the creation of pathways between on-site groundwater and off-site receptors.

Table 8-2: Groundwater impact during construction phase of the proposed development - after mitigation measures

Impact description	Mitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Hydrocarbon contamination associated with heavy machinery on site	Moderate	Short-term	Local	Low probability	-	-
Score	6	2	2	2	20	**Low**
Pathway between on-site in-situ hydrocarbon contamination associated with groundwater and off-site streams.	Very high	Short-term	Local	Low probability	-	-
Score	10	2	2	2	28	**Low**

8.1.2 Alternative development

During the construction phase of the alternative development, hydrocarbon contamination is possible due to the presence of heavy machinery on-site. Spillages may occur which may impact both the soil and groundwater environment. The impacts are costly and difficult to clean up, however, only small amounts are envisaged to be stored on site. The magnitude of said impacts are however of lesser significance given that hydrocarbon contamination has already been identified within the groundwater on-site (as indicated in Table 7-2).

Given that there is shallow groundwater, which has been impacted by hydrocarbon in places, and that the shallow groundwater might be exposed during excavation works a potential pathway for the wetland to be impacted has been identified.

Table 8-3 tabulates the impact of hydrocarbon contamination on-site and the impacts on the soil and groundwater environment. The score of 40 and 56 points results in a medium negative impact.

Table 8-3: Groundwater impact during construction phase of the alternative development - prior to mitigation measures

Impact description	Unmitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Hydrocarbon contamination associated with heavy machinery on site	Moderate	Short-term	Local	Highly probable	-	-
Score	6	2	2	4	40	**Medium**
Pathway between on-site in-situ hydrocarbon contamination associated with groundwater and off-site streams.	Very high	Short-term	Local	Highly probable	-	-
Score	10	2	2	4	56	**Medium**

Table 8-4 tabulates the impact of hydrocarbon contamination on site and the impacts on the soil and groundwater environment with mitigation measures in place. The mitigation measures would include containing the contaminated groundwater within the appropriate areas and preventing such water from entering the wetland and associated streams.

In addition, ensure clean up protocols are in place and followed. Additionally, the municipality should be informed that up-gradient activities are affecting the groundwater quality at the site prior to construction. The score of 30 points results in a negative medium impact for hydrocarbon contamination associated with heavy machinery, whilst the score of 42 points results in a negative medium impact for the creation of pathways between on-site groundwater and off-site receptors.

Table 8-4: Groundwater impact during construction phase of the alternative development - subsequent to mitigation measures

Impact description	Mitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Hydrocarbon contamination associated with heavy machinery on site	Moderate	Short-term	Local	Medium probability	-	-
Score	6	2	2	3	30	**Medium**
Pathway between on-site in-situ hydrocarbon contamination associated with groundwater and off-site streams.	Very high	Short-term	Local	Medium probability	-	-
Score	10	2	2	3	42	**Medium**

8.2 Potential Impacts Identified – Operation Phase

8.2.1 Proposed development

On-site stormwater will be managed via drainage into the proposed retention ponds and attenuation dams with a 30m wetland buffer put in place (located along the eastern site boundary), prior to being drained out into an adjacent stream located to the east. Given that the proposed site is a transport facility minor hydrocarbon impacts may result from leaking vehicles on-site that will be collected by the stormwater system. If the potentially contaminated stormwater is released into the wetland, or if the associated infrastructure of the dam becomes impaired (e.g., leaking of underground pipes, as detailed in Section 7.1.2), the soil and groundwater environment would be negatively impacted.

Hydrocarbon impacts associated with leaking vehicles may also affect the soil and groundwater environment through leakages entering the subsoils.

Furthermore, leaks or other inadequacies resulting from the sewer system may negatively impact the soil and groundwater environment. As the on-site sewer will be connected to the municipal sewer drain system the risk to groundwater will be mitigated as long as the system remains operational and functioning. It will therefore be prudent that the operator of the site takes responsibility for the maintenance of the on-site sewer network.

Table 8-5 tabulates the impacts of the proposed attenuation dam and on-site activities. The score of 42 points results in a medium, negative impact for the attenuation dam. The score of 36 points results in a medium impact for leaking vehicles and the sewer system.

Table 8-5: Groundwater impact during operation phase of the proposed development - prior to mitigation measures

Impact description	Unmitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Impacts on the soil and groundwater environment due to release of contaminated stormwater into wetland/faulty stormwater infrastructure.	High	Long-term	Local	Medium probability	-	-
Score	8	4	2	3	42	**Medium**
Impacts on the soil and groundwater environment via leaking vehicles (on site).	Moderate	Long-term	Local	Medium probability	-	-
Score	6	4	2	3	36	**Medium**
Impacts on the soil and groundwater environment via faulty on-site sewer system.	Moderate	Long-term	Local	Medium probability	-	-
Score	6	4	2	3	36	**Medium**

Table 8-6 tabulates the mitigating impacts of the potential impacts to the wetland and soil and groundwater environment. To mitigate the identified risks a series of ecological attenuation dams that would serve to reduce any potentially hazardous substances present in surface run-off (a plan depicting the layout of said dams is provided in Appendix D) has been included in the facility design. In particular, the stormwater will be intercepted and routed to flow through a series of retention ponds, attenuation dams and bioswales. A 30m wetland buffer was also included in this design to reduce the probability of potentially contaminated surface run-off reaching the wetland.

Included in this design is re-vegetating each section of the series through a targeted mixture of various plant species selected to aid in reducing/eliminating dissolved phase chemicals of potential concern (refer to the March 2020 report prepared by Habitat Landscape Architects for the list of proposed plant species).

Further mitigation measures would include the implementation of the groundwater monitoring program (detailed in Section 9) for the site and surrounding area whereby the dam water and adjacent streams are monitored and sampled on a regular basis. This would allow for the early detection of water quality deterioration associated with the site. Maintenance and in-house inspections of the attenuation dam system should be undertaken regularly.

The risks associated with the on-site sewer system are considered unlikely for as long as the on-site sewer system is connected to the main municipal sewer system in the area and is kept in a functional state.

The score for the release of stormwater into the wetland is reduced to 24, which is a low, negative result. The score of 24 points results in a low, negative impact for leaking vehicles and the sewer system.

Table 8-6: Groundwater impact during operation phase of the proposed development - subsequent mitigation measures

Impact description	Mitigated					
	Magnitude	**Duration**	**Scale**	**Possibility**	**TOTAL**	**SP**
Impacts on the soil and groundwater environment due to the release of stormwater into stream/faulty stormwater infrastructure.	Moderate	Long-term	Local	Low probability	-	-
Score	6	4	2	2	24	**Low**
Impacts on the soil and groundwater environment via leaking vehicles.	Moderate	Short-term	Local	Low probability	-	-
Score	6	4	2	2	24	**Low**
Impacts on the soil and groundwater environment via an inadequate sewer system.	Moderate	Short-term	Local	Low probability	-	-
Score	6	4	2	2	24	**Low**

Furthermore, it is recommended that the attenuation dam and associated infrastructure are installed according to regulations stipulated in the National Water act 36 of 1998: Regulations regarding the safety of dams in terms of section 123(1) of the National Water Act, 1998 (act no. 36 of 1998).

8.2.2 Alternative development

On-site stormwater will be managed via drainage into the proposed retention ponds and attenuation dams (located along the eastern site boundary), prior to being drained out into an adjacent stream located to the east. Given that the proposed site is a transport facility minor hydrocarbon impacts may result from leaking vehicles on-site that will be collected by the stormwater system. If the potentially contaminated stormwater is released into the wetland, or if the associated infrastructure of the dam becomes impaired (e.g., leaking of underground pipes, as detailed in Section 7.1.2), the soil and groundwater environment would be negatively impacted.

Hydrocarbon impacts associated with leaking vehicles may also affect the soil and groundwater environment through leakages entering the subsoils.

Furthermore, leaks or other inadequacies resulting from the sewer system may negatively impact the soil and groundwater environment. As the on-site sewer will be connected to the municipal sewer drain system the risk to groundwater will be mitigated as long as the system remains operational and functioning. It will therefore be prudent that the operator of the site takes responsibility for the maintenance of the on-site sewer network.

Table 8-7 tabulates the impacts of the proposed attenuation dam and on-site activities. The score of 70 points results in a high, negative impact for the attenuation dam. The score of 36 points results in a medium impact for leaking vehicles and the sewer system.

Table 8-7: Groundwater impact during operation phase of the alternative development - prior to mitigation measures

Impact description	Unmitigated					
	Magnitude	**Duration**	**Scale**	**Possibility**	**TOTAL**	**SP**
Impacts on the soil and groundwater environment due to release of contaminated stormwater into wetland/faulty stormwater infrastructure.	High	Long-term	Local	Highly probable	-	-
Score	8	4	2	5	70	**High**
Impacts on the soil and groundwater environment via leaking vehicles (on site).	Moderate	Long-term	Local	Medium probability	-	-
Score	6	4	2	3	36	**Medium**
Impacts on the soil and groundwater environment via faulty on-site sewer system.	Moderate	Long-term	Local	Medium probability	-	-
Score	6	4	2	3	36	**Medium**

Table 8-8 tabulates the mitigating impacts of the potential impacts to the wetland and soil and groundwater environment. To mitigate the identified risks a series of ecological attenuation dams that would serve to reduce any potentially hazardous substances present in surface run-off (a plan depicting the layout of said dams is provided in Appendix D) has been included in the facility design. In particular, the stormwater will be intercepted and routed to flow through a series of retention ponds, attenuation dams and bioswales. Included in this design is re-vegetating each section of the series through a targeted mixture of various plant species selected to aid in reducing/eliminating dissolved phase chemicals of potential concern (refer to the March 2020 report prepared by Habitat Landscape Architects for the list of proposed plant species). Further mitigation measures would include the implementation of the groundwater monitoring program (detailed in Section 9) for the site and surrounding area whereby the dam water and adjacent streams are monitored and sampled on a regular basis. This would allow for the early detection of water quality deterioration associated with the site. Maintenance and in-house inspections of the attenuation dam system should be undertaken on a regular basis. The risks associated with the on-site sewer system are considered unlikely for as long as the on-site sewer system is connected to the main municipal sewer system in the area and is kept in a functional state. The score for the release of stormwater into the wetland is reduced to 36, which is a medium, negative result. The score of 24 points results in a low, negative impact for leaking vehicles and the sewer system.

Table 8-8: Groundwater impact during operation phase of the alternative development - subsequent mitigation measures

Impact description	Mitigated					
	Magnitude	Duration	Scale	Possibility	TOTAL	SP
Impacts on the soil and groundwater environment due to release of stormwater into stream/faulty stormwater infrastructure.	Moderate	Long-term	Local	Medium probability	-	-
Score	6	4	2	3	36	**Medium**
Impacts on the soil and groundwater environment via leaking vehicles.	Moderate	Short-term	Local	Low probability	-	-
Score	6	4	2	2	24	**Low**
Impacts on the soil and groundwater environment via an inadequate sewer system.	Moderate	Short-term	Local	Low probability	-	-
Score	6	4	2	2	24	**Low**

Furthermore, it is recommended that the attenuation dam and associated infrastructure are installed according to regulations stipulated in the National Water act 36 of 1998: Regulations regarding the safety of dams in terms of section 123(1) of the National Water Act, 1998 (act no. 36 of 1998).

9 PROPOSED GROUNDWATER MONITORING PLAN

The following monitoring plan, as presented in Table 9-1, must be implemented once the site is operational. Care must be taken during the construction phase to ensure that environmental receptors in the vicinity of the site are not impacted.

Table 9-1: Monitoring plan details

Sampling ID	Co-ordinates (WGS 84. Geographic)		Status	Analyses	Sampling Frequency
	S	E			
Sampling locations					
Attenuation dam	-26.242260°	27.841512°	To be installed	COD, pH, EC, TPH C_6 to C_{40}	Monthly
Up-stream	-26.241867°	27.841630°			
Down-stream	-26.244715°	27.841613°			
MW1	TBC	TBC	To be installed	Heterotrophic plate count, COD, pH, EC, chloride, ammonia, nitrate, sulphate, mercury, TPH C_6 - C_{40} and BTEXN	Bi-annually
MW2	TBC	TBC			
MW3	TBC	TBC			

It is recommended that the attenuation dam be sampled monthly to ensure that the system is functioning and that no contamination is released into the associated wetland. Samples should also be collected from down- and up-gradient of the attenuation dam to assess the impact the dam has on the water quality of the nearby wetland.

Time-series data should be presented via trend analyses after each sampling event to determine if the facility has any detrimental effects on the water resources and to assess for increasing concentrations of targeted contamination compounds and relevant inorganic indicators. It is recommended that access and approval for off-site sampling be obtained from the landowner.

CONCLUSION

Following the hydrogeological investigation conducted at the proposed Emdeni Public Transport Facility, the following was concluded:

Field Investigation

- During the hydrocensus conducted on the 1st November 2019, no boreholes were identified within 1 km of the site;
- Five auger holes (AH1-AH5) were completed up to depths ranging between 1.2 to 4.2 m bgl;
- Groundwater was encountered during the completion of auger holes AH2, AH3 and AH5 on the 30th October 2019. SWLs measured on the 1st November 2019 ranged between 0.5 and 2.92 m bgl.
- Topographical surveying of the soil bore locations indicated that groundwater flow is towards the south-south-west; and
- Three groundwater samples were collected from auger holes AH2, AH3 and AH5. The laboratory results indicated the following:
    - The detected mercury concentrations exceeded the SANS drinking water standards; and
    - slightly elevated concentrations of GRO C_6-C_{10} were detected in the groundwater samples collected from auger holes AH3 and AH5 and exceeded the applicable USEPA drinking water standards. The source of the hydrocarbon concentrations detected in the groundwater from AH3 and AH5 is most likely from an upgradient and off-site source.

Impact Assessment

- Impacts during construction phase:
    - Hydrocarbon contamination is possible due to the presence of heavy machinery on-site for both the proposed and alternative development. Spillages may occur which may impact both the soil and groundwater environment. The mitigation measures would include secondary containment for all fuel stored on site. Clean-up protocols must in place and adhered to;
    - Additionally considering the hydrocarbon impact from off-site sources it would be prudent to inform the local municipality that upgradient activities are affecting the quality of the groundwater at the site.
    - The likelihood of impacted groundwater to affect the nearby wetland system is lower with the proposed development than the alternative development layout. Given that there is shallow groundwater, which has been impacted by hydrocarbon in places, and that the shallow groundwater might be exposed

during excavation works a potential pathway for the wetland to be impacted has been identified for the alternative development. However, with the proposed development a 30m wetland buffer has been put into the design to reduce the chances of exposed groundwater reaching the wetland. The mitigation measures would include containing the contaminated groundwater within the appropriate areas and preventing such water from entering the wetland and associated streams.

- Impacts during operational phase of the proposed development
    - During the operational phase, impacts to the soil and groundwater environment may result from the release of potentially impacted stormwater into the adjacent stream or from faulty stormwater infrastructure, leaking vehicles and the on-site sewer system. From a review of the updated project scope a series of ecological attenuation dams will be constructed that would serve to reduce potentially hazardous substances (both non-aqueous phase liquids as well as dissolved phase contaminants) present in surface run-off. Further mitigation measures would include the implementation of the groundwater monitoring program for the site and surrounding area whereby the attenuation dam water and adjacent streams are monitored and sampled regularly.
- Impacts during operational phase of the alternative development:
    - During the operational phase, impacts to the soil and groundwater environment may result from the release of potentially impacted stormwater into the adjacent stream or from faulty stormwater infrastructure, leaking vehicles and the on-site sewer system. From a review of the updated project scope a series of ecological attenuation dams will be constructed that would serve to reduce potentially hazardous substances (both non-aqueous phase liquids as well as dissolved phase contaminants) present in surface run-off. Further mitigation measures would include the implementation of the groundwater monitoring program for the site and surrounding area whereby the attenuation dam water and adjacent streams are monitored and sampled regularly.

RECOMMENDATIONS

Based on the findings of this investigation the following recommendations were made:

- Stormwater from the attenuation dams should be sampled regularly to ensure that no unacceptable contamination is released into the associated wetland. Samples should also be collected down- and up-gradient of the attenuation dam to assess the impact the dam has on the water quality in comparison to in-situ (up-stream) conditions;
- Groundwater monitoring should be conducted on a bi-annual basis for inorganic and hydrocarbon constituents and a trend analysis should be compiled to ensure the facility does not have any detrimental effect on the groundwater environment;
- The groundwater monitoring plan should commence once the site is operational.

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APPENDIX A - PHOTOGRAPHIC LOG

APPENDIX A - PHOTOGRAPHIC LOG

Client Name: Urban Innovate	**Date:** November 2019	**Site Location:** Zola, Extension 3	**Project Number:** 19-0753

Photo No. 1

Description: General view of the site looking west.

Photo No. 2

Description: View of the western portion of the site.

Photo No. 3

Description: View of the eastern portion of the site.

Photo No. 4

Description: View of northern portion of the site.

	
Photo No. 5	**Photo No. 6**
Description: View of the sport field located south of the site.	**Description**: View of the wetland and non-perennial stream located east of the site.
	
Photo No. 7	**Photo No. 8**
Description: Consumable waste noted within the adjacent non-perennial stream.	**Description**: Animals feeding and drinking water from the wetland outlet (approx. 380 m south of the site).

Photo No. 9

Description: View of the dumpy level used for surveying.

APPENDIX B – SOIL LOGS

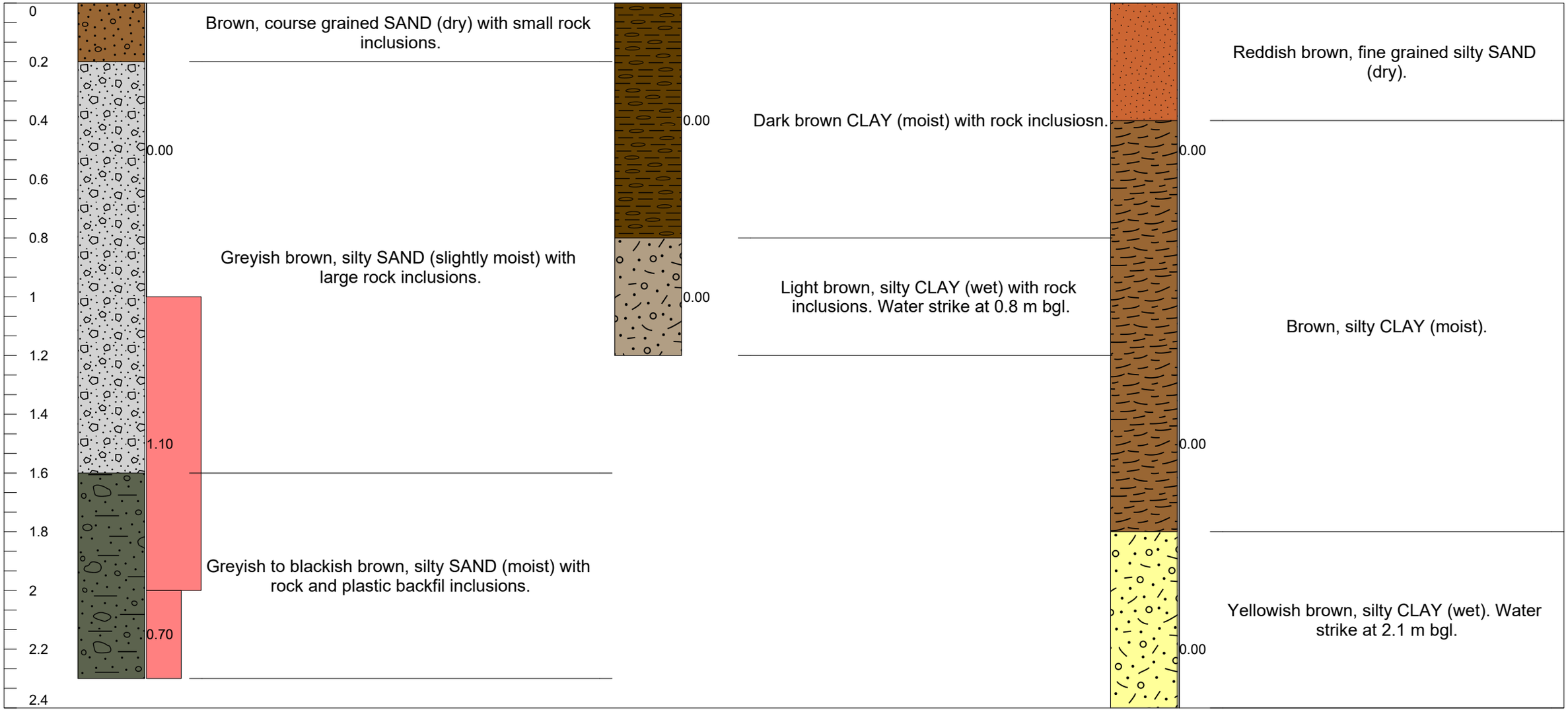
PROJECT: Emdemi Public Transport Facility

LOCATION: Zola, Extension 3

AUGER HOLE ID:	AH1
LONGITUDE:	-26.242176
LATITUDE:	27.841101
DEPTH:	2.3

AUGER HOLE ID:	AH2
LONGITUDE:	-26.242017
LATITUDE:	27.841432
DEPTH:	1.2

AUGER HOLE ID:	AH3
LONGITUDE:	-26.241772
LATITUDE:	27.840845
DEPTH:	2.4



PROJECT: Emdemi Public Transport Facility

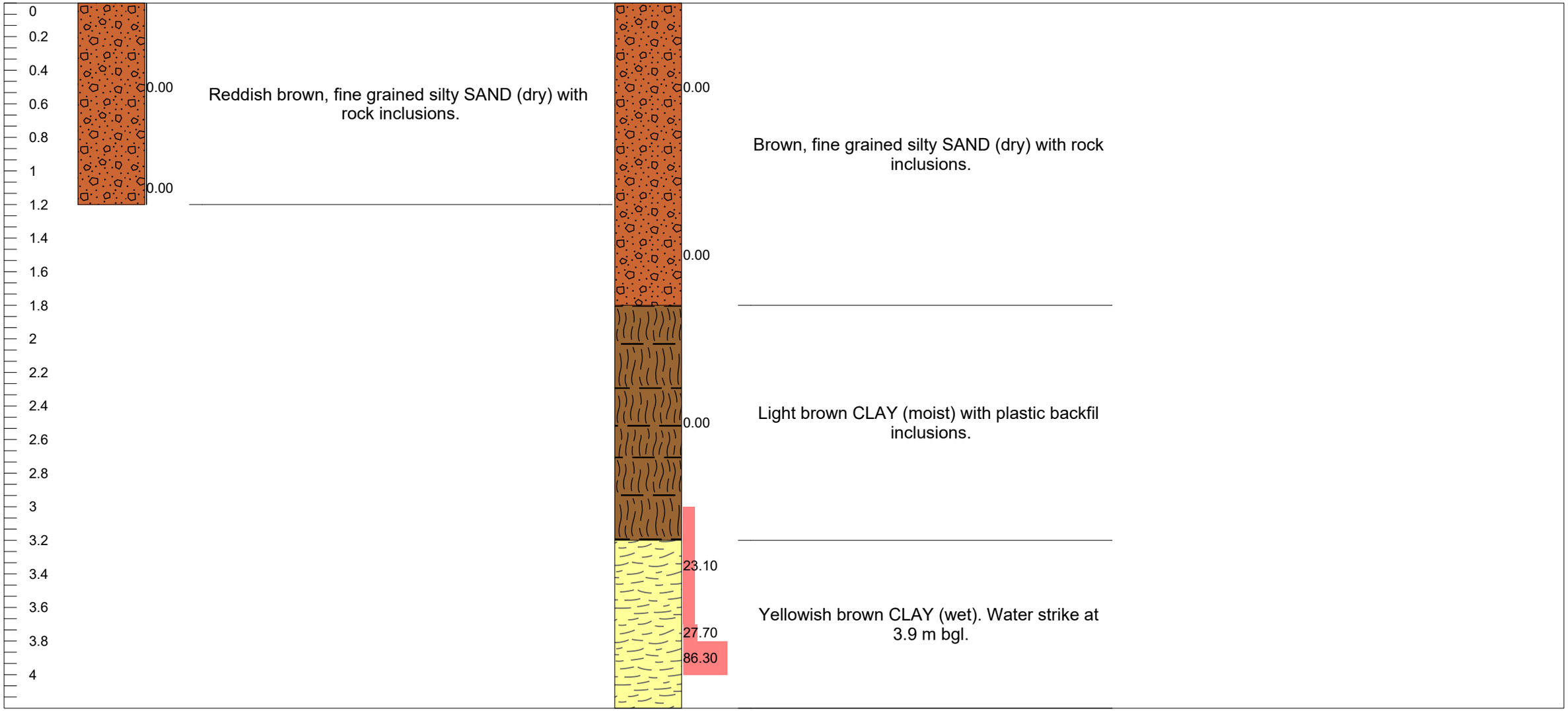
LOCATION: Zola, Extension 3

AUGER HOLE ID:	AH4
LONGITUDE:	-26.241964
LATITUDE:	27.840845
DEPTH:	1.2

AUGER HOLE ID:	AH5
LONGITUDE:	-26.242279
LATITUDE:	27.840553
DEPTH:	4.2

Depth (m)	Graphic log	PID (ppm)	Description
0 – 1.2		0.00 0.00	Reddish brown, fine grained silty SAND (dry) with rock inclusions.

Graphic log	PID (ppm)	Description
	0.00	Brown, fine grained silty SAND (dry) with rock inclusions.
	0.00	
	0.00	Light brown CLAY (moist) with plastic backfil inclusions.
	23.10	
	27.70	Yellowish brown CLAY (wet). Water strike at 3.9 m bgl.
	86.30	



APPENDIX C - LABORATORY RESULTS

UIS ORGANIC LABORATORY

sanas Testing Laboratory T0419

TEST REPORT
26288A

Test Description: Gasoline Range Organics and Total Petroleum Hydrocarbons
Test Method: UISOL-T-012 (GRO) and UISOL-T-011 (TPH)

Client and Project Information

Client: GCS (Pty) Ltd
Address: PO Box 2597
Rivonia
2128

Attention: Jason Muller - GCS
Tel: (011) 803 5726
Email: jasonm@gcs-sa.biz

Project number: 19-753
Project name: Zola

Sample Information

Matrix: Water
Storage: Fridge at 0-6°C
Container: Glass

Date Received: 2019/10/30
Date Analysed: 2019/10/30
Date Issued: 2019/11/04

SAMPLE ID	GRO C6-C10	TPH C10-C28	TPH C28-C40	DILUTIONS
AH2	<10 µg/liter	<382 µg/liter	<382 µg/liter	GRO=1, TPH=1
AH3	47 µg/liter	<382 µg/liter	<382 µg/liter	GRO=1, TPH=1
AH5	36 µg/liter	<382 µg/liter	<382 µg/liter	GRO=1, TPH=1

Disclaimers

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3) Parameters marked " * " are not included in the SANAS Schedule of Accreditation for this laboratory.
4) A = Concentration outside calibration range, O = Outsourced analysis, UTD = Unable to Determine.
5) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

Reinardt Cromhout
Authorised Signatory

www.uisorganiclaboratory.co.za 13 Sovereign Drive Route21 Corporate Park Irene South Africa Tel: +27 12 345 1004 info@uisol.co.za

UIS SEDIBA LABORATORY

sanas Testing Laboratory T0584

AMENDMENT TO TEST REPORT 9376A

Client and Project Information

Client:	UIS Organic Laboratory				
Address:	Unit 3 Carrera House, 17 Sovereign St, Route 21	**Attention:**	F Havenga	**Project number:**	19-753
	Irene	**Tel:**	(012) 345 1004	**Project name:**	Zola
	0061	**Email:**	willieh@uisol.co.za		

Sample Information

Sample ID:	**AH2**	**Matrix:**	Water	**Date Received:**	2019/10/30
Units:	mg/l [ppm] (unless stated elsewhere)	**Container:**	Glass	**Date Issued:**	2019/11/08

Cations and Metals

B	<0.5	**K**	1.70	**Hg***	0.008
Ca	44.24	**Mg**	24.37	**Cr(VI)***	<0.05
Cd	<0.05	**Na**	23.12		
Cr	<0.05	**Pb**	<0.1		

Anions (Discrete Analyser)

Cl	25.82	**NO3 as N**	<0.5	**SO4**	61.85

Other Parameters

pH	7.00	**COD***	11
EC (µs/cm)	545	**P-Alk as CaCO3**	<0.6
NH4 as N*	0.46	**M-Alk as CaCO3**	182
Total CN*	0.07	**Total Phenol***	<0.01

Disclaimers

Charlene Swanepoel
Authorised Signatory

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3) Parameters marked " * " are not included in the SANAS Schedule of Accreditation for this laboratory.
4) A = Concentration outside calibration range, ** = Outsourced analysis, UTD = Unable to Determine.
5) Methods: UISSL-WL-001 (Conductivity), UISSL-WL-002 (Alkalinity), UISSL-WL-003 (pH), UISSL-WL-004 (TDS), UISSL-WL-005 (Anions by IC), UISSL-WL-006 (Cations by IC), UISSL-WL-007 (Metals), UISSL-WL-008 (Cr(VI)), UISSL-WL-009 (TOC), UISSL-WL-010 (Hg by DMA), UISSL-WL-011 (Anions by Discrete Analyser).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

www.uissl.co.za 13 Sovereign Drive Route21 Corporate Park Irene South Africa Tel: +27 12 345 1004 info@uisol.co.za

UIS SEDIBA LABORATORY

sanas Testing Laboratory T0584

AMENDMENT TO TEST REPORT 9376A

Client and Project Information

Client:	UIS Organic Laboratory				
Address:	Unit 3 Carrera House, 17 Sovereign St, Route 21	**Attention:**	F Havenga	**Project number:**	19-753
	Irene	**Tel:**	(012) 345 1004	**Project name:**	Zola
	0061	**Email:**	willieh@uisol.co.za		

Sample Information

Sample ID:	**AH3**	**Matrix:**	Water	**Date Received:**	2019/10/30
Units:	mg/l [ppm] (unless stated elsewhere)	**Container:**	Glass	**Date Issued:**	2019/11/08

Cations and Metals

B	<0.5	**K**	2.25	**Hg***	0.015
Ca	47.72	**Mg**	29.63	**Cr(VI)***	<0.05
Cd	<0.05	**Na**	24.43		
Cr	<0.05	**Pb**	<0.1		

Anions (Discrete Analyser)

Cl	47.31	**NO3 as N**	10.51	**SO4**	62.82

Other Parameters

pH	6.78	**COD***	17
EC (µs/cm)	598	**P-Alk as CaCO3**	<0.6
NH4 as N*	<0.02	**M-Alk as CaCO3**	99
Total CN*	<0.07	**Total Phenol***	<0.01

Disclaimers

Charlene Swanepoel
Authorised Signatory

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4) A = Concentration outside calibration range, ** = Outsourced analysis, UTD = Unable to Determine.
5) Methods: UISSL-WL-001 (Conductivity), UISSL-WL-002 (Alkalinity), UISSL-WL-003 (pH), UISSL-WL-004 (TDS), UISSL-WL-005 (Anions by IC), UISSL-WL-006 (Cations by IC), UISSL-WL-007 (Metals), UISSL-WL-008 (Cr(VI)), UISSL-WL-009 (TOC), UISSL-WL-010 (Hg by DMA), UISSL-WL-011 (Anions by Discrete Analyser).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

www.uissl.co.za 13 Sovereign Drive Route21 Corporate Park Irene South Africa Tel: +27 12 345 1004 info@uisol.co.za

UIS SEDIBA LABORATORY

sanas Testing Laboratory T0584

AMENDMENT TO TEST REPORT 9376A

Client and Project Information

Client:	UIS Organic Laboratory				
Address:	Unit 3 Carrera House, 17 Sovereign St, Route 21	**Attention:**	F Havenga	**Project number:**	19-753
	Irene	**Tel:**	(012) 345 1004	**Project name:**	Zola
	0061	**Email:**	willieh@uisol.co.za		

Sample Information

Sample ID:	**AH5**	**Matrix:**	Water	**Date Received:**	2019/10/30
Units:	mg/l [ppm] (unless stated elsewhere)	**Container:**	Glass	**Date Issued:**	2019/11/08

Cations and Metals

B	<0.5	**K**	9.03	**Hg***	0.007
Ca	80.35	**Mg**	60.15	**Cr(VI)***	<0.05
Cd	<0.05	**Na**	33.06		
Cr	<0.05	**Pb**	<0.1		

Anions (Discrete Analyser)

Cl	105.02	**NO3 as N**	1.54	**SO4**	106.77

Other Parameters

pH	7.00	**COD***	47
EC (µs/cm)	1055	**P-Alk as CaCO3**	<0.6
NH4 as N*	0.12	**M-Alk as CaCO3**	235
Total CN*	0.21	**Total Phenol***	<0.01

Disclaimers

Charlene Swanepoel
Authorised Signatory

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4) A = Concentration outside calibration range, ** = Outsourced analysis, UTD = Unable to Determine.
5) Methods: UISSL-WL-001 (Conductivity), UISSL-WL-002 (Alkalinity), UISSL-WL-003 (pH), UISSL-WL-004 (TDS), UISSL-WL-005 (Anions by IC), UISSL-WL-006 (Cations by IC), UISSL-WL-007 (Metals), UISSL-WL-008 (Cr(VI)), UISSL-WL-009 (TOC), UISSL-WL-010 (Hg by DMA), UISSL-WL-011 (Anions by Discrete Analyser).
6) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

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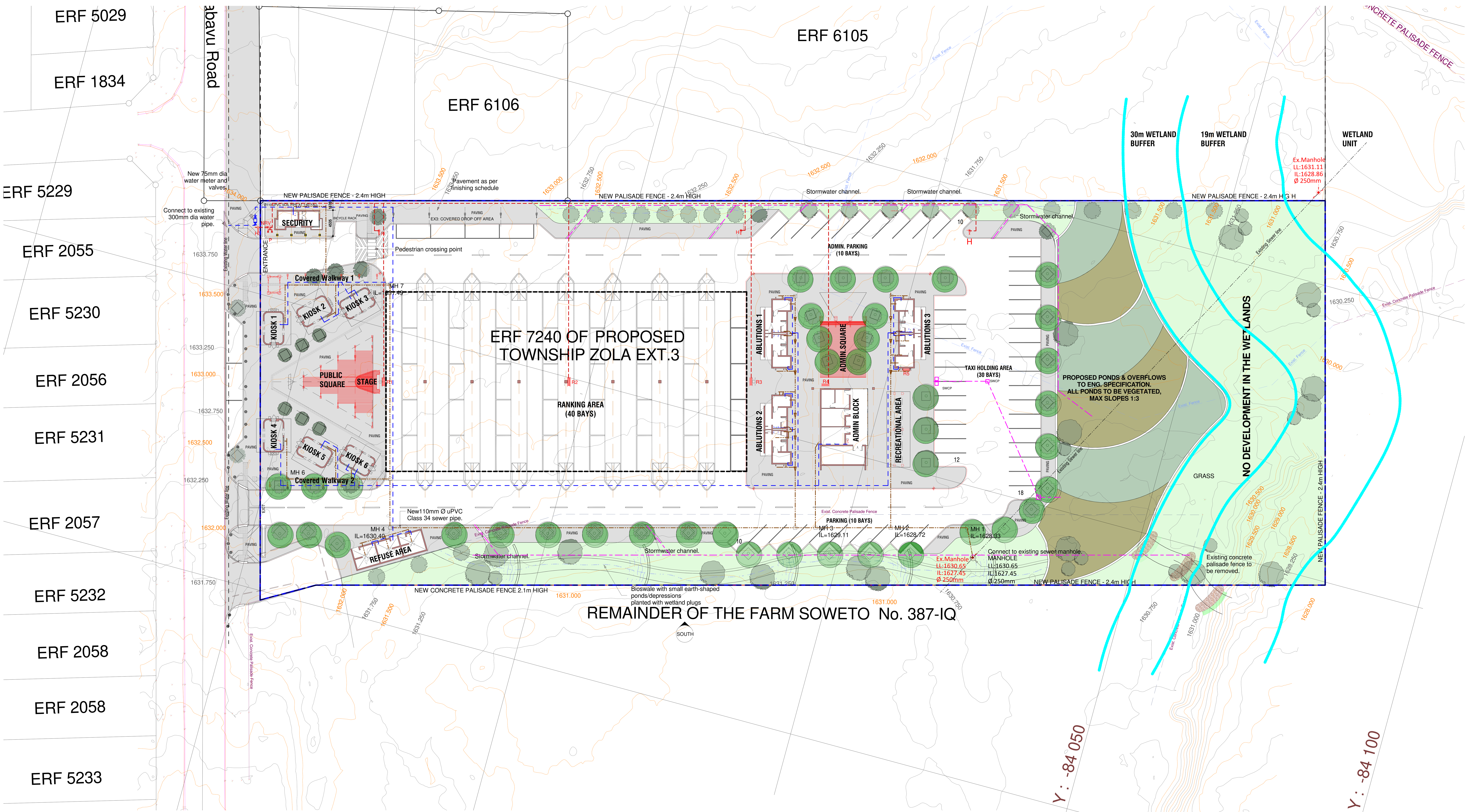
APPENDIX D – PROJECT ARCHITECT PLAN



SCALE 1:250

NORTH

SCHEDULE OF RIGHTS

PROPERY DESCRIPTION	
ERF NO :	7240 (PROPOSED)
TOWNSHIP	PROPOSED TOWNSHIP ZOLA EXT.3
SCHEME	ANNEXURE F
ZONING INFORMATION	
USE ZONE [CURRENT]	MUNICIPAL UNDETERMINED/AGRICULTURAL
USE ZONE [PROPOSED]	MUNICIPAL PURPOSES AND TRANSPORT FACILITIES
SITE AREA	12 484 m²
BUILDING LINES	TO THE SATISFACTION OF THE LOCAL AUTHORITY

STATUS OF ERF NO.:

THE FOLLOWING REFERS WITH ERF NO.:

1. THE SITE IS CURRENTLY LOCATED ON REM AINDER OF THE FARM SOWETO NO. 387-IQ
2. CURRENTLY THE ESTABLISHMENT OF NEW TOWNSHIP IS IN PROCESS, ZOLA EXT.3 WITH ERF 7238 & 7239
3. ONCE THE TOWNSHIP IS ESTABLISHED THE ABOVE ERF TO BE CONSOLIDATED TO ERF 7240.

PARKING:

RANKING AREA	=	40 Bays
DROP-OFF AREA	=	4 Bays
ADMIN.PARKING	=	10 Bays
TAXI HOLIDING	=	30 Bays
OVERALL TOTAL	=	84 Bays

DEVELOPMENT CONTROL MEASURES		PROPOSED PUBLIC TRANSPORT FACILITY
PERMISSABLE	CONTROL	ACTUAL
To the satisfaction of LA	COVERAGE	22%
To the satisfaction of LA	HEIGHT	1 STOREY
N/A	FAR	0.22
N/A	DENSITY	N/A

BUILDING AREA SCHEDULE m²	AREA m²
BLOCK A: GUARD -HOUSE	22.54m²
BLOCK B1- B6: KIOSKS	125.16m²
BLOCK C: REFUSE AREA	51.13m²
BLOCK D: ABLUTIONS	34.19m²
BLOCK E: ABLUTIONS	34.19m²
BLOCK F: ADMIN OFFICES	118.80m²
BLOCK G: ABLUTIONS	34.19m²
RANKING AREA	2375.37m²
RECREATIONAL AREA	54.20m²
TOTAL: BUILDING AREA	**2849.77m²**
DRIVEWAY & PARKING	2 724,35m²
PAVED WALKWAYS	2 505.74m²
SOFT LANDSCAPING	1 341.24m²
ATTENUATION PONDS	1 210.20m²
TOTAL: DEVELOPMENT FOOTPRINT	**10 631.30m²**
WETLAND BUFFER AREAS	1 852.70m²
TOTAL: SITE AREA	**12 484.00m²**

GENERAL NOTES:

THIS DRAWING IS NOT TO BE SCALED. FIGURE DIMENSIONS TO BE USED ALL THE TIME.

CONTRACTOR IS RESPONSIBLE FOR CORRECT SETTING OUT OF THE BUILDING, ALL EXTERNAL AND INTERNAL WALLS WITH PARTICULAR REFERENCE TO BOUNDARIES, BUILDING LINES ETC.

CONTRACTOR TO VERIFY ALL LEVELS, HEIGHTS AND DIMENSIONS BEFORE PUTTING ANY WORK

CONTRACTOR TO CHECK AND VERIFY ALL LEVELS, DATUMS AND DIMENSIONS ON SITE AND SHALL REPORT ANY DISCREPANCIES OR OMISSIONS TO THIS OFFICE PRIOR TO START OF WORKS OR DURING THE CONSTRUCTION PHASE.

THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH STRUCTURAL, MECHANICAL, ELECTRICAL AND/ OR ANY OTHER CONSULTANT / S DOCUMENTATION AS MAY BE APPLICABLE TO THE PROJECT PRIOR TO START OF WORKS AND ITS DURATION

REPORT TO THE ARCHITECT ALL AMBIGUITIES, DISCREPANCIES, OMISSIONS, ERRORS, DEPARTURES FROM GOOD PRACTICE DISCOVERED IN THE DRAWINGS

BEFORE TENDERING, EXAMINE THE SITE AND ASCERTAIN THE EXTENT AND NATURE OF ALL CONDITIONS AFFECTING THE WORK, NOT EXCLUDING THE LOCATION OF ALL BURIED SERVICES WHICH MAY HAVE TO BE PROTECTED, REMOVED OR RELOCATED

MATERIALS SHALL BE THE BEST OF THEIR RESPECTIVE KINDS DESCRIBED ON THE DRAWINGS AND THE CONTRACTOR SHALL WHERE REQUIRED HEREIN OR UPON REQUEST OF THE ARCHITECT/ ENGINEER FURNISH VOUCHERS TO PROVE THAT THE MATERIALS COMPLY HEREWITH

QUALITY OF MATERIALS & WORKMANSHIP TO COMPLY WITH THE RELEVANT S.A.B.S & B.S.S. SPECIFICATION & SHALL CONFORM TO THE MINIMUM STANDARD PREAMBLES IN THE BILL OF QUANTITIES OR, IN THE ABSENCE OF A BILL OF QUANTITIES, AVAILABLE FOR PERUSAL AT THE OFFICES OF THE ARCHITECT.

THE CONTRACTOR SHALL NOTIFY AND OBTAIN THE APPROVAL OF THE PLANNING DEPARTMENT AND / OR THE FIRE PREVENTION OFFICER FOR ANY WORKS UNDER THEIR RESPECTIVE JURISDICTION REQUIRING INSPECTIONS PRIOR TO COVERING UP OR PROCEEDING WITH SUBSEQUENT WORK.

ALL WORK TO BE DONE IN ACCORDANCE WITH THE SANS 10400.

THIS DRAWING IS COPYRIGHT AND REMAINS WITH THE ARCHITECT, ANY UNAUTHORISED REPRODUCTION, PIBLUCATION, TRANSMISSION AND OR INCLUSION OF MEDIA IS AN INFRIDGEMENT.

ISSUED FOR INFORMATION

SERVICES LEGEND:

COLOUR	DISCIPLINE
(magenta)	STORMWATER
(brown)	SEWER
(red)	FIRE
(blue)	DOMESTIC WATER

REVISIONS

REV	DATE	DRAWN	DESCRIPTION
A	2021/11/19	SELBY	ALTERNATIVE 'OPTION B' ISSUED FOR APPROVAL
B	2021/11/23	SELBY	GENERAL UPDATE, ISSUED FOR APPROVAL/INFORMATION
C	2021/11/24	SELBY	UPDATED AREA SCHEDULE;INDICATED EXIST.SEWER & WATER LINES

CLIENT

JDA Johannesburg Development Agency

IMPLEMENTING AGENT

ARCHITECT

dgit architects

PROJECT

PROPOSED NEW ZOLA EMDENI PUBLIC TRANSPORT FACILITY

PROJECT ADDRESS

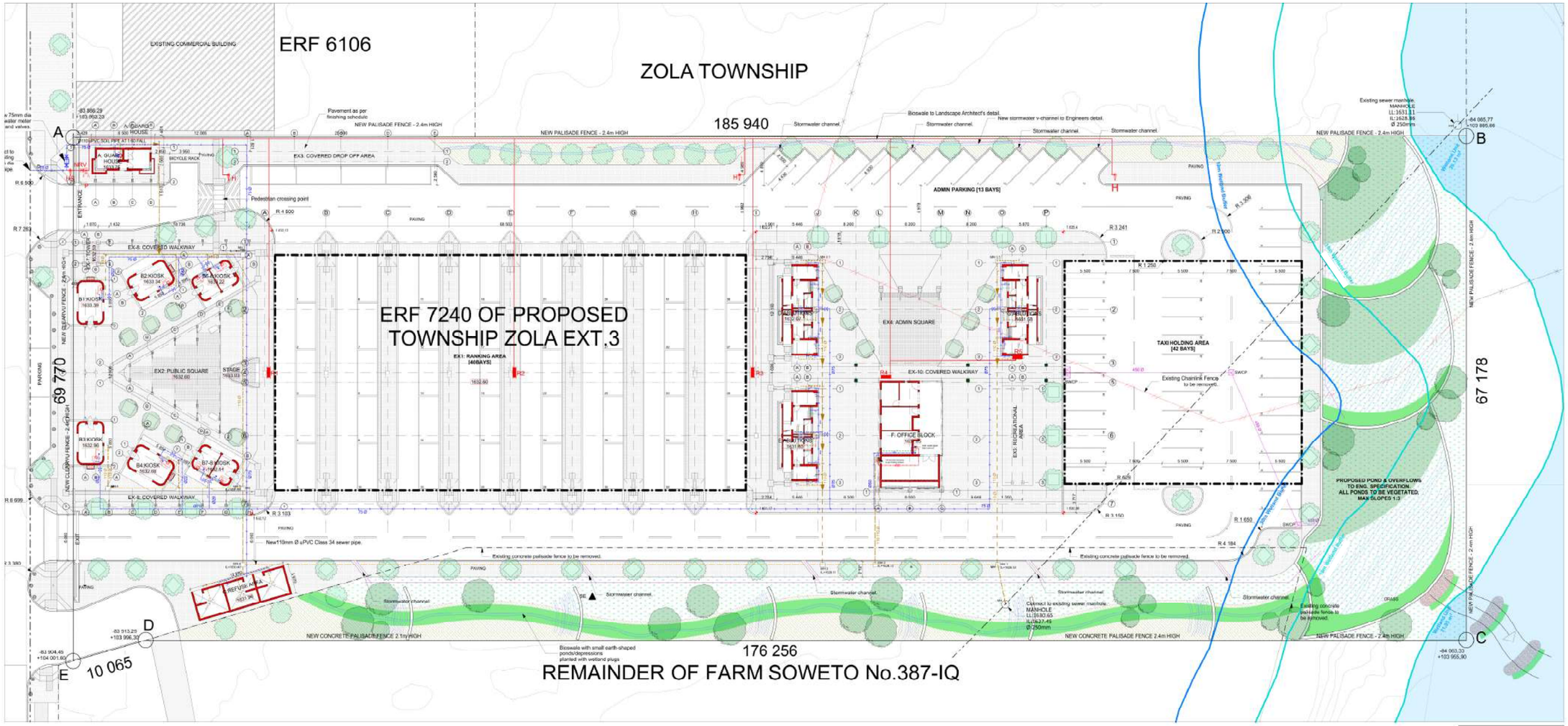
ERF 6105,6106 ZOLA TOWNSHIP SOWETO

BUILDING (CLUSTER):

DRAWING TITLE

PROPOSED PREFERED LAYOUT PLAN

DATE	DRAWN	SCALE	ISSUED BY	SHEET SIZE:
2021/12/06 13:04:02	SELBY		SELBY	A0
PROJECT No.	DRAWING No.			REVISION
21.05	101			C



01 SITE PLAN 1:200

Wetland Legend

- Wetland Unit 61,08m² (impacted area)
- 30m Wetland Buffer 752,61m² (impacted area)
- 100m Transport Buffer 998,51 m² (impacted area)

STATUS OF ERF NO.:

THE FOLLOWING REFERS WITH ERF NO.:

1. THE SITE IS CURRENTLY LOCATED ON REMAINDER OF THE FARM SOWETO NO. 387-IQ
2. CURRENTLY THE ESTABLISHMENT OF NEW TOWNSHIP IS IN PROCESS, ZOLA EXT.3 WITH ERF 7238 & 7239
3. ONCE THE TOWNSHIP IS ESTABLISHED THE ABOVE ERF TO BE CONSOLIDATED TO ERF 7240.

SCHEDULE OF RIGHTS

PROPERTY DESCRIPTION	
ERF NO :	7240 (PROPOSED)
TOWNSHIP	PROPOSED TOWNSHIP ZOLA EXT.3
SCHEME	ANNEXURE I'
ZONING INFORMATION	
USE ZONE [CURRENT]	MUNICIPAL UNDETERMINED/AGRICULTURAL
USE ZONE [PROPOSED]	MUNICIPAL PURPOSES AND TRANSPORT FACILITIES
SITE AREA	12 484 m²
BUILDING LINES	TO THE SATISFACTION OF THE LOCAL AUTHORITY

DEVELOPMENT CONTROL MEASURES		PROPOSED PUBLIC TRANSPORT FACILITY
PERMISSABLE	CONTROL	ACTUAL
To the satisfaction of LA	COVERAGE	22%
To the satisfaction of LA	HEIGHT	1 STOREY
N/A	FAR	0.22
N/A	DENSITY	N/A

BUILDING AREA SCHEDULE m²	AREA m²
BLOCK A: GUARD HOUSE	22.54m²
BLOCK B1- B8: KIOSKS	125.16m²
BLOCK C: REFUSE AREA	51.13m²
BLOCK D: ABLUTIONS	34.19m²
BLOCK E: ABLUTIONS	34.19m²
BLOCK F: ADMIN OFFICES	116.80m²
BLOCK G: ABLUTIONS	34.19m²
RANKING AREA	2375.37m²
RECREATIONAL AREA	54.20m²
TOTAL: BUILDING AREA	**2849.77m²**

CONSULTANT: ZAS Architects and planners TEL : (011) 486-4103 FAX : (086) 515 1833

JDA Johannesburg Development Agency

REVISIONS

No.	Description	Date
A	Structural Coordination	2018-07-24
B	General design development	2019-02-22
C	Council Submission	2020-02-20
D	Updated to water attenuation	2020-09-03

WORK DESCRIPTION: WORKING DRAWING: ISSUED FOR APPROVAL

INSTITUTION: JOHANNESBURG DEVELOPMENT AGENCY

SERVICE: ZOLA PUBLIC TRANSPORT FACILITY

CONTRACT: CN002 | DISCIPLINE: ARCHITECTURAL

DRAWING DESCRIPTION: *Alternative#1 Layout Plan*

DESIGN	ZS	KM, KP & WE	DRAWN
SCALE	AS SHOWN	ZS	CHECKED

RESPONSIBLE PROFESSIONALS/ CLIENT

DISCIPLINE	DATE	NAME	ORGANISATION	SIGNATURE	PR No.
PROJECT ARCHITECT	2021/08/24	ZAYN SHAIKH	ZAS ARCHITECTS & TOWN PLANNERS (INCORPORATING SERVICES (PTY) LTD		S340
CIVIL ENGINEER	2021/08/24	CHRIS VANCOLLIE	CIVIL CONSULTING SERVICES (PTY) LTD		700339
TRAFFIC ENGINEER	2021/08/24	ONDUKA MAJA	CIVIL CONSULTING SERVICES (PTY) LTD		20190102
CLIENT	2021/08/24		JDA TRANSPORTATION		N/A

CONTRACTOR: T.B.C

FORMAT	DRAWING NUMBER	REV
A0	ZOLA -PTF/STG004/01A-SITE	D