APPENDIX D5.1

GEO-HYDROLOGICAL RISK ASSESSMENT FOR THE ACORN CITY FUEL STATION

GROUNDWATER ASSESSMENT FOR A PROPOSED FUEL STATION AT THE PLANNED ACORN CITY URBAN MIXED-USE DEVELOPMENT ON PORTION 27 OF THE FARM ARTHURSSEAT 214KU

GEOHYDROLOGICAL REPORT

VERSION 1

CLIENT: DZANA INVESTMENTS (PTY) LTD

DATE: 17 February 2022

PROJECT NUMBER: 22-IS-1047

PROVINCE: Mpumalanga

DISTRICT COUNCIL: Ehlanzeni

MUNICIPALITY: Bushbuckridge

IN-SITU CONSULTING CC P.O. Box 26280 Nelspruit Tel: 013-741 5158 Fax: 086-686-2720

IN-SITU CONSULTING

Tel nr: (013) 741 5158
Fax nr: (013) 741 4043
E-mail: info@insituconsulting.co.za
P.O. Box 26280
Nelspruit, 1200

GROUNDWATER ASSESSMENT FOR A PROPSED FUEL STATION AT THE PLANNED ACORN CITY URBAN MIXED-USE DEVELOPMENT ON PORTION 27 OF THE FARM ARTHURSSEAT 214KU

DOCUMENT ISSUE STATUS

Report Type	Geohydrological Investigation
Project Number	22-IS-1047
Report Number	221047hV1F
Report Issue	Version 1
Date	17 February 2022

	Name	**Signature**
Author	Ronell Kotze Geohydrologist (Pr.Sci.Nat.)	
Reviewer	Aubrey Meyer Senior Geohydrologist (Pr.Sci.Nat.)	
Managing Director		

EXECUTIVE SUMMARY

In-Situ Consulting was appointed by Dzana Investments, dated the 17th of January 2022, to conduct a geohydrological risk assessment of the proposed fuel station at the planned Acorn City mixed-use township development. The study area will be rezoned for the flowing land uses: Hotel, urban agriculture, business, educational, institutional, fuel filling station, transportation services, other residential, private/public open spaces (including sport and recreational uses).

The development and related operation of facilities or infrastructure, for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 cubic metres or more (but not exceeding 500 cubic metres), listed as Activity 14 of Listing Notice 1 [GN R327 of 7 April 2017] under the National Environmental Management Act (1998, as amended)

There are two existing boreholes on the premises that can be implemented for monitoring purposes as the development will not be depending on groundwater to meet the water demand. It is recommended that both boreholes on site (BR-03007 and BR-03008) be rehabilitated and properly capped (borehole BR-03008 could not be accessed during the site visit).

A total of eighteen (18) existing boreholes were recorded, within a 1-kilometer radius, during the hydro-census and from database records: ten (10) are listed as dry or destroyed, five (5) are listed as currently unused and three (3) are listed as in use. Estimated abstractions varied from 4.90m^3/day to 64.80m^3/day, with the average calculated as 29.12m^3/day. Of the eighteen (18) boreholes, ten (10) static water levels ranging from 1.88mbgl to 34.44mbgl could be measured in the field or obtained from database records. The average static water level of the area was calculated as 16.40mbgl.

Two (2) groundwater and two (2) surface water samples were analysed and interpreted: According to sewage/wastewater standards water from both boreholes (BR-03007/AC-01 and AC-05) classified as compliant. The wastewater norms, for iron- and arsenic-concentrations, are exceeded in both surface water samples; these results will be used as background chemistry records.

The ratings for the Aquifer System Management Classification and Aquifer Vulnerability Classification yield a Ground Water Quality Management Index of 2, indicating a low-level of ground water protection (Parsons, 1995).

Magni and du Cann (1978), state that approximate permeability limits of soil in which on-site sanitation to be constructed should be less than 3.46E+00m/day to prevent pollution and more than 4.32E-01m/day to be sufficiently permeable to allow for attenuation of the effluent. A higher permeability value may be permissible where the water table is very deep, or where there are no water supply boreholes in the immediate vicinity. Acceptable permeability values from literature for completely weathered gneiss (soil and saprolitic soil) and weathered gneiss are indicated to be low to high, range between 10^{-7} to 10^{-3} cm/sec. Permeability (k – in house) values, obtained from previous studies conducted on similar geology, was calculated as 3.78E^{-04} or 3.3E^{-01} m/day, which classify as medium to low permeable soils. Medium to low permeable soils will be sufficient to retarding te spread of pollution. Site specific permeabilities was not provided in the geotechnical report.

All underground installations must comply with SABS SANS10089-3:2010. Steel tanks shall comply with SABS SANS1535:2018 and all work with that of SABS 0131 Part 3. In addition, stormwater drainage infrastructure must be equipped with strategically placed filters and oil traps.

The water, sanitation, and stormwater drainage infrastructure will be linked to that of the planned Acorn City Development.

During the rating and ranking procedure of impacts, no impact had the “no-go” implication for certain aspects of the project and all impacts can be countered by appropriate mitigation and training of all personnel.

In conclusion, considering the available information, the proposed Filling Station at the planned AcornCity development on portion 27 of the farm Arthursseat 215KU might have some impact on the environment, however with proper management procedures in place, the effect will be minimal. The filling station does create long-term jobs that translate into a positive economic effect on the social environment.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF DIAGRAMS

LIST OF APPENDICE

1. INTRODUCTION

1.1 Background

In-Situ Consulting was appointed by Dzana Investments, dated the 17th of January 2022, to conduct a geohydrological risk assessment of the proposed fuel station at the planned Acorn City mixed-use Acorn City mixed use township development.

The study area will be rezoned for the flowing land uses (as stipulated in the final scoping report[12], dated November 2021): Hotel, urban agriculture, business, educational, institutional, fuel filling station, transportation services, other residential, light industrial, private/public open spaces (including sport and recreational uses).

The development and related operation of facilities or infrastructure, for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 cubic metres or more (but not exceeding 500 cubic metres), listed as Activity 14 of Listing Notice 1 [GN R327 of 7 April 2017] under the National Environmental Management Act (1998, as amended)

There are two existing boreholes on the premises that can be implemented for monitoring purposes as the development will not be depending on groundwater to meet the water demand. These boreholes will require rehabilitation.

1.2 Aim of the report

The aim of this report is to evaluate current groundwater resources and the risk of contamination of these resources and groundwater regime by the planned fuel station with a storage capacity of more than 80m³.

1.3 Scope of Work

- Desktop study and data assimilation.
- Site visit and limited hydro-census of existing boreholes/springs.
- Collect ground- and surface-water samples.
- Assess the aquifer vulnerability.
- Compile a geohydrological risk assessment report.

1.4 Terms of Reference

- Study available information, which includes, background information, climatic data, geological data, previous investigations near the study area and generalised hydrogeological data, was collected and assimilated.
- A hydro-census investigation of on-site and other groundwater users was carried out to collect information such as:
  - Borehole depth, groundwater use, status and equipment, depth to groundwater table (static water level), abstraction volumes, etc.
- Chemistry data analysis to establish background chemistry analysis of groundwater.
  - Analyses to be done by Yanka Laboratories in Emalahleni.
- Aquifer characterisation and groundwater quality management classification.
- Compile a geohydrological assessment report discussing the conclusions and recommendations made from the results of the above-mentioned categories.

1.5 Location and setting

The proposed Acorn City development is located approximately 6km south-west of Acornhoek, along the R40 provincial road and west of the Sefoma Township, that falls under the jurisdiction of the Bushbuckridge Local Municipality, Ehlanzeni District Municipality,

Limpopo Province. It is framed by lines of latitude 24° 38' and 24° 39' S and lines of longitude 31° 01' and 31° 03' E and falls on 1:50 000 topo-sheet 2431AC (Figure 1 – Regional Locality, see next page).

The proposed Sasol Petrol Station (0.5ha) will be located at the main entrance, on the eastern boundary of the development adjacent the R40 provincial road.

1.6 Information Consulted

The regional geology and geohydrological information for the investigation area was extrapolated from the following published maps:

- The 1:250 000 scale, 2430 Pilgrim's Rest Geological map-sheet, 1986.
- The Hydrogeological Map Series of the Republic of South Africa, Phalaborwa Map, 1998, scale 1:500 000.
- Colour satellite images, provided by Google Earth, AfriGis (PTY) Ltd. Image @ 2022 Maxar Technologies.
- The 1:2 500 000 scale, Groundwater Resources of the Republic of South Africa, Sheet 1, First edition 1995.
- The 1:2 500 000 scale, Groundwater Resources of the Republic of South Africa, Sheet 2, First edition 1995.
- Department of Water Affairs and Forestry (DWAF) Groundwater Phase 2 Hydrogeological Maps (GRA2).

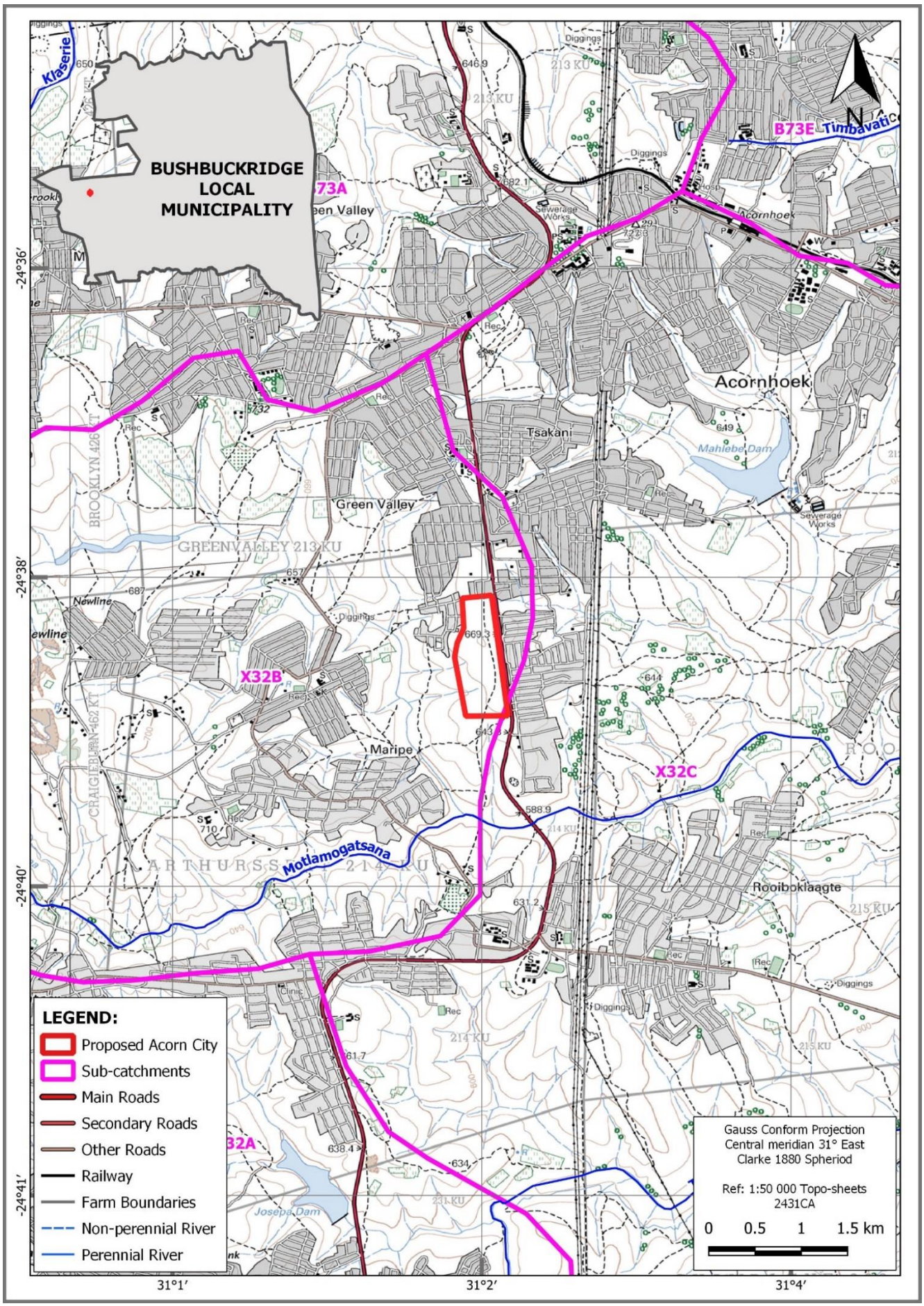


Figure 1. Regional Locality

2. REGIONAL GEOHYDROLOGICAL AND GEOLOGICAL SETTING

2.1. Physiographical Setting

2.1.1 Morphology, Soil, Vegetation and Drainage

Physiographically, the investigation area constitutes undulating terrain (elevation of between 640 and 680mamsl). The investigation area is situated on a watershed (topographic high), sloping east and south-west towards tributaries of the Klein-Sandrivier River.

The area is underlain by moderate to deep sandy loam with *Tropical Bush and Savana* the dominant veld type (Acock, 1988). The study area falls within soil mapping units 4 of the Institute for Soil, Climate and Water (ISCW) broad natural homogeneous soil zone (BNHSZ) regions (Schulze et. al, 1997). Unit 4 assigns a soil depth of 450 to 850mm to 100%. Of which 90% comprises of sand and loam (SaLm) and 10% of sand, clay, and loam (SaClLm), that typically support a slow drainage rate.

2.1.2 Climate and Rainfall

The CSIR Köppen-Geiger map, based on 1985 to 2005 South African Weather Services data indicate the climate warm temperate, dry winters and hot summers. The investigation areas fall within the X32B quaternary sub-catchments, as defined by the Water Research Commission in their 1994 report (Midgley *et al*, 1994), of the Inkomati Water Management Area. The main rivers draining the Inkomati Water Management Area include the Sand-, Sabie-, Crocodile-, Lomati-, and Komati-rivers.

Table 1: Summary of Quaternary sub-catchments

Sub-Catchment	Mean annual precipitation (mm) WRC	Mean annual evaporation (mm) WRC	Mean annual run-off (mm) WRC
X32B	700 - 800	1500 - 1600	200-500

Annual rainfall and evaporation data were obtained from the B7E003 Guernsey @ Klaserie Rainfall Station (Latitude: S24.52130°; Longitude: E31.06666°), located approximately 13km north-northeast of the investigation area. Indicating a long-term average annual total rainfall of 649.90mm/annum and an average evaporation of 1694.2mm/annum recorded from 1963 to 2022, attached as Appendix A.
(Source: http://www.dwa.gov.za/hydrology/Verified/HyDataSets.aspx?Station=B7E003).

Groundwater is usually associated with the following geological features:

- Deeply weathered zones underlain by competent, hard gneiss with water being found on the contact zone and
- Secondary fractures found within the gneiss, apertures can vary from millimetres to meters and may or may not contain groundwater.
- Contact zones between the host rock and intrusions, e.g., diabase/dolerite dykes.

2.2 Regional Geohydrological Setting

Published hydrogeological maps were studied in order to obtain a better understanding of the expected groundwater and geological conditions of the investigation areas. Maps are listed in section 1.6, Information Consulted (page4). From these sources of groundwater information, the following could be deducted:

Table 2: Groundwater Resources of the Republic of South Africa, Sheet 1 and Sheet 2

	Subject Area
Nature of the water-bearing rock / surface/sub-surface lithology	Acid, intermediate & alkaline intrusives.
Saturated interstice (storage medium) / aquifer	Fractures restricted principally to a zone directly below groundwater (a zone that is transitional between weathered and fresh rock. In fresh rock, water-bearing fractures are comparatively sparse) in igneous and/or crystalline metamorphic rocks.
Recommended drilling depth	20 – 30 m below the static ground water level
Typical storage coefficient	< 0.001
Qualitative indication of spatial distribution of storage media based on drilling success rate	40 - 60%
Probability of drilling a successful borehole (Accessibility)	40 - 60%. (A borehole is deemed successful if upon completion it yields more than 0.1L/s.)
Probability of drilling a successful borehole, yielding more than 2L/s (Exploitability)	30 – 40%
Mean depth to water table. Depth range - Standard deviation from mean (m)	20 to 30m
	< 15m (18.27 according to GRA2 information)
Mean annual recharge	37 to 75 mm/a
Groundwater component of river base flow. Mean Annual Flow.	50 to 100mm/a
Groundwater quality	TDS < 500mg/l (lower standard deviation) and 1500-2000mg/l (upper standard deviation). Fluoride concentration exceeds 1.5mg/l as F in more than 20% of the analysed samples.
Hydro-chemical Type	Dominant cations Na^+ and/or K^+; dominant anion HCO_3^-

Table 3: Hydrogeological map series, 2530 Phalaborwa.

	Subject Area
Nature of the water-bearing rock / surface/sub-surface lithology	Predominantly meta-arenaceous rocks (quartzite, gneiss and migmatite)
Saturated interstice (storage medium) / aquifer type	Intergranular and fractures
Borehole yield class (median l/s) (excluding dry boreholes)	0.5 - 2.0 l/s
Elevation above sea level	400 - 800 m
Mean annual precipitation	600 – 800 mm
Groundwater quality	0 - 70mS/m (Electrical Conductivity)

2.3 Local Geohydrological Setting

Basic geohydrological concepts:

- *Confined (secondary) aquifer: a confined aquifer is bounded above and below by an aquiclude.*
- *Transmissivity (KD or T): the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the whole saturated thickness of the aquifer (Kruseman & de Ridder, 1994).*
- *Storativity (S): the volume of water released from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to that surface (Kruseman & de Ridder, 1994).*

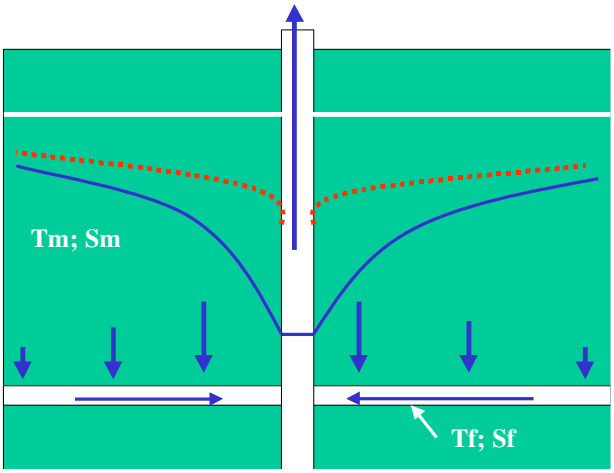
The area of investigation is underlain by lithologies which were subjected to shearing, fracturing and metamorphism. Aquifers in the area are predominantly secondary in nature and vary in their lateral extent, thickness, and distribution.

- Structural secondary aquifers: Aquifers associated with geological structures such as dykes, faults, fractures, and joints. Generally, these aquifers exhibit high transmissivity but low storage capacity.
- Weathered secondary aquifers: Aquifers generally exhibit low transmissivity; storage capacity varies between very low to low and the aquifer is often semi-confined by overlying layers of lesser permeability.
- Contact secondary aquifers: Aquifers associated with geological contacts. Water transmissivity is generally high and storage capacity may be enhanced by seepage from overlying alluvial or weathered deposits.

The secondary aquifers in the investigation area are classified as double porosity systems, conceptionally consisting of two major components: matrix rock blocks and fractures, each with its own character and behaviour, in which groundwater flow takes place. The fractures serve as higher conductivity conduits for flow if the apertures are large enough, whereas the matrix blocks may be permeable or impermeable, with most of the storage usually contained within the matrix (Kirchner and van Tonder, 1995).

The hydraulic conductivities of fractured systems vary considerably and are dependent on:

- Aperture (distance between fracture walls),
- Frequency or spacing (density),
- Length,
- Orientation (random or preferred),
- Wall roughness,
- Presence of filling material,
- Fracture connectivity, channelling (preferred paths),
- Porosity and permeability of the rock matrix.



Close to the tested borehole the pressure in the large fractures decline rapidly relative to its rate of decline in the matrix blocks resulting in the development of a large, localised pressure gradient between the piezometric head of the matrix block and that of the large conduit fracture.

Diagram 1: Conceptional model for the flow regimes in a double porosity system.

The former therefore releases a relatively large amount of water into the conductive fractures. Far from the pumping borehole, the pressure gradient between the fracture and matrix block is relatively small and water released from the matrix into the fracture is slow. During the first stages of pump testing water is abstracted from the fracture and linear flow dominates but as the fracture area dewatered and water is released from matrix storage into the conduit fractures, matrix flow becomes dominant over time.

2.4 Aquifer Management and Vulnerability Classification

DWA's Aquifer Classification Map of South Africa indicates the area to be underlain by a **minor aquifer** – a moderately-yielding system of good water quality.

The **vulnerability**, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer, in terms of the above, is classified as **low/least vulnerable**.

Aquifer **susceptibility**, a qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities, and which includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification, and in relations of the above, is classified as **low**.

The ratings for the Aquifer System Management Classification and Aquifer Vulnerability Classification yield a Ground Water Quality Management Index of 2 for the subject area. The calculation was done as follows: Minor aquifer system = 2 points. Aquifer vulnerability – low = 1 points thus the GQM index = 2 and will therefore require **a low-level protection**, Parsons, 1995.

Table 4: Basis for Assigning Aquifer Contamination Susceptibility Classes

	Vulnerability Class		
Aquifer System Management Class	*Low (1)*	*Medium (2)*	*High (3)*
Poor groundwater region (1)	Low susceptibility (1)	Low susceptibility (2)	Medium susceptibility (3)
Minor aquifer region (2)	Low susceptibility (2)	Medium susceptibility (4)	High susceptibility (6)
Major aquifer region (3)	Medium susceptibility (3)	High susceptibility (6)	High susceptibility (9)

2.5 General Geological Setting

The investigation area is underlain by grey to pale-brown, medium- to coarse-grained quartz-feldspar-biotite gneiss, with subordinate mafic to ultramafic xenoliths (Zbg) of the Swazian Era.

Multiple north-east, south-west striking lineaments are indicated in the area. These lineaments play a crucial role in the movement of groundwater; they act as semi-impermeable barriers (dykes) and pathways (fractures). Figure 2 shows a portion of the 1:250 000 Geological map series, map sheet 2430 Pilgrim's Rest, indicating the study areas (see next page).

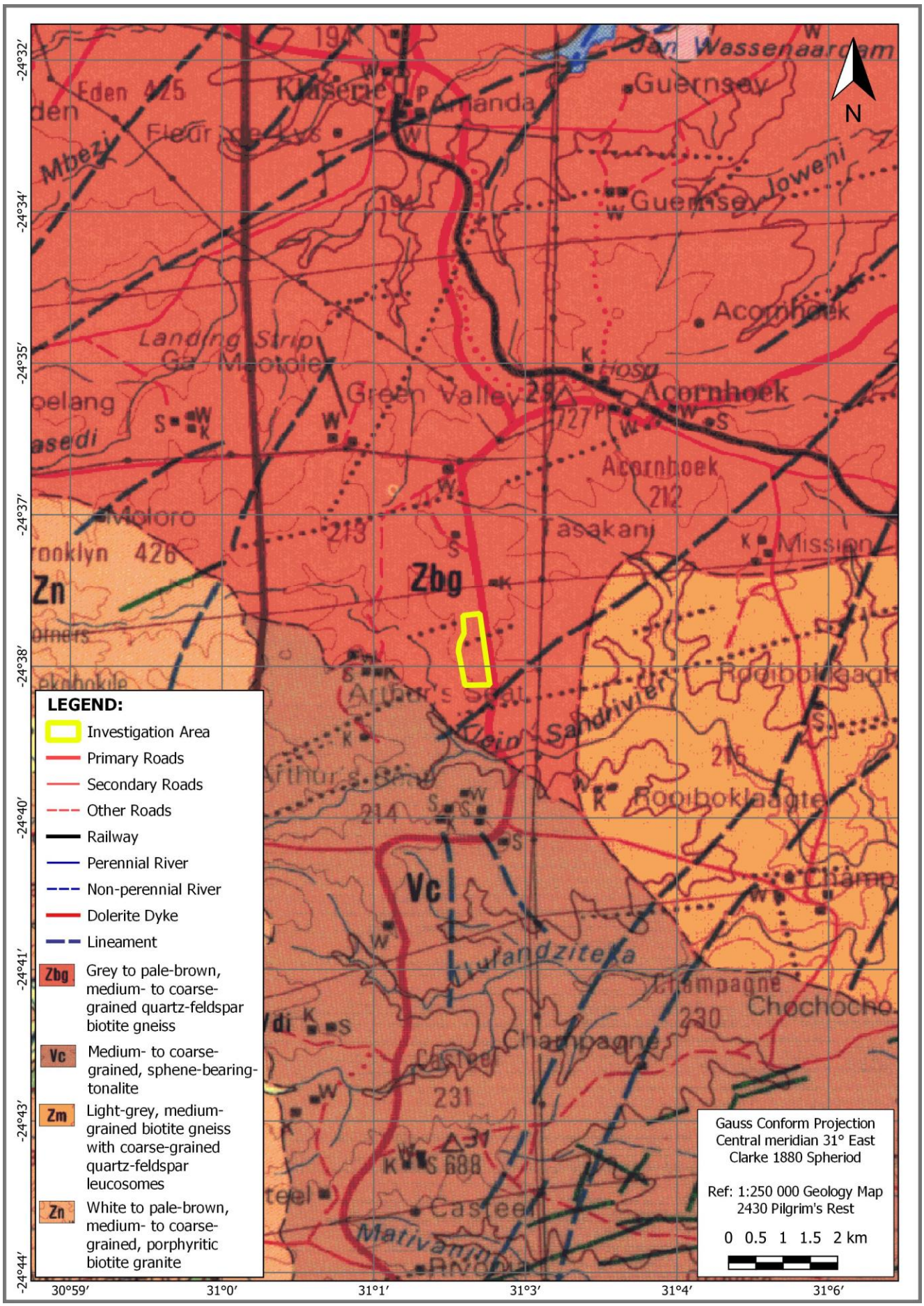


Figure 2. General Geology

2.6 Local Geological Setting (Geotechnical Investigation)

A geotechnical investigation was conducted by DVH Consulting[14], report reference number DVH-21-108 (attached as Appendix C). Based on the recorded soil profiles the fuel station site falls within the geotechnical soils zone C2 (in proximity of test pits TP6, TP7 and TP14, refer to the site map included in Appendix C). No perched water table or seepage zones were noted in any of the test pits.

The soil profile of Zone C2 (based on test pits TP6, TP7 and TP14) - comprises:

a medium dense, locally firm, intact, silty sand/slightly silty clayey sand of TRANSPORTED HILLWASH, depths varying between 0.2 to 1.1m

overlying,

loose to medium dense/medium dense, intact, micaceous, slightly silty clayey sand/micaceous, silty sand REWORKED RESIDUAL GNEISS, depths varying between 1.6m to 2.3m

overlying,

loose/loose to medium dense, jointed, micaceous, slightly clayey silty sand/silty sand RESIDUAL GNEISS, to depths in excess of 3m (excavation limit)

According to the geotechnical report the soil classifies as soft excavation material that is potentially highly compressible and/or collapsible. Special foundation procedures would be required (e.g., reinforced concrete rafts).

Magni and du Cann (1978), state that approximate permeability limits of soil in which on-site sanitation to be constructed should be less than 3.46E+00m/day to prevent pollution and more than 4.32E-01m/day to be sufficiently permeable to allow for attenuation of the effluent. A higher permeability value may be permissible where the water table is very deep, or where there are no water supply boreholes in the immediate vicinity.

Acceptable permeability values from literature for completely weathered gneiss (soil and saprolitic soil) and weathered gneiss are indicated to be low to high, range between 10^{-7} to 10^{-3} cm/sec. Permeability (k – in house) values, obtained from previous studies conducted on similar geology, was calculated as $3.78E^{-04}$ or $3.3E^{-01}$ m/day, which classify as medium to low permeable soils. Medium to low permeable soils will be sufficient to retarding te spread of pollution. Site specific permeabilities was not provided in the geotechnical report.

3. DATA COLLECTED

3.1 Hydro-census and Database Data

A hydro-census of existing groundwater sources, within a one-kilometre radius, was conducted on the 25th and 26th of January 2022. During the hydro-census borehole information was verified and the status quo of the groundwater sources updated.

The results of the census are presented in Table 5 and Figure 3 (see next page) indicates the localities of the boreholes. Temporary numbers (AC-#) were assigned to boreholes that was not marked in the field or found on the National Groundwater Archive (NGA) or In-Situ Consulting's database. Information from historic/database records were incorporated.

Table 5: Hydro-census Borehole Information

Borehole Number	Latitude (S)	Longitude (E)	Current Borehole Depth (m)	Static Water Level (mbgl) and Date Recorded (Database Information)	Daily Abstraction Rate(m^3/day) (Database Information)	Status
*BR-03007 (AC-01)	-24.641987°	31.04054°	21.2	15.15 26/01/2022	0	Unused
*BR-03008 (AC-02)	-24.636296°	31.039469°	Unknown	Unknown	0	Unused
AC-03	-24.630337°	31.036858°	0.24	Unknown	0	Destroyed
AC-04	-24.63025°	31.036836°	0.45	Unknown	0	Destroyed
AC-05	-24.630123°	31.036904°	70	13.73 (dyn) 26/01/2022	32.94 26/01/2022	In use
AC-06	-24.622918°	31.038253°	Unknown	Unknown	Unknown	In use
AC-07	-24.623518°	31.030461°	Unknown	8.4 26/01/2022	0	Unused
H05-0406 (AC-08)	-24.623846°	31.03049°	27.9	7.5 26/01/2022	43.20 12/09/2009	Destroyed
AC-09	-24.624496°	31.04276°	Unknown	Unknown	Unknown	In use
H05-1072	-24.635332°	31.023895°	Unknown	9.06 30/03/2004	64.80 30/03/2004	Destroyed
H05-1080	-24.633992°	31.024222°	Unknown	10.81 11/08/1996	6.48 11/08/1996	Not found/ not verified
H05-1082	-24.632603°	31.023667°	Unknown	6.11 30/03/2004	Low yielding	Not found/ not verified
H05-1335	-24645031°	31.032733°	Unknown	Unknown	0 (Dry)	Dry
H05-1336	-24.642576°	31.045934°	Unknown	1.88 26/01/2022	0 (Dry)	To be equipped
H05-1375	-24.638646°	31.023869°	1	26.79 14/09/2000	51.84 14/09/2000	Destroyed
H05-2040	-24.624185°	31.045236°	Unknown	31 26/01/2022	4.90 11/11/2004	To be equipped
H05-2041	-24.627048°	31.045334°	Unknown	34.44 18/10/1996	7.20 18/10/1996	Not found/ not verified
H05-2135	-24.62592°	31.043156°	Unknown	21.89 22/08/2000	21.60 22/08/2000	Destroyed

*Proposed Acorn City Existing Borehole

(dyn) = dynamic water level

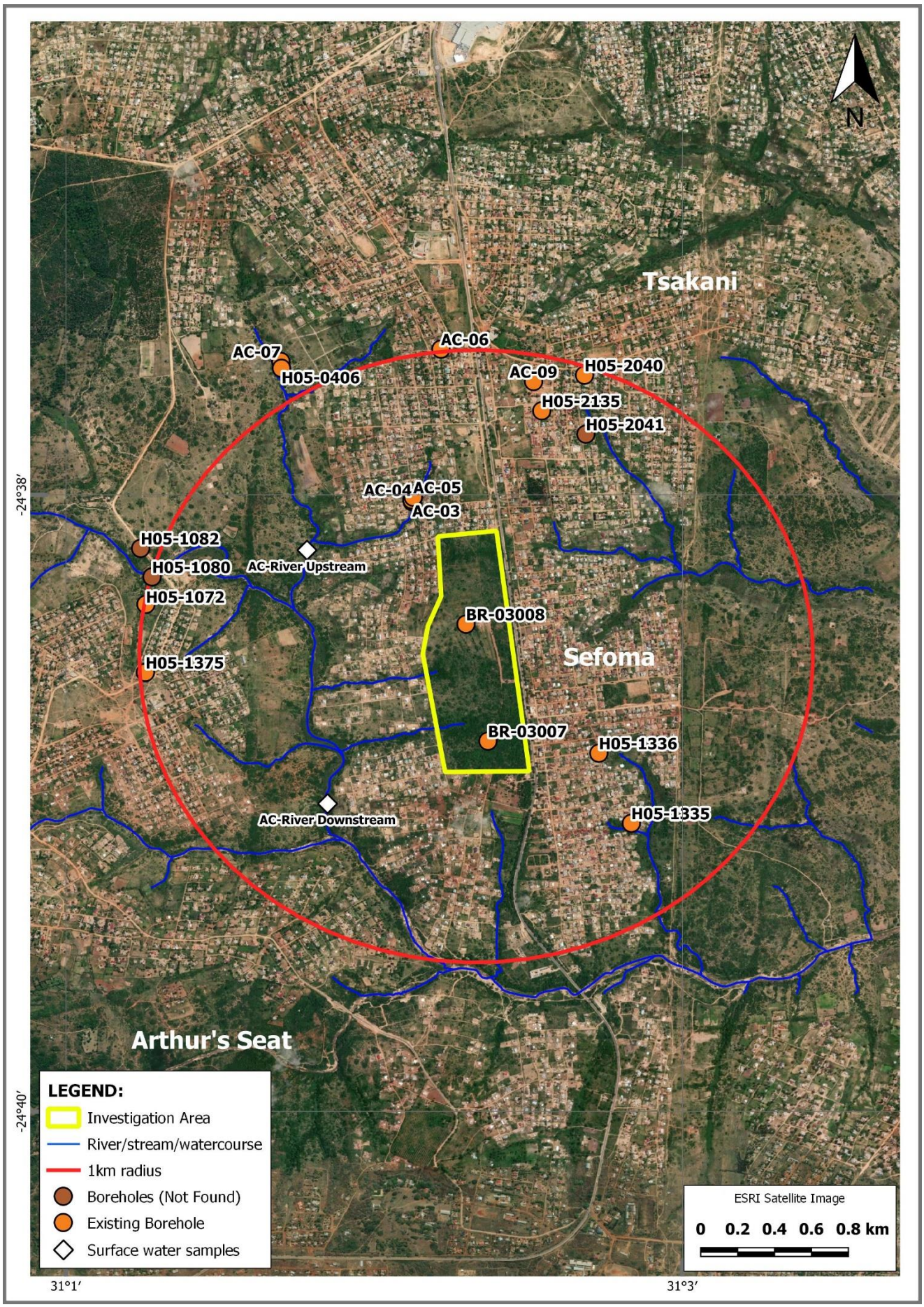


Figure 3. Hydro-census

Information gleaned from the Hydro-census data comprises of the following:

- Groundwater level distribution in the area.
- Borehole yield distribution and abstraction.

3.1.1 Groundwater Level Distribution

Of the eighteen (18) boreholes, listed in Table 5, ten (10) static water levels ranging from 1.88mbgl to 34.44mbgl (metres below ground level) that could be measured in the field or obtained from the databases.

The average static water level of the area was calculated as 16.40mbgl.

3.1.2 Borehole Yield Distribution

There are mainly two aquifer types that have a direct bearing on the potential yield of groundwater sources in this area. The more important of the two is the shallow intergranular aquifer represented by the alluvial deposits within and along the rivers. The second is the deep fractured aquifer found within hard rock such as gneiss, granite and tonalite.

A total of eighteen (18) boreholes were recorded within and around the investigation area: ten (10) are listed as dry or destroyed, five (5) are listed as currently unused and three (3) are listed as in use. Estimated abstraction (obtained during the census and from the database records) varied from 4.90m^3/day to 64.80m^3/day, with the average calculated as 29.12m^3/day.

3.1.3 Groundwater Flow

Groundwater moves from areas of higher hydraulic pressure to areas of lower pressure in the direction of the hydraulic gradient i.e., from areas of recharge to areas of discharge, thus down-slope towards the streams and rivers.

As indicated in section 3.1.1, static water levels were obtained from ten (10) boreholes. The water table, under normal conditions (e.g., homogenous, isotropic aquifer systems) is expected to emulate the surface topography. See figures 4a and 4b (next page) for the general surface water flow directions of the investigation area. A correlation between the surface elevation and static water levels was determined by fitting a regression line through the static water level data points, plotted against topography data points. The data indicates that the groundwater level will only have a 51% corelation to the topography which can be contributed to confined aquifers, presence of lineaments and structures within the area of investigation (therefore a heterogenous, anisotropic aquifer system).

As indicated on Figure 2 (page 8), there are generally north-east, south-west trending lineaments (i.e., dykes, fractures zones, etc.) in and around the investigation area. Dykes normally act as no flow or semi-impermeable barriers, whereas the contact zones (fracture zones) between the dykes and/or lineaments are normally associated with higher potential for groundwater flow. Taking this into consideration, it is anticipated that groundwater flow will be influence by these lineaments (conduits) and the contact zones will act as preferred pathways for groundwater flow. To identify the tipe and position of these lineaments a comprehensive geophysical investigation is required.

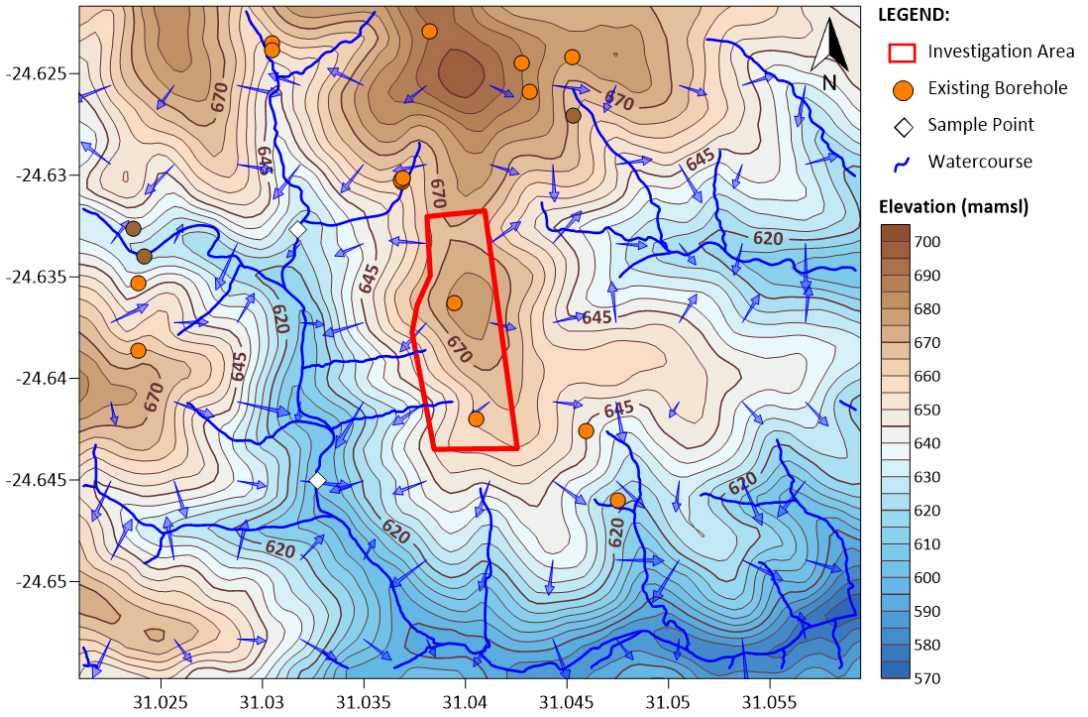


Figure 4a. General Surface Water Flow Direction (2D View)

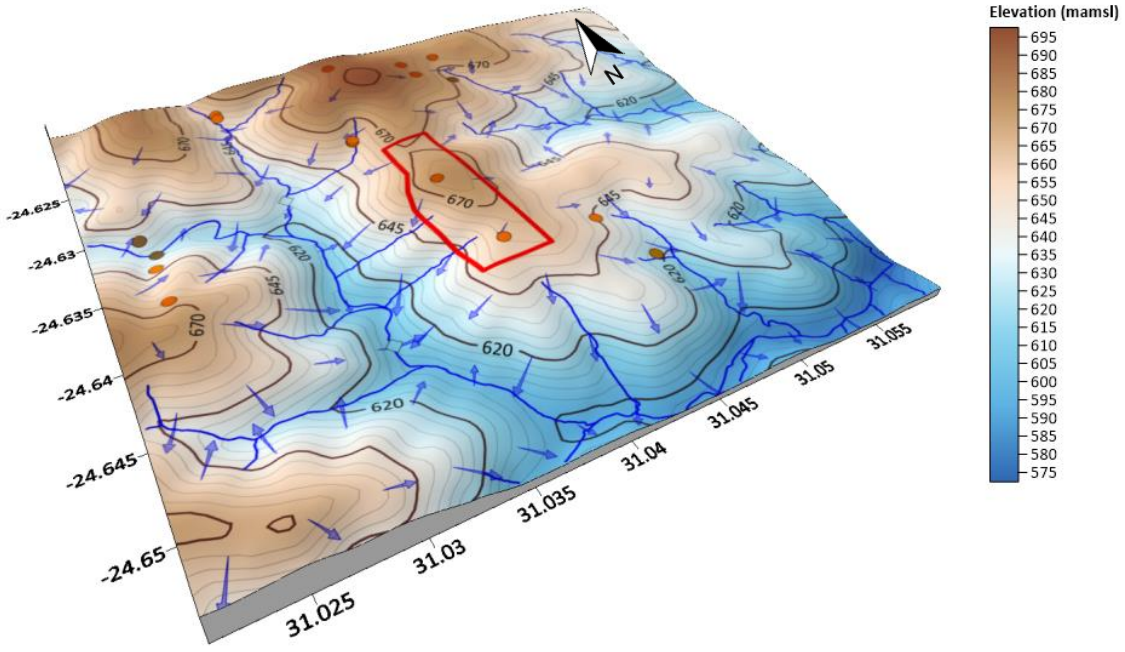


Figure 4b. General Surface Water Flow Direction (3D View)

3.2 Groundwater Quality

3.2.1 Sampling procedure:

Two (2) groundwater and two (2) surface water samples were collected and sent to Yanka Laboratories in Emalahleni for sewage/wastewater and BTEX analysis. Laboratory analysis (expressed as mg/L) was converted to meq/L using the conversion factors presented in Hem (1970) to determine the various analytical parameters by which groundwater quality in the investigation area could be evaluated (full Water Analysis Reports are attached in Appendix B).

3.2.2 Groundwater Quality Results

A groundwater sample was collected from borehole BR-03007 using a bailer. Water from borehole BR-03007 has been stagnant for a prolonged period, the borehole is also uncapped (open/covered with a rock), therefore exposed to the surface elements (leaves, insects, and small animals, etc.). Birds and reptiles tend to fall down boreholes leading to elevated microbial activities, which might be the case in BR-03007.

It is recommended that both boreholes on site (BR-03007 and BR-03008) be rehabilitated and property capped (borehole BR-03008 could not be accessed during the site visit). A second groundwater sample was collected from borehole AC-05, this borehole was operational during the census investigation. Both samples were taken on the 25th of January 2022.

According to sewage/wastewater standards water from both boreholes classified as compliant. The Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) analysis results indicated no pollution.

Table 6: Summary of the Groundwater Chemistry Results

Borehole BR-03007 (alternative no. AC-01)											
Ph	**EC**	**TSS**	**COD**	**OSG**	**Cl_2 (Free)**	**N (TON)**	**N (Ammonia)**	**Mn**	**Fe**	**F**	**P (Orto Phosphate)**
6.84	21.1	17.2	1.00	1.10	<0.1	0.79	<0.45	<0.01	<0.01	0.13	0.09
Faecal Coliforms (cfu/100ml)				**E.coli (cfu/100ml)**			**Wastewater Norms**				
130				70			Compliant				
Borehole AC-05											
Ph	**EC**	**TSS**	**COD**	**OSG**	**Cl_2 (Free)**	**N (TON)**	**N (Ammonia)**	**Mn**	**Fe**	**F**	**P (Orto Phosphate)**
6.76	20.4	<0.40	1.00	0.50	<0.1	1.88	<0.45	<0.01	0.02	0.23	0.18
Faecal Coliforms (cfu/100ml)				**E.coli (cfu/100ml)**			**Wastewater Norms**				
0				0			Compliant				

Colour code: blue = compliant with sewage water limit; Orange = not compliant with sewage water limit.

3.2.3 Hydro-chemical Facies

Hydro-chemical facies are defined as distinct zones that have cation and anion concentrations describable within defined compositional categories. The definition of a composition category is based on subdivisions of tri-linear diagrams such as Piper diagrams. For visual inspection of hydro-chemical data the result of the analysis was plotted on a semi-logarithmic Schoeller diagram (diagram 2) and a tri-linear Piper diagram (diagram 3).

Both these diagrams permit the cation and anion compositions of the sample to be represented on single graphs in which major groupings or trends in the data can be discerned visually. The Schoeller diagram shows the total concentrations of the cations and anions whereas the tri-linear Piper diagram represents the concentrations as percentages.

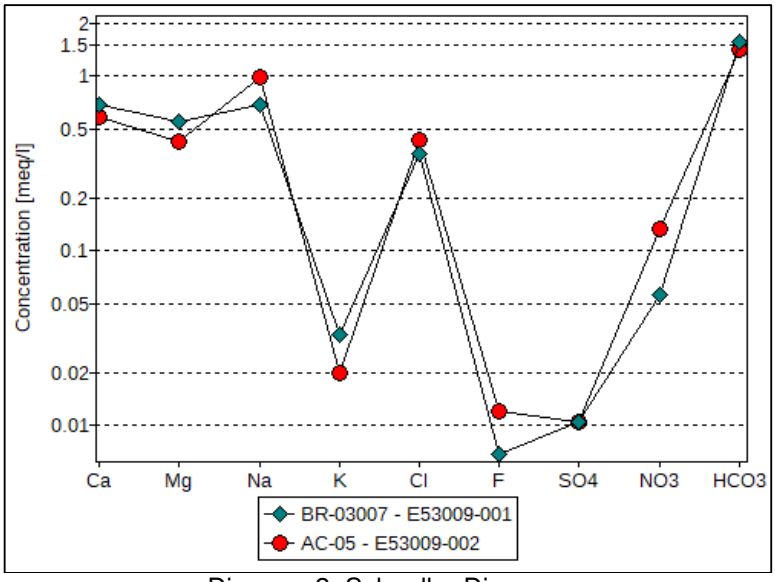


Diagram 2: Schoeller Diagram

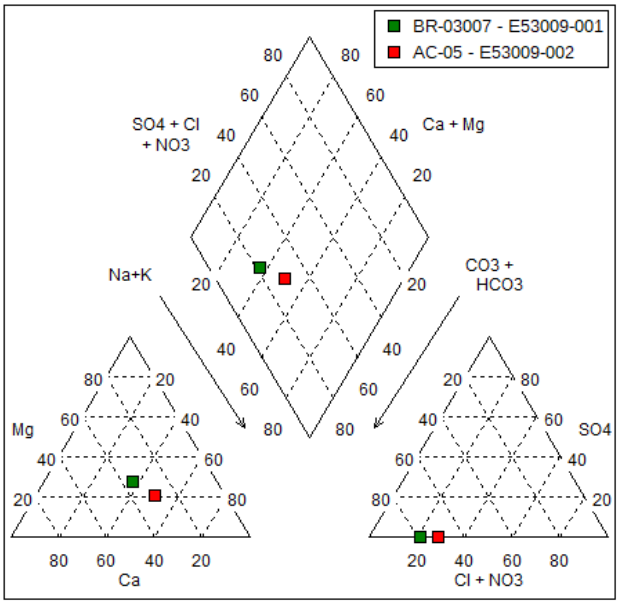


Diagram 3: Piper Diagram

Water from both boreholes BR-03007 (AC-01) and AC-05 exhibit a sodium bicarbonate (NaHCO3) character, often indicative of ion exchange water (see Groundwater Evolution for explanation). A strong bicarbonate character of the borehole reflects the general freshness of the aquifer.

3.2.4 Groundwater Evolution

Groundwater evolution follows the classic Chebotarev Sequence. As groundwater moves along its flow paths in the saturated zone, an increase of total dissolved solids and most major ions occur due to the increased residence time and travel distance. Crystalline rocks (such as granites) contain abundant aluminosilicate minerals (feldspar and mica) and quartz.

As these minerals formed at temperatures and pressures far above those occurring at or near earth's surface, these minerals are thermodynamically unstable and tend to dissolve when in contact with water. The dissolution process is strongly influenced by the presence of dissolved CO2 (acquired through infiltration of water through the soil horizon) and causes the groundwater to acquire dissolved constituents. When CO2-charged waters that are low in dissolved solids encounter silicate minerals high in cations, aluminium and silica, cations and

silica are leached, leaving behind clay minerals. Relatively recent recharged groundwater has a high bicarbonate (HCO3) concentration due to interaction with CO2 in the soil horizon. This water reacts with carbonate and silicate minerals and Ca2+ and Mg2+ ions are added. Further movement through the subsurface exposes the water to cation exchange processes where Na+ in clays exchange for Ca2+ and Mg2+ from the groundwater, thus increasing the Na+ content of the water. At the end of the Chebotarev Sequence for groundwater evolution is the saline NaCl water that is not seen in the investigation area.

3.2.5 Surface Water Quality Results

Two surface water samples were collected, see Table 7 for a summary of the sample locations (the full Water Analysis Reports are attached in Appendix B):

Table 7: Surface Water Sample Locations

Sample Name	Latitude (S)	Longitude (E)	Comments
AC-River Up Stream	-24.632700°	31.031733°	Water sample collected from the Klein-Sandrivier. Upstream of the proposed development.
AC-River Down Stream	-24.645033°	31.032733°	Water sample collected from the Klein-Sandrivier. Downstream of the proposed development.

Table 8: Summary of the Surface Water Chemistry Results

AC-River Up Stream											
Ph	**EC**	**TSS**	**COD**	**OSG**	**Cl_2 (Free)**	**N (TON)**	**N (Ammonia)**	**Mn**	**Fe**	**As**	**P (Orto Phosphate)**
7.04	22.0	2.00	18.0	0.70	<0.10	<0.35	<0.45	<0.01	1.11	0.15	<0.03
Faecal Coliforms (cfu/100ml)				**E.coli (cfu/100ml)**			**Wastewater Norms**				
390				160			Not Compliant				
AC-River Down Stream											
Ph	**EC**	**TSS**	**COD**	**OSG**	**Cl_2 (Free)**	**N (TON)**	**N (Ammonia)**	**Mn**	**Fe**	**As**	**P (Orto Phosphate)**
7.20	21.0	1.20	17.0	0.70	<0.10	<0.35	<0.45	<0.01	1.11	0.15	<0.03
Faecal Coliforms (cfu/100ml)				**E.coli (cfu/100ml)**			**Wastewater Norms**				
220				190			Not Compliant				

Colour code: blue = compliant with sewage water limit; Orange = not compliant with sewage water limit.

The wastewater norms, for iron- and arsenic-concentrations, are exceeded in both surface water samples. These results will be used as background chemistry records.

4. SABS UNDERGROUND INSTALLATION REGULATIONS

All underground installations will comply with SABS SANS10089-3:2010. Steel tanks shall comply with SABS SANS1535:2018 and all work with SABS 0131 Part 3:

- Tank farm:
  - Fuel storage tanks are proposed to be installed underground, which ensures better temperature stability, which in turn reduces breathing losses from the tanks due to fluctuations in temperature.
  - Steek tanks are to be coated with glass-fibre-reinforced polyester as per SANS 1535 to reduce the risk of corrosion posed by the sub-surface environment.
  - Fibre-reinforced plastic tanks shall comply with the requirements of SANS 1668.

- Tanks will be fitted with monitoring devices, including on-line leak detection, for purposes of pro-actively detecting any potential product loss (leaks) which might potentially result in pollution or contamination.
- Pump sumps and containment manholes will serve as containment tools in the event of a leak.
- The tank farm is to be covered with a 200mm thick concrete slab, and tanks will be buried at least 1m below ground (1m cover over fuel tanks).
- All submersible pumps shall include a leak detector that automatically checks the integrity of the pipework on the pressure side of pipework.
- Submersible pumps will be flame or explosion proof.

➢ Piping:
- Corrosion-resistant "PetroPlus" piping is to be used for secondary containment around piping. The secondary piping will ensure that, in the event of a leak occurring in the piping, any fuel leaking from the pipe will be contained and will not come into direct contact with soil or groundwater.
- Piping will conform to SANS 1830 and will be non-metallic and flexible. Plastic is inherently more corrosion-resistant than metals, and the flexible design eliminates unnecessary joints and elbows which are potential sources for leakages.
- Sasol does not allow pipe joints underground, in order to reduce the risk of pipe failure.

➢ Fuel dispensers:
- Fuel dispensers will be equipped with automatic nozzles, which automatically prevent vehicles from being overfilled and therefore reduces potential fuel spillage.
- Dispensary nozzles will be equipped with splash guards to help prevent fuel spill in the event of an overfill.
- Each dispenser will be fitted with a safety shear valve.
- A single header may be run from the pump to the dispenser island with branches leading to each dispenser, but each branch shall have its own isolating valve located in a manhole.

➢ Forecourt and paving:
- The forecourt is to consist of a 150mm-thick concrete slab, which forms an impermeable layer. In the event of a fuel spill on the forecourt due to an overfill, fuel will therefore be contained and will not infiltrate into the ground. The risk of soil or groundwater contamination is therefore greatly reduced.
- A containment concrete slab around the surface of the tank farm will ensure that, should a spill occur during delivery of fuel from road tankers into the underground fuel storage tanks, the fuel will be contained, preventing infiltration into soil and/or groundwater.
- Sufficient fire extinguishers will be provided. One 9kg dry chemical power type extinguisher will be provided to each pump island.

➢ Miscellaneous:
- Vents will be placed in a safe place and the installations will be done according to SANS 10089-3. Fugitive emissions due to the storage of fuel will thus be minimised.
- Vent pipes are to be at a minimum of 3.6m above ground to minimise potential health risk associated with possible fugitive emissions.
- Daily dip inspections as well as regular stock reconciliations will also indicate possible loss of product. This is another pro-active means of detecting potential risks of pollution or contamination.

Of note, the water, sanitation, and stormwater drainage infrastructure will be linked to that of the planned Acorn City Development. The stormwater drainage infrastructure must be equipped with strategically placed filters and oil traps.

5. RISK ASSESSMENT

Two different activities are associated with the development of a fuel station. Firstly, the installation and construction must take place (construction phase) before the filling station can be put into operation (operational phase). The potential impacts associated with the project proposal are described, and where appropriate, ranked by a significance assessment methodology.

The assessment of overall impact significance provides an indication of the extent to which the impacts either could have "no-go" implications for certain aspects of the project or will need to be countered by appropriate mitigation.

This section will look briefly at the different stages of the development as well as at measures that are taken to mitigate any potential impact. After the significance of each impact was determined, a rank was awarded to each impact.

5.1 Significance Assessment Methodology

The significance of Environmental Impacts was assessed in accordance with the following method.

Significance is the product of probability and severity. Probability describes the likelihood of the impact actually occurring, and is rated as follows:

Improbable - Low possibility of impact to occur either because of design or historic experience.
Rating = 2

Probable - Distinct possibility that impact will occur.
Rating = 3

Highly probable - Most likely that impact will occur.
Rating = 4

Definite - Impact will occur regardless of any prevention measures.
Rating = 5

The severity rating is calculated from the factors given to intensity and duration. Intensity and duration factors are awarded to each impact, as described below.

The Intensity factor is awarded to each impact according to the following method:

Low intensity - nature and/or manmade functions not affected (minor process damage or personnel injury may have occurred).
Factor 1

Medium intensity - environment affected but natural and/or manmade functions and processes continue (Some process damage or personnel injury may have occurred).
Factor 2

High intensity	-	environment affected to the extent that natural and/or manmade functions are altered to the extent that it will temporarily or permanently cease (Major process damage or personnel injury may have occurred). Factor 4

Duration is assessed and a factor awarded in accordance with the following:

Short term	-	<1 to 5 years - Factor 2
Medium term	-	5 to 15 years - Factor 3
Long term	-	impact will only cease after the operational life of the activity, either because of natural process or by human intervention – Factor 4.
Permanent	-	mitigation, either by natural process or by human intervention, will not occur in such a way or in such a time span that the impact can be considered transient - Factor 5.

The severity rating is obtained from calculating a severity factor and comparing the severity factor to the rating in the table below. For example:

The Severity factor	=	Intensity factor x Duration factor
	=	2 x 3
	=	6

A Severity factor of six (6) equals a Severity Rating of Medium severity (Rating 3) as per table below:

Table 9: Significance Rating

RATING	FACTOR
Low Severity (Rating 2)	Calculated values 2 to 4
Medium Severity (Rating 3)	Calculated values 5 to 8
High Severity (Rating 4)	Calculated values 9 to 12
Very High severity (Rating 5)	Calculated values 13 to 16
Severity factors below 3 indicate no impact	

A Significance Rating is calculated by multiplying the Severity Rating with the Probability Rating.

The significance rating should influence the development project as described below:

- Low significance (calculated Significance Rating 4 to 6)
  - Positive impact and negative impacts of low significance should have no influence on the proposed development project.

- Medium significance (calculated Significance Rating ≥ 7 to 12)
  - Positive impact:

  Should weigh towards a decision to continue
  - Negative impact:

  Should be mitigated, before project can be approved.

- High significance (calculated Significance Rating ≥ 13 to 18)
  - Positive impact:

  Should weigh towards a decision to continue, should be enhanced in final design.
  - Negative impact:

  Should weigh towards a decision to terminate proposal, or mitigation should be performed to reduce significance to at least low significance rating.

- Very High significance (calculated Significance Rating ≥ 19 to 25)
  - Positive impact:

  Continue definite.
  - Negative impact:

  If mitigation cannot be effectively implemented, proposal should be terminated.

5.2 Assessment of Impacts

The impacts associated with the proposed development are summarised in Table 10 below.

Table 10: Significance Assessment of the impacts identified, and mitigation plans for the proposed filling station, Acorn City

Aspect	Possible Impacts	Significance of Impacts							
		Probability	Significance rating		Severity Factor	Severity Rating	Significance Rating	Mitigation Plan	Responsible Person
			Intensity	Duration					
1. Construction phase									
1.1. Wastewater	Contamination of soil, groundwater	3	1	2	2	2	6 Low	No wastewater is expected to be generated during the construction phase.	Oil company / Contractor
2. Operational phase									
2.1. Accidental Spillages	Contamination of soil and groundwater	5	4	4	16	5	25 Very High	On hard surfaces, the product will be covered and adsorbed with biodegradable absorbent materials. Spills on soil would require the determination of the lateral and vertical extent of the contamination and then based on the risk that the contamination pose to the receiving environment, remedial actions will be implemented.	Oil company / Site Manager
2.2 Overfill	Contamination of soil and groundwater	4	4	4	16	5	20 Very High	As part of the SABS 089-3 requirements, secondary containment features will be installed around the filler points and on top of the tanks. These units are sealed and facilitate the recovery of product in the event of an overfill or spill.	Oil company / Site Manager
2.3. Leaking Tank	Contamination of soil and groundwater	4	4	3	8	3	12 Medium	A Leak is detected immediately by means of reconciliation of delivery and use/sales. Existing monitoring wells (rehabilitated to comply with the SABS 089-3 regulations) serve as an early warning system. Tanks will be fitted with on-line leak detection, for purposes of pro-actively detecting any potential product loss. Leaks are also detected by means of visual inspection, smell and record keeping of fuel volumes. Pump sumps and containment manholes will serve as containment tools in the event of a leak.	Oil company / Site Manager

The risk that the proposed filling station poses to the rural and natural environments must be considered in terms of the source, pathway, and receptor principle. The proposed filling station is a potential source of petroleum pollution if an accidental release of product takes place. The most hazardous pathway through which the contamination can impact on human receptors is through groundwater ingestion.

Even though the proposed Acorn City development will be supplied by water from the Bushbuckridge Local Municipality and not rely on groundwater to meet its water demand, there are three existing (listed in table 11, below) and two potential water supply boreholes located within a 1-kilometre radius of the proposed development.

Table 11: Current and Potential Groundwater Abstraction Points

Borehole Description	Borehole Number	Risk Level	Status and Approximate Distance from the Proposed Fuel Station
Community water supply	AC-05	Low	Currently in use. >1km north, north-west.
Privately owned	AC-06	Low	Currently in use. >1.5km north
School water supply	AC-09	Low	Currently in use. >1.5km north, north-east
Community water supply	H05-1336	Medium (if equipped)	Currently not in use. ±500m south-east.
Community water supply	H05-2040	Low	Currently not in use. >1.5km north, north-east.

Observed and potential groundwater usage increases the risk in terms of the impact on human receptors significantly. Even though borehole AC-05 is located over a kilometre away from the proposed filling station, a groundwater sample was collected and analysed. It is also recommended that this borehole be included in the monitoring program to ensure that the water quality remains unpolluted by the proposed Acorn City activities.

6. RECOMMENDATIONS

6.1 Spills and Leaks

Unfortunately spills and leaks do sometimes occur and then employees should react immediately. To minimise the risk of a spill or a leak which has occurred within his premises resulting in the environment becoming polluted the customer should follow the following procedures:

1. Spill and leak prevention
2. Spill response procedures
3. Spill reporting
4. Leak response procedures
5. Leak reporting

6.1.1 Spill and Leak Prevention

- All personnel who have anything to do with fuel or oil use and tank systems should know their individual responsibilities for controlling and/or reducing pollution. Employees should be well informed to apply the appropriate techniques.
- All employees involved in spillages or leaks must be informed about the spill/leak emergency response plan and must know how to act in the event of a spillage or leak.

Equipment installed or used to avoid pollution should be operated efficiently and will be maintained.

- Spill clean-up equipment, like absorbing fibres, squeegees, sandbags, etc. should be located in a clean, dry and easily accessible storage facility.
- Spill fighting material should be kept near places where spills and leaks are most likely to occur, i.e., near pumps. Customers should have materials like absorbing fibres and sandbags in place. The proposed procedure:
- Place two 200L bins at each area:
  - bin to be used for storage of unused fibres,
  - bin to be used for receiving the used fibres.
- Apply the fibres as per the instructions as soon as the spill occurs.
- Used fibres should be disposed of in an environmentally friendly way by either burning or dispatching to a class 1 waste dump.
- Ensure that Emergency Spill/Leak Response Plans and the necessary associated equipment are appropriate for your operation and are the subject of regular exercises, where possible in conjunction with the industry and/or local authorities. Provide regular training for key response employees in dealing with emergencies.

6.1.2 Spill Response Procedure

It is not possible to give detailed recommendations on how to clean up specific kinds of spillages as the method and materials used will depend on the type of product handled, the amount involved, the wind, the weather, equipment available, etc. However, all spills, minor or major, should be cleaned up as soon as they occur. Whatever the spill there are five basic steps in dealing with spillages:

1. Limit the spillage
2. Contain the spillage
3. Remove the spilled product
4. Final clean up and soil rehabilitation
5. Complete a spillage report

Containment of the oil near the point of spillage localizes the problem, minimises pollution and makes it easier to remove the pollution. Cleaning of the spill area depends on whether there is a major spill or a minor spill and whether there is a spill on paving or on soil. A major spill is any spill where more than 200 L of product is involved.

- Minor spillage (less than 200L):
  - Soak up the spill with unused fibres.
  - If the spill has soaked into the ground the soil should be ploughed to allow aeration.
  - Collect the used fibres in the bin for used fibres.

- Major spillage of oil or fuel on paving or non-permeable surfaces:
  - Wherever possible, try to limit the spillage by turning off all activities that caused the spill, i.e., closing a valve that has been accidentally opened, plugging the hole where the product is leaking or stop pumping through a ruptured pipeline, hose or overflowing tank.
  - Contain spill immediately with absorbing fibres, sandbags, sand, or soil.
  - Prevent any of the spilt oil substance from entering your drain, storm water systems, septic tanks or from contaminating any natural water systems by forming a barrier from soil, sand, sandbags or absorbing material.
  - If any of the spill enters the storm water system, the flow must be intercepted before it can contaminate other environments

- If natural water systems are contaminated, use straw bales, absorbent, booms, and sandbag dams for containment of and absorption.
- Mop up as much of the spillage as possible by using absorbing materials
- Contact your Oil Company Field manager.

- Major spillage of oil or fuel on soil or permeable surface:
  - Wherever possible, limit the spillage by turning off all activities that cause the spill.
  - Contain the spill and prevent spread of the substance by using sandbags, sand or soil, absorbent booms or planking to divert flow.
  - Prevent any of the oil substances from entering your drains, storm water systems or septic tanks, or from contaminating any natural water systems by forming a barrier from soil, sand, sandbags or absorbing material.
  - Prevent any of the oil substances from contaminating groundwater. It may be necessary to remove contaminated soil for disposal or rehabilitation.
  - Remove and mop up as much as possible by using spill fighting materials.
  - Plough soil for aeration and apply fertilizer/suitable neutralising chemicals if viable.
  - Contact your Oil Company Field manager.

6.1.3 Spill Reporting

The Sasol Field manager should be notified whenever a spill in excess of 200L occurs. For oil spill incidents of lesser magnitude with impact on water sources, rivers, streams, etc., or that are likely to attract public or press attention, the oil company should be notified.

For every major spill (over 200L of product) that occurs, the Incident Report Form must be completed. Investigate spill cause and implement Recommendations for preventing re-occurrence. If water courses and ground water are contaminated, then the Local Department of Water Affairs must be notified. Site operating staff should check regularly, if the tank system, pipework and equipment are in good condition. Inform the oil company when tank systems, pipework or equipment need maintenance.

6.1.4 Leak Response Procedure

If the Stock Monitoring and Control Procedures are used properly it will be possible to detect a leak at an early stage. Damage to the environment and cleaning costs will then be minimised.

If an above ground tank is leaking it will be possible to detect the leakage by visual inspection of the tank. If the tank has a bund wall, ensure draining outlets are closed. The procedure to be followed is:

- Shut down all activities from the leaking tank.
- If possible, try to stop product from leaking out of the tank.
- Notify Oil Company immediately.
- Any loss or suspected loss must be confirmed in a letter addressed to your Sasol manager.
- For product pouring out of the tank, the Spill Response Procedure (section 7.2) must be followed.

6.1.5 Spill and Leak Procedure

Notify the oil company immediately of any suspected leaks in a tank system or malfunctioning of their equipment. Any loss or suspected loss must be confirmed in writing.

For every suspected leak in above ground or underground tanks the Incident Report Form must be completed.

Investigate leak cause (in co-operation with the oil company) and implement recommendations for preventing re-occurrence.

6.2 Groundwater Monitoring Programme

The following monitoring programme is recommended.

Table 12: Proposed groundwater monitoring points

Monitoring System	Monitoring Point	Description
Groundwater	MB-03007	On-site monitoring borehole
	MB-03008	On-site monitoring borehole
	AC-05	Community water supply borehole

The following general comments relate to the proposed monitoring system design:

- Dedicated groundwater sampling points are proposed in Table 12.

- Sampling methodology:
  - The monitoring boreholes are to be sampled with disposable Teflon bailers just below the surface of the static water table.
  - External user's boreholes are to be sampled under application conditions.
  - Select and follow an accredited laboratory's (under the South African National Accreditation System (SANAS) in terms of SABS Code 0259, specifications for sample preservation, holding times and sampling bottles (specialized vials for organic analyses) as well as chain of custody.

- Monitoring schedule:
  - The proposed monitoring frequencies are summarized in Table 13.
  - The "Lists" of water qualities for analyses are presented in Tables 14.

Table 13: Proposed monitoring schedule

Purpose	*Borehole*	Weekly	Monthly	Quarterly	Annually
Monitoring boreholes	MB-03007 MB-03008		[*] [^]	[*] [^] List 2	[*] [^] List 3
	AC-05				List 3

[*] = Monitor water level
[^] = Monitor presence of free product on water table with Teflon disposable bailer

Table 14: Proposed lists of variables for hydro-chemical analyses

LIST 1	LIST 2	LIST 3
pH Electrical Conductivity	pH Electrical Conductivity Gasoline & Diesel Range (BTEX)	pH, EC, TDS, Ca, Mg, Na, K, Si, T-Alk, Cl, SO4, NO_3, F, Al, Fe, Mn Gasoline & Diesel Range (BTEX) Organic Scan

7. CONCLUSIONS

During the rating and ranking procedure of impacts, no impact had the "no-go" implication for certain aspects of the project and all impacts can be countered by appropriate mitigation and training of all personnel.

In conclusion, considering the available information, the proposed Filling Station at the planned AcornCity development on portion 27 of the farm Arthursseat 215KU might have some impact on the environment, however with proper management procedures in place, the effect will be minimal. The filling station does create long-term jobs that translate into a positive economic effect on the social environment.

8. REFERENCES

1. *Chief Directorate: Surveys and Mapping. The 1:50 000 Series Topographical Map 2431CA.*
2. *Council for Geoscience, 1978. 1: 250 000 Geological Map Sheet, 2430 Pilgrims Rest.*
3. *Council for Geoscience, 1986. The Geology of the Pilgrim's Rest Area, Explanation: Sheet 2430 Scale1:250 000.*
4. *DWAF, 1995. Groundwater Resources of the Republic of South Africa, SHEET 1 & SHEET 2.*
5. *DWAF, 1999. 1: 500 000 Hydrogeological map series of the Republic of South Africa, Sheet Phalaborwa.*
6. *DWAF, 1996. Groundwater Harvest Potential of the Republic of South Africa.*
7. *DWAF, 2002. Republic of South Africa Water Management Areas - Water Availability and Requirements.*
8. *Midgley DC, Pitman WV, Middleton BJ, 1994. Surface Water Resources of South Africa 1990, Book of Maps, Volume II, WRC Report No 298/2.2/94.*
9. *Parsons Roger, 1995. A South African Aquifer System Management Classification, WRC Report No KV 77/95.*
10. *DWAF, 2003. Protocol to Manage the Potential of Groundwater Contamination from On Site Sanitation, National Sanitation Co-ordination Office, Directorate of Geohydrology, Edition 2, 2003.*
11. *ECO8 Environmental Planners, November 2021. Proposed acorn city mixed use township development on portion 27 of the farm Arthursseat 214-KU Bushbuckridge Local Municipality, Environmental Investiation, Final Scoping Report. Project Number E/393.*

12. *EcoSat, 27 September 2021. Sewage and Effluent Plant (AcornCity) Quotation and Document for Discussion. Reference ECO/ACORNCITY AFRICA/01.*
13. *Davel & van Huyssteen Consulting Engineering Geologists, 10 January 2022. Evaluation of Founding Conditions & Excavatibility for proposed Fuel Station, Acorn City, Geotechnical Report. Report Number DVH-21-108.*

APPENDIX A

RAINFALL AND EVAPORATION REPORTS FROM GUERNSEY @ KLASERIE RAINFALL STATION B7E003

Data are continuously updated and reviewed.
Format of the data is as follows :(I4,X,I2,13(X,A6,A1,A1) where:
    I4 = CCYY
     X = /
    I2 = YY
    13(X,A6,A1,A1) = 12 Monthly rainfall in mm from Oct to Sep.
                     Value 13 is the yearly total.
                     X = Space
                     A6 = 999999
                     A1 = & or space (& = Monthly Reading)
                     A1 = # or space (# = record incomplete or does not exist)

MONTHLY RAINFALL B7E003
Variable 10.00 Rainfall
I4,X,I4,13(X,A6,A1,A1)
AAAAAAAAAAAA

1963/64	#	37.2	56.1	102.7	52.1	76.2	30.8	11.8	0.0	4.0	17.5&	0.0&	#
1964/65	97.2	36.0	107.3	155.4	153.0	19.0	10.0&	0.0&	0.0&	0.0&	0.0&	45.5	623.4&
1965/66	2.5&	108.6&	28.0	98.5	70.5	22.0	16.5	10.0	18.0	1.0	8.0	9.5	393.1&
1966/67	63.0	32.0	65.5	45.0	128.0	43.0	129.0&	0.0&	0.0&	17.0	13.5&	0.0&	536.0&
1967/68	15.5	38.5	20.5	29.5&	153.7&	13.3&	27.7	8.1	24.9	0.5	13.7	1.5	347.5&
1968/69	33.3	99.6	120.2	74.7	78.2	120.9	41.4	1.8&	0.0&	9.4	0.5	14.2	594.1&
1969/70	152.4	42.2	95.0	25.2	45.5	23.9	6.1	2.8	41.9	6.1	0.5	13.0	454.5
1970/71	57.2	69.9	143.0	19.2&	51.0&	13.9	18.2	4.5	1.0&	0.0&	0.0&	13.0	390.8&
1971/72	101.5	99.0	152.5	262.0	156.7	216.5	28.0	53.5&	0.0&	1.0	1.4	1.0	1073.1&
1972/73	47.0	81.0	55.5	37.2	60.0	35.7	66.5	17.0	1.0	6.0	28.0	136.5	571.4
1973/74	62.7	73.5	257.0	81.5	85.0	78.0	61.0	15.0	3.0	44.5	4.5	24.5	790.2
1974/75	53.0	112.0	133.6	220.0	134.5	46.0	22.0	63.7	16.0&	0.0&	0.0&	2.0	802.8&
1975/76	17.5	18.5	207.5	411.5	232.0	85.0	13.5	44.7&	0.0&	0.0&	2.0&	0.0&	1032.2&
1976/77	25.0	75.0	72.5	183.0	174.0	217.5	76.5	13.0&	0.0&	0.0&	1.5	80.0	918.0&
1977/78	12.0	129.5	167.0	196.5	139.0	117.0	20.0	7.5	0.0&	3.8&	0.0&	0.0&	792.3&
1978/79	90.5	103.5	54.0	75.2&	19.3&	93.0	24.0	4.0&	0.0&	0.0&	29.0	1.3	493.8&
1979/80	44.5	62.5	119.0	85.0	114.0	52.5	44.0	10.0&	0.0&	0.0&	8.5	42.5	582.5&
1980/81	54.0	149.5	113.0	180.5	50.0	58.5	7.5	20.0&	0.0&	0.0&	21.5	16.0	670.5&
1981/82	40.5	66.0	60.5	96.5	15.0&	0.0&	82.0	25.5	0.0&	31.0	2.0	1.0	420.0&
1982/83	16.0	36.5	17.5	70.0	19.0	99.5	28.5	39.0	3.0&	0.0&	11.5	0.5	341.0&
1983/84	36.0	171.0	141.5	130.0	29.0	102.5	15.5&	0.0&	13.0	106.5	3.0	30.5	778.5&
1984/85	78.0	123.1	63.0	117.0	148.6	91.0	6.0	62.4	18.0	2.3&	0.0&	7.6	717.0&
1985/86	90.2	110.6	204.8	18.6	56.2	38.0	103.6	24.0	6.8&	0.0&	15.8	4.5	673.1&
1986/87	25.4	46.4	142.9	48.4	12.0	97.6	0.0&	1.8	5.0&	0.0&	34.5	97.3	511.3&
1987/88	53.0	19.6	195.4	43.0	100.8	119.2	27.0&	0.0&	8.0&	0.0&	1.0	15.0	582.0&
1988/89	54.0	18.0	85.0	26.0	122.0	87.0	19.0	30.0	36.0	2.0	2.2	1.0	482.2
1989/90	83.2	152.2	97.8	88.0	100.2	36.3	43.0&	0.0&	0.0&	22.0	37.0&	0.0&	659.7&
1990/91	62.1	27.2	180.4	46.0	140.7	85.7&	0.0&	10.1	22.0&	0.0&	0.0&	1.8	576.0&
1991/92	5.6	53.2	52.8	45.9	31.8	42.0	22.6	1.6&	0.0&	0.0&	9.6	0.2	265.3&
1992/93	2.0	71.7	278.5	119.3	75.8	147.6	15.7	7.6	8.4&	0.0&	3.4&	0.0&	730.0&
1993/94	18.8	52.1	243.3	63.8	33.5	48.7	18.6	0.0&	0.0&	0.0&	1.0	7.9	487.7&
1994/95	51.2	9.0	63.9	127.7	85.0	13.5	91.0	1.8&	0.0&	0.0&	15.7&	0.0&	458.8&
1995/96	40.2	105.5	162.6	149.8	357.8	146.9	61.8	92.1	2.8	13.8	40.2&	0.0&	1173.5&
1996/97	40.9	70.4	127.3	126.8	86.3	184.8	165.2	7.0	1.5&	0.0&	5.5	20.2	835.9&
1997/98	66.2	103.8	43.5	141.3	2.5	63.5	9.7&	0.0&	0.0&	3.8	0.2	3.5	438.0&
1998/99	50.2	91.7	205.7	89.7	140.0	55.5	37.8	12.5&	0.0&	1.0	14.0	7.5	705.6&
1999/00	77.0	107.3	92.2	149.7	306.0	234.5	62.5	22.0	27.5&	0.0&	0.0&	0.0&	1078.7&
2000/01	6.5	97.3	118.5	40.5	141.5	29.0	92.5	3.0&	0.0&	3.5	0.0&	0.0	532.3&
2001/02	16.0	243.0	53.5	174.8&	130.8&	52.1&	201.9&	7.1&	5.1&	2.5&	5.9&	15.0&	907.7&
2002/03	31.9&	36.3&	140.1&	89.6&	71.1&	53.9&	0.0&	0.0&	14.1&	0.0&	0.0&	22.5&	459.6&
2003/04	0.0&	64.8&	0.0&	215.1&	407.7&	156.6&	86.1&	9.6&	0.0&	30.1&	0.0&	24.6&	994.6&
2004/05	33.5&	114.6&	340.4&	109.1&	46.5&	148.5&	99.6&	44.6&	0.0	0.0	0.0	#	#
2005/06	#	#	#	#	#	#	#	#	#	#	#	#	#
2006/07	#	#	#	#	#	#	#	#	#	#	#	#	#
2007/08	#	#	#	#	#	#	10.4	0.0	1.6	0.0	0.0	0.0	#
2008/09	29.0	63.2	176.6	211.3	117.7	115.8	30.8	28.6	9.6	4.8	10.2	0.0	797.6
2009/10	0.0	142.2	108.5	68.4	#	82.7	157.8	144.5	0.0	#	#	0.0	#
2010/11	9.0	90.6	150.3	#	#	#	#	#	#	#	#	#	#
2011/12	#	#	#	#	35.4	9.4	38.8	0.0	0.0	0.0	0.0	30.8	#
2012/13	64.4	29.6	235.0	299.6	68.4	32.8	96.6	11.8	0.0	#	5.6	#	#
2013/14	#	64.0	274.0	77.4	79.2	286.8	34.8	0.0	0.0	0.0	7.4	0.0	#
2014/15	47.0	10.4	64.6	2.0	55.6	59.6	#	8.8	0.0	0.0	#	32.2	#
2015/16	#	#	32.8	15.4	38.4	125.2	0.0	#	#	0.0	0.0	12.0	#
2016/17	38.6	49.0	74.6	159.8	131.4	68.8	34.8	56.4	1.3	2.0	7.0	0.0	623.7
2017/18	37.8	25.2	85.2	24.4	56.8	82.2	19.6	11.7	0.0	#	0.0	1.6	#
2018/19	#	9.6	69.8	105.1	97.2	39.0	56.2	0.0	0.0	0.0	0.0	4.8	#
2019/20	1.6	35.6	#	110.2	#	#	#	#	#	#	#	#	#
2020/21	#	#	#	0.0 #	124.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#
2021/22	20.4	116.8	65.6	#	#	#	#	#	#	#	#	#	#
Avg:	43.1	75.4	121.0	109.3	103.1	82.4	45.5	17.9	5.5	6.2	7.4	14.3	649.9

ZZZZZZZZZZ

Data are continuously updated and reviewed.
Format of the data is as follows :(I4,X,I2,13(X,A6,A1,A1) where:
    I4 = CCYY
     X = /
    I2 = YY
    13(X,A6,A1,A1) = 12 Monthly evaporation in mm from Oct to Sep.
                     Value 13 is the yearly total.
                     X = Space
                     A6 = 999999
                     A1 = &/E/* or space(& = Monthly Reading)
                                        (E = Estimated Data
                                        (* = Calculated estimate)
                     A1 = # or space (# = record incomplete or does not exist)

MONTHLY EVAPORATION B7E003
Variable 711.50 Evaporation from S Class Pan
I4,X,I4,13(X,A6,A1,A1)
AAAAAAAAAAA

1963/64	#	195.3	225.3E	217.9	175.8	192.0	142.0	114.6E	107.7	98.3	133.9	174.0	#
1964/65	183.6E	166.2E	171.9E	186.7	207.0E	198.6E	134.9E	129.8	100.6	106.2	151.9	165.4	1902.7E
1965/66	#	#	234.2E	203.6E	144.0	185.2	149.6	133.1	96.1E	123.4	133.9E	168.4E	#
1966/67	169.9E	172.2E	187.7E	148.9E	124.2E	157.5E	108.2E	94.7	92.0	97.9E	118.3E	150.4	1621.9E
1967/68	142.6E	152.3E	207.3E	#	#	#	73.4 #	119.6	97.8E	107.4E	134.4	203.5E	#
1968/69	211.6E	175.0	207.3	228.3E	193.8E	149.6E	127.8E	110.5E	98.8	97.0	129.1	159.5	1888.3E
1969/70	142.2E	194.3	200.2E	242.6	212.6E	198.6E	154.9	127.0E	95.4E	98.0E	134.1	174.5	1974.4E
1970/71	91.3E#	209.1E	198.1E	#	#	92.7E	18.0E	54.0E	68.1E	97.0	119.4	167.2	#
1971/72	153.2	131.6E	177.0	145.3E	160.3E	132.9E	119.1	97.3E	81.6	89.2	119.6	160.8	1567.7E
1972/73	164.9E	164.1E	223.8E	216.7	173.5E	162.6	105.7	101.9	79.5	93.0	117.1	160.0E	1762.5E
1973/74	153.7E	150.6E	161.1E	173.5	158.8	153.7	101.9	95.7	87.9	91.2	131.6	142.3	1601.9E
1974/75	181.8	155.2	172.7E	179.7E	127.5E	143.0	109.7	89.9E	64.2	88.7	116.1	126.2	1554.9E
1975/76	171.2	189.5	160.6E	176.0E	155.2E	130.5E	103.9	84.4	84.3	90.9	117.9	145.8	1610.2E
1976/77	172.2	180.4	209.5E	218.2	145.0E	105.9E	110.7	100.1	80.3	88.4	113.1	118.1E	1641.8E
1977/78	164.6	173.5E	163.0E	151.2E	146.3E	134.9E	127.0	106.2	83.6	77.0	115.1	140.7	1582.9E
1978/79	132.6E	159.3	213.4	183.4E	159.3&	151.5	62.0 #	98.5	87.3E	82.0	94.5	126.3	1550.0E#
1979/80	153.0	148.0E	178.3E	170.5	145.5	133.6E	54.5 #	101.0	83.0	80.5	99.0	125.0	1471.9E#
1980/81	151.5	132.5	170.8E	175.0	119.5	132.0	111.1E	88.5	86.5	94.5	92.3E	131.0	1485.2E
1981/82	146.0	175.5	171.0	184.5	176.5	165.5	100.0E	93.5E	79.5	88.0	113.5	139.0	1632.5E
1982/83	157.5	170.0	228.5	212.0	184.0E	163.5E	132.7E	93.1E	80.0	93.0	113.5	157.0	1784.8E
1983/84	155.0	136.3E	168.5	193.0	160.0	146.1E	103.0	120.1E	72.5	74.0	97.0	117.0	1542.5E
1984/85	125.5	138.1	185.5	180.1E	157.0E	133.5	113.5	95.8E	71.0	81.3	103.5	131.1	1515.9E
1985/86	179.6E	178.6	165.6E	167.1	152.2	96.4E#	65.6 #	91.5	77.3	90.0	119.3	131.0	1514.2E#
1986/87	163.9	167.9	178.7E	165.7E	191.2E	155.6	124.0	112.3	83.0	95.5	110.0	119.4E	1667.2E
1987/88	138.5	149.1	142.4	194.5	152.2E	141.7E	125.5	101.0	84.5	95.5	113.0	153.5	1591.4E
1988/89	144.0	186.0	159.0	191.1E	153.9E	179.5E	130.0	106.0	78.0	98.5	129.7	167.5	1723.2E
1989/90	216.7E	150.2E	177.4E	178.0E	159.3E	151.3	108.0	113.5	108.3E	103.0	127.5	155.0	1748.2E
1990/91	182.1	198.8E	162.4E	187.9E	176.0E	143.2	146.5	112.6	87.3E	112.0	136.0	150.8	1795.6E
1991/92	192.6	191.7E	213.2E	234.4	222.0	198.5	165.6	137.6	118.0	118.5E	135.6	166.2	2093.9E
1992/93	193.4E	178.6E	203.9E	201.8	167.3	144.6	129.2	105.1	84.4	89.0	116.4	151.0	1764.7E
1993/94	145.8	156.0E	189.5E	189.8	165.0E	148.3E	136.1	116.5	110.5	114.5	117.0	177.4	1766.4E
1994/95	187.2E	196.8E	211.9E	214.7E	185.5	153.0	149.5E	92.8	92.0	108.5	133.7	164.5	1890.1E
1995/96	199.5E	164.5E	164.8E	158.3	145.7E	169.2E	108.0E	95.6	84.8	79.3	112.2	170.0E	1651.9E
1996/97	194.4E	168.9	176.0E	180.6E	187.3E	130.5E	137.9E	93.0	89.0	92.5	143.0	145.3E	1738.4E
1997/98	167.8E	181.3E	187.0	175.8	185.1E	188.3E	144.7E	121.9E	104.0	99.8E	134.2	157.0E	1846.9E
1998/99	137.2	141.5E	147.0E	181.4E	153.0E	134.0E	119.8E	90.0	88.5	88.5E	121.0	127.0	1528.8E
1999/00	114.9E	137.4E	173.2E	160.0E	116.1E	159.6E	105.0E	125.0	141.0	125.5E	106.0	127.0	1590.6E
2000/01	113.5	147.7E	146.2E	141.0E	135.1E	112.3E	97.5E	139.0E	84.0E	82.8E	101.5	152.5	1453.1E
2001/02	157.8E	155.0E	128.0E	#	#	#	#	#	#	#	#	#	#
2002/03	#	#	#	#	#	#	#	#	#	#	#	#	#
2003/04	#	#	#	#	#	#	#	#	#	#	#	#	#
2004/05	#	#	#	#	#	#	#	#	59.2E#	103.7E	82.5E#	#	#
2005/06	#	#	#	#	#	#	#	#	#	#	#	#	#
2006/07	#	#	#	#	#	#	#	#	#	#	#	#	#
2007/08	#	#	#	#	#	#	#	#	#	#	#	#	#
2008/09	#	#	#	#	#	#	#	#	#	#	#	#	#
2009/10	#	#	#	#	#	#	#	#	#	#	#	#	#
2010/11	#	#	#	#	#	#	#	#	#	#	#	#	#
2011/12	#	#	#	#	#	#	#	#	#	#	#	#	#
2012/13	#	#	#	#	#	#	#	#	#	#	#	#	#
2013/14	#	#	#	#	#	#	#	#	#	#	#	#	#
2014/15	#	#	#	#	#	#	#	#	#	#	#	#	#
2015/16	#	#	#	#	#	#	#	#	#	#	#	#	#
2016/17	#	#	#	#	#	#	#	#	#	#	#	#	#
2017/18	#	#	#	#	#	#	#	#	#	#	#	#	#
2018/19	#	#	#	#	#	#	#	#	#	#	#	#	#
2019/20	#	#	#	#	#	#	#	#	#	#	#	#	#
2020/21	#	#	#	#	82.2E#	#	46.0E#	60.3E#	63.5E	85.5E	97.3E	111.2E	#
2021/22	112.1E	156.6E	98.9E#	#	#	#	#	#	#	#	#	#	#
Avg:	161.4	166.0	183.1	186.4	163.1	152.0	120.6	105.3	88.6	95.5	119.3	149.0	1694.2

ZZZZZZZZZZ

APPENDIX B

GROUNDWATER AND SURFACE WATER CHEMISTRY RESULTS – YANKA LABORATORY

YANKA LABORATORIES

(Pty) Ltd.
Registration No. 2012/113891/07 VAT No. 4380263659
PO Box 11396, AERORAND, 1055, South Africa
Office: 6 Drakensberg Str., Aerorand, MIDDELBURG, MP
Laboratory: 40 Minerva Ave., Reyno Ridge, WITBANK, MP
Phone: +27-87-701-9265 or 6
Cell: +27-83-232-3230 / Fax: +27-86-551-1071
E-Mail: yanka@yanka.co.za

In-Situ Consulting CC
Attention: Aubrey Meyer
P.O. Box 26280
Steiltes
NELSPRUIT
1200

Job No: **E53009 - W22 _ 0442**
Report Reference: **ER_IN-_2022-01-28_09244_001**
Enquiries: **Rita Botha**
Date: **2022/01/28**
RitaB@yanka.co.za
Job Reference: **W22/0442 - Advice Note 2202W033**
Job Description: **2 x Routine Analysis**
Project: **BOREHOLE / FILLING STATION**

TEST RESULTS FOR In-Situ - Borehole / Filling Station - 26 January 2022

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see http://www.yanka.co.za/TestsAndStandards.htm

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

Electronically approved

RITA BOTHA (Technical Signatory)
ENVIRONMENTAL SERVICES

ANALYSED WITHIN 26 January 2022 - 2022/01/28
SANAS Certificate obtainable from the address below
http://www.yanka.co.za/Services.htm

*Results not marked with a Test Method YE###***, as well as results marked "Subcontracted" or "Outsourced" , in this report, are not included in the SANAS Schedule of Accreditation for this laboratory. However, outsourced results may be within the Schedule of Accreditation of the source laboratory.*
Opinions and interpretations expressed herein are outside the scope of SANAS accreditation.
Limits shown to the right of results are for information only and may need further interpretation, and is not suitable for conformance evaluation as shown.

Although reasonable precautions are taken to ensure accuracy, correctness, and applicability, it is emphasized that all results of analysis or any other notifications are provided on the explicit condition that YANKA LABORATORIES will accept no responsibility whatsoever, for any losses or costs that may result from faulty, incorrect, or inappropriate interpretation, use, or application of results.
This report relates only to the specific sample(s) tested as identified herein and may not be reproduced in part without written permission from Laboratory Management.

ANALYSTS
Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Charnelle, Petricia, Jeandre, Nadine

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	Domestic Water. Class II is for information only SANS 241:2015 / 2011 / 2006					
SAMPLE DESCRIPTION			AC - 01	AC - 05	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT	Target WQ Guidelines
SAMPLE NUMBER			E53009-001	E53009-002						
SAMPLED		Test Method **	2022/01/25 15:40	2022/01/25 16:05						
Remarks			Clear	Clear						
Acidity	mg $CaCO_3$/L	YE011Ac	17.6	14.7						
Total Alkalinity (pH>4.5)	mg $CaCO_3$/L	YE010Alk	78.4	71.6						
Bicarbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	78.4	71.6						
Carbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	0.00	0.00						
M Alkalinity (8.3>pH>4.5)	mg $CaCO_3$/L	YE010Alk	78.4	71.6						
P Alkalinity (pH>8.3)	mg $CaCO_3$/L	YE010Alk	0.00	0.00						
Colour	mg/l as Pt	ISO 7887 based	<2.86	5.10	< 15	20 - 50	No limit			< 15
Conductivity (Laboratory)	mS/m	YE020CON	21.1	20.4	< 170	150 - 370	7 years	* < 70	* < 50	< 40
pH (Laboratory)		YE030pH	6.84	6.76	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5	6.5 - 8.5
Total Hardness	mg $CaCO_3$/L	YE061H	61.5	50.5						< 50
Calcium Hardness	mg $CaCO_3$/L	YE061H	34.2	29.3						
Magnesium Hardness	mg $CaCO_3$/L	YE061H	27.3	21.2						
Total Dissolved Solids (TDS)	mg/L	Calculation	101	108	< 1200	1000-2400	7 years			<450
Suspended Solids (TSS)	mg/L	YE081TSS	17.2	<0.4				< 25	< 10	< 5
Temperature	°C	Thermometer	21.0	21.0						
Turbidity	NTU	YE082TB	7.03	0.73	< 1	1 - 5	No limit			< 1
Chemical Oxygen Demand (COD)	mg O_2/L	YE052COD	1.00	1.00				(i) < 75	(i) < 30	< 10
Oil, Soap and Grease (OSG)	mg/L	SANS 6051 based	1.10	0.50				<2.5	0.0	
Oxygen Absorbed (OA4)	mg O_2/L	YE050OA	0.08	0.02						
Settleable Solids	mg/L	SM 2540F based	<0.01	<0.01						
Sludge Volume Index (SVI)		SM 2710D based	<1.0	<1.0						
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	< 1.5			< 6	< 2	< 1
Calcium	mg Ca/L	YE060ICP	13.7	11.7	< 150	150 - 300	7 years			< 32
Total Chlorine (Laboratory)	mg Cl_2/L	ISO 7393 based	<0.1	<0.1						
Soluable/Free Chlorine (Lab)	mg Cl_2/L	ISO 7393 based	<0.1	<0.1	< 5			<0.25	0.00	< 0.2
Chloride	mg Cl/L	YE070AK	12.8	15.4	< 300	200 - 600	7 years			<100
Magnesium	mg Mg/L	YE060ICP	6.62	5.14	< 70	70 - 100	7 years			< 30
Nitrate and Nitrite (TON)	mg N/L	YE070AK	0.79	1.88	< 12	10 - 20	7 years	< 15	<1.5	< 6
Nitrite	mg N/L	YE070AK	<0.01	<0.01	< 0.9					
Ortho Phosphate	mg P/L	YE070AK	0.09	0.18	< 5			< 10	< 1	<0.025
Potassium	mg K/L	YE060ICP	1.29	0.78	< 50	50 - 100	7 years			< 50
Sodium	mg Na/L	YE060ICP	15.8	22.5	< 200	200 - 400	7 years			< 70
Silicon	mg Si/L	YE060ICP	23.5	28.5						
Sulphate	mg SO_4/L	YE070AK	<0.5	<0.5	< 500	400 - 600	7 years			< 200
Aluminium	mg Al/L	YE060ICP	<0.01	0.06	< 0.3	0.3 - 0.5	1 year			< 0.15
Antimony	mg Sb/L	YE060ICP	<0.01	<0.01	<0.02					
Arsenic	mg As/L	YE060ICP	<0.009	<0.009	<0.01			<0.02	<0.01	<0.01
Barium	mg Ba/L	YE060ICP	<0.01	<0.01						
Beryllium	mg Be/L	YE060ICP	<0.01	<0.01						
Boron	mg B/L	YE060ICP	<0.01	<0.01	< 0.3			<1.0	<0.5	<0.5
Bromide	mg Br/L	YE070AK	<0.01	<0.01						
Cadmium	mg Cd/L	YE060ICP	<0.002	<0.002	<0.003			<0.005	<0.001	<0.005
Chromium	mg Cr/L	YE060ICP	<0.01	<0.01	<0.05			<0.05	<0.02	
Hexavalent Chromium	mg Cr/L	YE070AK	<0.02	<0.02						<0.05
Cobalt	mg Co/L	YE060ICP	<0.01	<0.01	< 0.5					<0.05
Copper	mg Cu/L	YE060ICP	<0.01	<0.01	< 2			<0.01	<0.002	< 0.2
Fluoride	mg F/L	YE070AK	0.13	0.23	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	<0.01	0.02	< 2	0.2 - 2.0	7 years	<0.3	<0.3	< 0.1

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	Domestic Water. Class II is for information only SANS 241:2015 / 2011 / 2006					
SAMPLE DESCRIPTION			AC - 01	AC - 05	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT	Target WQ Guidelines
SAMPLE NUMBER			E53009-001	E53009-002						
SAMPLED		Test Method **	2022/01/25 15:40	2022/01/25 16:05						
Lead	mg Pb/L	YE060ICP	<0.01	<0.01	< 0.01			< 0.01	<0.006	< 0.01
Lithium	mg Li/L	YE060ICP	<0.01	0.02						<0.075
Manganese	mg Mn/L	YE060ICP	<0.01	<0.01	< 0.4	0.1 - 1.0	7 years	< 0.1	< 0.1	< 0.02
Mercury	mg Hg/L	060ICP	<0.003	<0.003	<0.006			<0.005	<0.001	<0.001
Molybdenum	mg Mo/L	YE060ICP	<0.01	<0.01	< 0.07					
Nickel	mg Ni/L	YE060ICP	<0.01	<0.01	< 0.07					< 0.2
Selenium	mg Se/L	YE060ICP	<0.01	<0.01	< 0.04			< 0.02	< 0.02	< 0.02
Strontium	mg Sr/L	YE060ICP	0.13	0.09						
Tin	mg Sn/L	YE060ICP	0.01	0.01						
Vanadium	mg V/L	YE060ICP	<0.01	<0.01	< 0.2					< 0.1
Zinc	mg Zn/L	YE060ICP	<0.01	<0.01	< 5			<0.1	<0.04	< 1
Phenol	mg Phenol/L	YE070AK	<0.01	<0.01	< 0.01					<0.001
Total Organic Carbon (TOC)	mg C/L	090TOC	4.98	3.83	< 10					< 5
Dissolved Organic Carbon (DOC)	mg C/L	090TOC	4.59	3.82						< 5
Cyanide (Free)	mg CN/L	070AK	<0.01	<0.01	< 0.2			< 0.02	< 0.01	<0.001
Biological Oxygen Demand (BOD)	mg O_2/L	SANS 738 based	<1.0	<1.0						
Silver	mg Ag/L	YE060ICP	<0.01	<0.01						
Lanthanum	mg La/L	YE060ICP	<0.01	<0.01						
Titanium	mg Ti/L	YE060ICP	<0.01	<0.01						
TPH C10 - C28	ug/L	Outsourced	<382	<382						
TPH C28 - C40	ug/L	Outsourced	<382	<382						
TPH Total	ug/L	Outsourced	<382	<382						
MTBE	ug/L	Outsourced	<5	<5						
Benzene	ug/L	Outsourced	<0.4	<0.4						
TAME	ug/L	Outsourced	<5	<5						
Toluene	ug/L	Outsourced	<1	<1						
Ethyl Benzene	ug/L	Outsourced	<0.4	<0.4						
m+p-Xylene	ug/L	Outsourced	<0.8	<0.8						
o-Xylene	ug/L	Outsourced	<0.4	<0.4						
1,3,5 Trimethyl benzene	ug/L	Outsourced	<0.4	<0.4						
1,2,4 Trimethyl benzene	ug/L	Outsourced	<0.4	<0.4						
Naphthalene	ug/L	Outsourced	<0.4	<0.4						
GRO TPH (C6-C10)	ug/L	Outsourced	<10	<10						
Langelier Index (indicative, not SANS)		Calculation	-1.60	-1.79	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on surfaces due				
pHs (indicative, not SANS)		Calculation	8.44	8.55		Saturation pH (used in calculations)				
Sodium Absorption Ratio (indicative)		Calculation	0.87	1.37	< 1.5	Relevant in irrigation and water/plant/soil				< 1.5
TDS to EC Ratio (indicative, not SANS)		Calculation	4.79	5.28		Analytical indicator				
Corrosion Ratio (indicative, not SANS)		Calculation	0.46	0.61	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due to (sulphate				
Ryznar Index (indicative, not SANS)		Calculation	10.03	10.33	6 - 7	< 6: water may form scale on surfaces; > 7: water may corrode surfaces				
Anion Sum			2.01	2.04						
Cation Sum			1.96	2.03						
Difference			-0.05	-0.01						
% Difference			-1.15%	-0.24%						

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

Ion balance is not used as QC check where pH<3.5.

**** Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards,**

YANKA LABORATORIES

MICROBIOLOGY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	STANDARD LIMIT SANS 241:2015	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance 4% of	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance of 1% of	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION			AC - 01	AC - 05					
SAMPLE NUMBER			E53009-001	E53009-002					
SAMPLED		Test Method	2022/01/25 15:40	2022/01/25 16:05					
Remarks			Clear	Clear					
Standard Plate Count or Heterotrophic Pl. Count	count/mL	YE100SPC / ISO 9308 based	>3000	>3000	< 1000	No Limit	Alert 5000		
Total Coliforms	CFU/100mL	YE101TC / ISO 9308 based	710	0	< 10	No Limit	Alert 10		
Faecal Coliforms	CFU/100mL	YE102FC / ISO 9308 based	130	0	0	0	1	<1000	0
e.Coli	CFU/100mL	YE104EC / ISO 9308 based	70	0	0	0	1	<1000	

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

*** Methods Starting with YE are accredited. For ranges, uncertainties, etc., please contact us.*

YANKA LABORATORIES

(Pty) Ltd.
Registration No. 2012/113891/07 VAT No. 4380263659
PO Box 11396, AERORAND, 1055, South Africa
Office: 6 Drakensberg Str., Aerorand, MIDDELBURG, MP
Laboratory: 40 Minerva Ave., Reyno Ridge, WITBANK, MP
Phone: +27-87-701-9265 or 6
Cell: +27-83-232-3230 / Fax: +27-86-551-1071
E-Mail: yanka@yanka.co.za

In-Situ Consulting CC
Attention: Aubrey Meyer
P.O. Box 26280
Steiltes
NELSPRUIT
1200

Job No: **E53008 - W22 _ 0441**
Report Reference: **ER_IN-_2022-01-28_09243_001**
Enquiries: **Rita Botha**
Date: **2022/01/28**
RitaB@yanka.co.za
Job Reference: **W22/0441 - Advice Note 2202W032**

Job Description: **2 x Routine Analysis**

Project: **RIVER SAMPLES**

TEST RESULTS FOR In-Situ Consulting - River Samples - 25 January 2022

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see http://www.yanka.co.za/TestsAndStandards.htm

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

Electronically approved

RITA BOTHA (Technical Signatory)
ENVIRONMENTAL SERVICES

ANALYSED WITHIN 26 January 2022 - 2022/01/28
SANAS Certificate obtainable from the address below
http://www.yanka.co.za/Services.htm

*Results not marked with a Test Method YE###***, as well as results marked "Subcontracted" or "Outsourced" , in this report, are not included in the SANAS Schedule of Accreditation for this laboratory. However, outsourced results may be within the Schedule of Accreditation of the source laboratory.*
Opinions and interpretations expressed herein are outside the scope of SANAS accreditation.
Limits shown to the right of results are for information only and may need further interpretation, and is not suitable for conformance evaluation as shown.

Although reasonable precautions are taken to ensure accuracy, correctness, and applicability, it is emphasized that all results of analysis or any other notifications are provided on the explicit condition that YANKA LABORATORIES will accept no responsibility whatsoever, for any losses or costs that may result from faulty, incorrect, or inappropriate interpretation, use, or application of results.
This report relates only to the specific sample(s) tested as identified herein and may not be reproduced in part without written permission from Laboratory Management.

ANALYSTS
Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Charnelle, Petricia, Jeandre, Nadine

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	Domestic Water. Class II is for information only SANS 241:2015 / 2011 / 2006					
SAMPLE DESCRIPTION			AC River Up Stream	AC River Down Stream	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT	Target WQ Guidelines
SAMPLE NUMBER			E53008-001	E53008-002						
SAMPLED		Test Method **	2022/01/25 16:45	2022/01/25 15:10						
Remarks			Clear	Clear						
Acidity	mg $CaCO_3$/L	YE011Ac	3.55	3.52						
Total Alkalinity (pH>4.5)	mg $CaCO_3$/L	YE010Alk	69.0	74.6						
Bicarbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	69.0	74.6						
Carbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	0.00	0.00						
M Alkalinity (8.3>pH>4.5)	mg $CaCO_3$/L	YE010Alk	69.0	74.6						
P Alkalinity (pH>8.3)	mg $CaCO_3$/L	YE010Alk	0.00	0.00						
Colour	mg/l as Pt	ISO 7887 based	15.2	16.1	< 15	20 - 50	No limit			< 15
Conductivity (Laboratory)	mS/m	YE020CON	22.0	21.0	< 170	150 - 370	7 years	* < 70	* < 50	< 40
pH (Laboratory)		YE030pH	7.04	7.20	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5	6.5 - 8.5
Total Hardness	mg $CaCO_3$/L	YE061H	54.6	46.5						< 50
Calcium Hardness	mg $CaCO_3$/L	YE061H	31.0	28.2						
Magnesium Hardness	mg $CaCO_3$/L	YE061H	23.6	18.2						
Total Dissolved Solids (TDS)	mg/L	Calculation	114	100	< 1200	1000-2400	7 years			<450
Suspended Solids (TSS)	mg/L	YE081TSS	2.00	1.20				< 25	< 10	< 5
Temperature	°C	Thermometer	21.0	21.0						
Turbidity	NTU	YE082TB	21.4	15.1	< 1	1 - 5	No limit			< 1
Chemical Oxygen Demand (COD)	mg O_2/L	YE052COD	18.0	17.0				(i) < 75	(i) < 30	< 10
Oil, Soap and Grease (OSG)	mg/L	SANS 6051 based	0.70	0.70				<2.5	0.0	
Oxygen Absorbed (OA4)	mg O_2/L	YE050OA	1.14	1.50						
Oxygen Dissloved (DO)	mg O_2/L	YE051OD	6.73	6.27						80 - 120
Settleable Solids	mg/L	SM 2540F based	<0.01	<0.01						
Sludge Volume Index (SVI)		SM 2710D based	<1.0	<1.0						
Ammonia and Ammonium	mg N/L	YE070AK	<0.45	<0.45	< 1.5			< 6	< 2	< 1
Calcium	mg Ca/L	YE060ICP	12.4	11.3	< 150	150 - 300	7 years			< 32
Total Chlorine (Laboratory)	mg Cl_2/L	ISO 7393 based	<0.1	<0.1						
Soluable/Free Chlorine (Lab)	mg Cl_2/L	ISO 7393 based	<0.1	<0.1	< 5			<0.25	0.00	< 0.2
Chloride	mg Cl/L	YE070AK	26.5	17.4	< 300	200 - 600	7 years			<100
Magnesium	mg Mg/L	YE060ICP	5.73	4.43	< 70	70 - 100	7 years			< 30
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35	<0.35	< 12	10 - 20	7 years	< 15	<1.5	< 6
Nitrite	mg N/L	YE070AK	<0.01	<0.01	< 0.9					
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03	< 5			< 10	< 1	<0.025
Potassium	mg K/L	YE060ICP	0.11	0.15	< 50	50 - 100	7 years			< 50
Sodium	mg Na/L	YE060ICP	21.0	20.6	< 200	200 - 400	7 years			< 70
Silicon	mg Si/L	YE060ICP	10.6	10.2						
Sulphate	mg SO_4/L	YE070AK	4.16	<0.5	< 500	400 - 600	7 years			< 200
Aluminium	mg Al/L	YE060ICP	0.96	0.28	< 0.3	0.3 - 0.5	1 year			< 0.15
Antimony	mg Sb/L	YE060ICP	<0.01	<0.01	<0.02					
Arsenic	mg As/L	YE060ICP	0.15	0.15	<0.01			<0.02	<0.01	<0.01
Barium	mg Ba/L	YE060ICP	<0.01	<0.01						
Beryllium	mg Be/L	YE060ICP	<0.01	<0.01						
Boron	mg B/L	YE060ICP	<0.01	<0.01	< 0.3			<1.0	<0.5	<0.5
Bromide	mg Br/L	YE070AK	<0.01	<0.01						
Cadmium	mg Cd/L	YE060ICP	<0.01	<0.01	<0.003			<0.005	<0.001	<0.005
Chromium	mg Cr/L	YE060ICP	<0.01	<0.01	<0.05			<0.05	<0.02	
Hexavalent Chromium	mg Cr/L	YE070AK	<0.02	<0.02						<0.05
Cobalt	mg Co/L	YE060ICP	<0.01	<0.01	< 0.5					<0.05
Copper	mg Cu/L	YE060ICP	<0.01	<0.01	< 2			<0.01	<0.002	< 0.2
Fluoride	mg F/L	YE070AK	0.13	0.19	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0	<1.0

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	Domestic Water. Class II is for information only					
					SANS 241:2015 / 2011 / 2006					
SAMPLE DESCRIPTION			AC River Up Stream	AC River Down Stream	SANS 241:2015 STANDARD LIMIT [Operational] [Aesthetic] [2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT	Target WQ Guidelines
SAMPLE NUMBER			E53008-001	E53008-002						
SAMPLED		Test Method **	2022/01/25 16:45	2022/01/25 15:10						
Iron	mg Fe/L	YE060ICP	1.11	1.11	< 2	0.2 - 2.0	7 years	<0.3	<0.3	< 0.1
Lead	mg Pb/L	YE060ICP	<0.01	<0.01	< 0.01			< 0.01	<0.006	< 0.01
Lithium	mg Li/L	YE060ICP	<0.01	<0.01						<0.075
Manganese	mg Mn/L	YE060ICP	<0.01	0.01	< 0.4	0.1 - 1.0	7 years	< 0.1	< 0.1	< 0.02
Mercury	mg Hg/L	060ICP	<0.003	<0.003	<0.006			<0.005	<0.001	<0.001
Molybdenum	mg Mo/L	YE060ICP	<0.01	<0.01	< 0.07					
Nickel	mg Ni/L	YE060ICP	<0.01	<0.01	< 0.07					< 0.2
Selenium	mg Se/L	YE060ICP	<0.01	<0.01	< 0.04			< 0.02	< 0.02	< 0.02
Strontium	mg Sr/L	YE060ICP	0.09	0.10						
Tin	mg Sn/L	YE060ICP	<0.01	<0.01						
Vanadium	mg V/L	YE060ICP	<0.01	<0.01	< 0.2					< 0.1
Zinc	mg Zn/L	YE060ICP	<0.01	<0.01	< 5			<0.1	<0.04	< 1
Phenol	mg Phenol/L	YE070AK	<0.01	<0.01	< 0.01					<0.001
Total Organic Carbon (TOC)	mg C/L	090TOC	7.86	7.90	< 10					< 5
Dissolved Organic Carbon (DOC)	mg C/L	090TOC	7.54	7.50						< 5
Cyanide (Free)	mg CN/L	070AK	<0.01	0.01	< 0.2			< 0.02	< 0.01	<0.001
Biological Oxygen Demand (BOD)	mg O_2/L	SANS 738 based	<1.0	<1.0						
Lanthanum	mg La/L	YE060ICP	<0.01	<0.01						
Titanium	mg Ti/L	YE060ICP	0.02	<0.01						
Uranium	mg U/L	YE060ICP	<0.01	<0.01	<0.015					<0.010
Silver	mg Ag/L		<0.01	<0.01						
Langelier Index (indicative, not SANS)		Calculation	-1.50	-1.34	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on surfaces due				
pHs (indicative, not SANS)		Calculation	8.54	8.54		Saturation pH (used in calculations)				
Sodium Absorption Ratio (indicative)		Calculation	1.23	1.31	< 1.5	Relevant in irrigation and water/plant/soil				< 1.5
TDS to EC Ratio (indicative, not SANS)		Calculation	5.16	4.77		Analytical indicator				
Corrosion Ratio (indicative, not SANS)		Calculation	1.11	0.66	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due to (sulphate				
Ryznar Index (indicative, not SANS)		Calculation	10.04	9.88	6 - 7	< 6: water may form scale on surfaces; > 7: water may corrode surfaces				
Anion Sum			2.23	2.00						
Cation Sum			2.18	1.93						
Difference			-0.05	-0.07						
% Difference			-1.08%	-1.85%						

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.

Ion balance is not used as QC check where pH<3.5.

**** Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards, please see http://www.yanka.co.za/TestsAndStandards.htm . For ranges, uncertainties, etc., please contact us.**

YANKA LABORATORIES

MICROBIOLOGY TEST RESULTS

LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	STANDARD LIMIT SANS 241:2015	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance 4% of	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance of 1% of	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION			AC River Up Stream	AC River Down Stream					
SAMPLE NUMBER			E53008-001	E53008-002					
SAMPLED		Test Method	2022/01/25 16:45	2022/01/25 15:10					
Remarks			Clear	Clear					
Standard Plate Count or Heterotrophic Pl. Count	count/mL	YE100SPC / ISO 9308 based	>3000	>3000	< 1000	No Limit	Alert 5000		
Total Coliforms	CFU/100mL	YE101TC / ISO 9308 based	650	400	< 10	No Limit	Alert 10		
Faecal Coliforms	CFU/100mL	YE102FC / ISO 9308 based	390	220	0	0	1	<1000	0
e.Coli	CFU/100mL	YE104EC / ISO 9308 based	160	190	0	0	1	<1000	

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Water and Wastewater.

*** Methods Starting with YE are accredited. For ranges, uncertainties, etc., please contact us.*

APPENDIX C

DVH-21-108: EVALUATION OF FOUNDING CONDITIONS AND EXCAVATIBILITY FOR PROPOSED FUEL STATION, ACORN CITY

DAVEL & VAN HUYSSTEEN
CONSULTING ENGINEERING GEOLOGISTS
www.dvhgeotech.co.za
Registration number:
2019/095491/07

10 January 2022

Attention: Mr D. Malabie

REPORT DVH-21-108: EVALUATION OF FOUNDING CONDITIONS & EXCAVATIBILITY FOR PROPOSED FUEL STATION, ACORN CITY

At the request of D. Malabie we have carried out an evaluation of founding conditions and excavatibility for the proposed new fuel station at the Acorn City development. Exact earthworks details are unknown at this stage.

1. Fieldwork

The fieldwork operation for the township establishment of the Acorn City development was carried out in June 2020 (see report DVH-20-28). Based on the location of the proposed new fuel station development, test pits TP6, TP7 and TP14 are relevant owing to their general proximity to the site. Test pit TP7 is located in immediate proximity to the site.

Further to the above, it is noted that the current letter report should be read in conjunction with the original geotechnical report "DVH-20-28 Acorn City Urban Mixed Use Development".

2. Regional And Site-Specific Geology

According to the available geological maps (1:250 000, 2430 Pilgrims Rest) the area of investigation is underlain by **medium to coarse grained quartz-feldspar-biotite gneiss** of the Swazian Erathem. This was confirmed during the fieldwork operation. Owing to weathering of the gneiss bedrock residual gneiss soils occur across the area of investigation. The upper soil layer comprises a layer of transported hillwash.

Based on the recorded soil profiles the fuel station site falls within geotechnical soils zone, Zone C2 .

Geotechnical Soil Zone	General Soil Profile Description
Zone C2	Transported Hillwash overlying localised Transported Pebble Marker overlying thick potentially collapsible Reworked Residual Gneiss overlying Residual Gneiss.

This geotechnical soil zones are based on the classification systems as provided by the NHBRC Home Builders Manual (2015) and SANS 10400-H Foundations (2012). The approximate areal extent of each soil zone is shown on the site plan enclosed in Appendix A. The recorded soil profile within the vicinity of the fuel station as based o the most relevant test pits (see test pits TP6, TP7 and TP14) is described in below.

The upper soil layer in the vicinity of the fuel station comprises medium dense and locally firm intact slightly clayey silty sand / slightly silty clayey sand of **transported hillwash** origin. The hillwash extends to depths of the order of 0,2m to 1,1m (average depth 0,65m).

The hillwash is underlain by loose to medium dense / medium dense intact micaceous slightly silty clayey sand / **reworked residual gneiss**. The reworked residual gneiss extends

justin.davel@dvhgeotech.co.za
076 966 8445
justin.vanhuyssteen@dvhgeotech.co.za
082 467 5346
Strijdom Park, Randburg, JHB

to depths varying between 1,6m and 2,3m. The reworked residual gneiss is underlain by loose / loose to medium dense jointed micaceous slightly clayey silty sand / silty sand **residual gneiss** to depths in excess of 3,0m, the excavation limit of the backactor, in those test pits where it occurs across Zone C2.

No perched water table or zones of seepage were noted in any of the test pits excavated across the site

3. Evaluation of Founding Conditions & Foundation Recommendations

The portions of the site upon which the proposed fuel station will be located are noted as occurring within the previously identified soil Zone C2. Across Zone C2, owing to the potentially highly compressible and/or collapsible nature of the upper in situ soils, special foundation procedures would be required. Considering the nature of the proposed structure within the fuel station it is recommended that suitably designed **reinforced concrete rafts** be regarded as the optimal foundation solution. The rafts could be placed at shallow depth within the upper in situ soils. A Modulus of Subgrade Reaction (k) value of 40kPa/mm could be applied to the in-situ soils to facilitate the design of the raft foundations.

4. Excavation Procedures

Based on the findings of the near-surface geotechnical investigation of June 2020, specifically the findings of the aforementioned test pits, those portions of the site in the vicinity of the proposed fuel station would classify as **soft excavation** material to depths in excess of 3,0m. This according to the classification system as provided in SANS 1200D, DA and DB.

It is anticipated that the excavation depth for the fuel tank portions of the development would be in excess of 3,0m, the depth limit of the abovementioned test pits, June 2020. In this regard, should additional information regarding excavatibility of the underlying soils below 3,0m depth be required, further geotechnical work in the form of Dynamic Probe Super Heavy (DPSH) testing would be necessary.

5. Soil Corrosivity

Based on the findings of the soil chemistry tests carried out during the geotechnical investigation of 2020, it is noted that the in-situ soils across the site classify as non-corrosive towards buried concrete and steel.

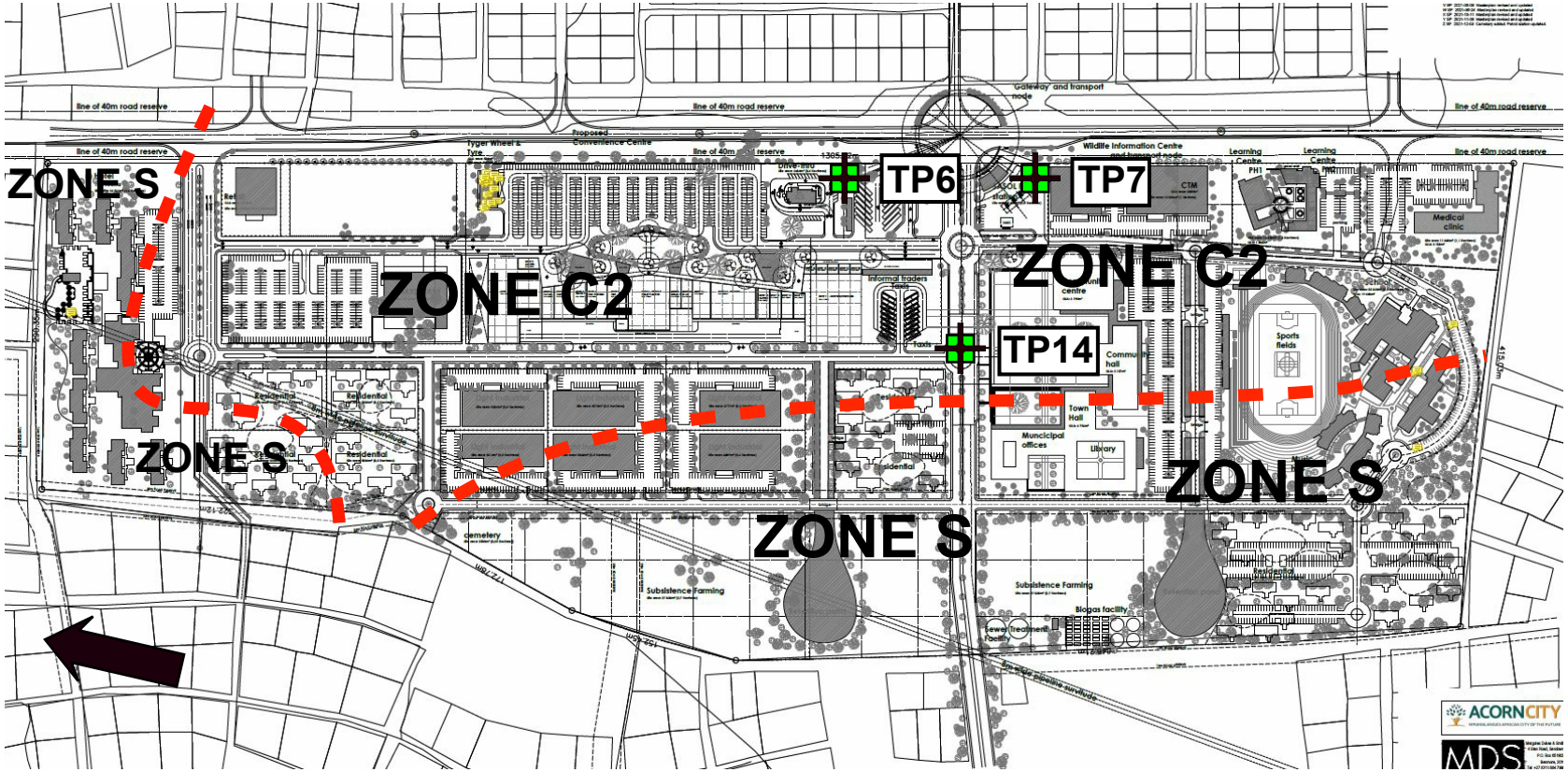
We trust the above meets with your current requirements. Please do not hesitate to contact us should you require any additional information.

Best regards,

Justin van Huyssteen

Director

justin.davel@dvhgeotech.co.za
076 966 8445
justin.vanhuyssteen@dvhgeotech.co.za
082 467 5346
Strijdom Park, Randburg, JHB



Geotechnical Soil Zone	General Soil Profile Description
Zone S	Transported Hillwash overlying localised Transported Pebble Marker overlying reworked residual gneiss overlying competent residual gneiss.
Zone C2	Transported Hillwash overlying localised Transported Pebble Marker overlying thick potentially collapsible reworked residual gneiss overlying residual gneiss.

KEY:

TP Test Pit Position

PROJECT: DVH-21-108
EVALUATION OF FOUNDING CONDITIONS
NEW FUEL STATION, ACORN CITY URBAN MIXED USE DEVELOPMENT

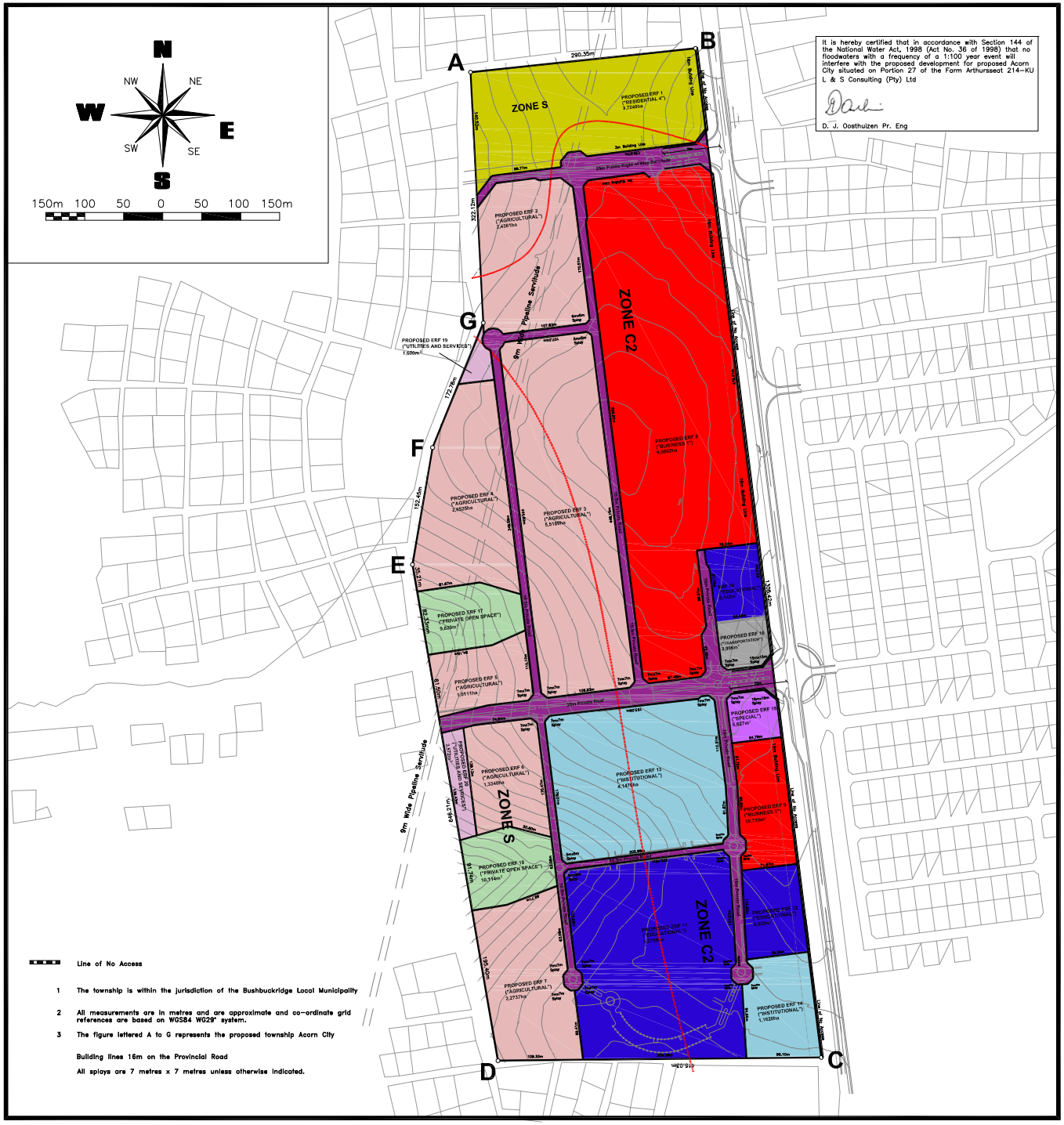
DECEMBER 2021

UPDATED SITE DEVELOPMENT PLAN INDICATING LOCATIONS OF TEST PIT EXCAVATIONS

DAVEL & VAN HUYSSTEEN
CONSULTING ENGINEERING GEOLOGISTS

APPENDIX D

PRELIMINARY SITE MAP – MDS ARCHITECHTURE



Line of No Access

1 The township is within the jurisdiction of the Bushbuckridge Local Municipality

2 All measurements are in metres and are approximate and co-ordinate grid references are based on WGS84 WG29° system.

3 The figure lettered A to G represents the proposed township Acorn City

Building lines 16m on the Provincial Road

All splays are 7 metres x 7 metres unless otherwise indicated.

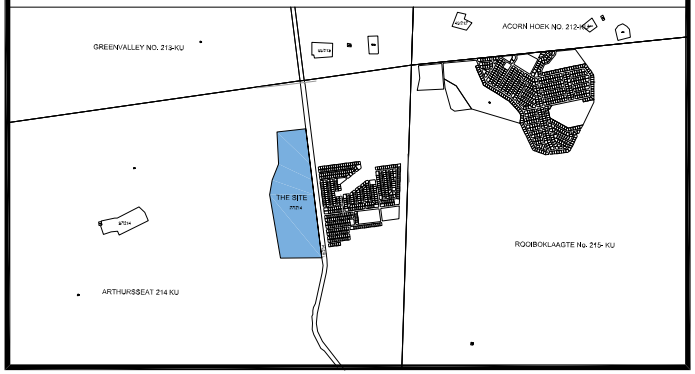
LAYOUT PLAN OF PROPOSED TOWNSHIP

ACORN CITY

SITUATED ON PORTION 27 OF THE FARM ARTHURSSEAT 214–KU
AS DEPICTED BY THE FIGURE A, B, C, D, E, F, G, A
ON THE LAYOUT PLAN

LOCALITY PLAN

SCALE 1 : 25 000



GROUND USE TABLE

NOTES	USE ZONE	No OF ERVEN	ERF No	AREA (ha)	%
	BUSINESS 1	3	8 & 9	10,6755	21.48
	AGRICULTURAL	4	2 – 7	15,2263	30.64
	EDUCATIONAL	3	10 – 12	6,8472	13.77
	INSTITUTIONAL	2	13 & 14	5,3090	10.68
	RESIDENTIAL 4	1	1	3,7240	7.49
	SPECIAL FOR A FILLING STATION	1	15	0,5627	1.13
	TRANSPORTATION SERVICE	1	16	0,3996	0.80
	OPEN SPACE	2	17 & 18	1,9934	4,01
	UTILITIES AND SERVICES	2	19 & 20	0,5172	1.04
	ROAD PURPOSES	1	21	4,4360	8,93
	TOTAL			49,6909	100.0

NOTES

1. PREPARED IN ACCORDANCE WITH THE STANDARDS PRESCRIBED IN THE BUSHBUCK RIDGE SPATIAL PLANNING AND LAND USE MANAGEMENT BY–LAW, 2014
2. CONTOURS ARE PREPARED BY . .
3. ALL DIMENSIONS ARE APPROXIMATE AND SUBJECT TO FINAL SURVEY
4. SEPARATION OF SOIL ZONE C2 AND SOIL ZONE S

NORTH
SCALE 1 : 2 500

REVISIONS

RR2162-5	MARCH 2020
RR2162-5	FEBRUARY 2021
RR2162-5	FEBRUARY 2022

RAVEN Town Planners
Professional Planning Consultants

3rd Floor, Bergild House
54 Andries Street
WYNBERG
2090

P. O. Box 522359
SAXONWOLD
2132

Telephone (011) 882 4035
Direct Fax 086 603 4467
E–mail : rick@raventp.co.za

PLAN: RR2162-5 Updated February 2022

APPENDIX E

PHOTOGRAPHS

PROPOSED ACORN CITY - HYDRO-CENSUS INVESTIGATION - PHOTOGRAPHS

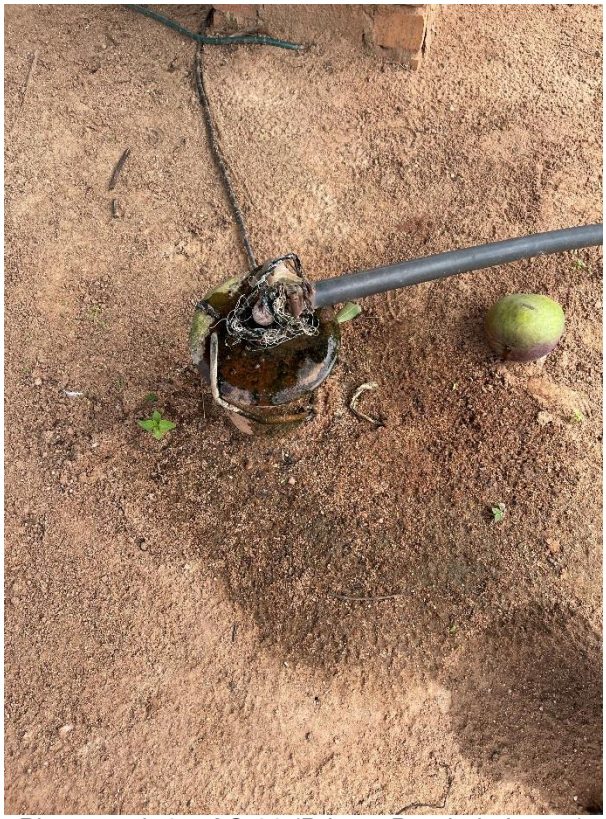
Photograph 1 – BR-03007 (Unused)

Photograph 2 – BR-03008 (Unused)

Photograph 3 – AC-03 (Destroyed)

Photograph 4 – AC-04 (Destroyed)

Photograph 5 – AC-05 (In use)



Photograph 6 – AC-06 (Private Borehole In use)

Photograph 7 – AC-07 (Unused)

Photograph 8 – H05-0406 (Destroyed)

Photograph 9 – AC-09 (School In use)

Photograph 10 – H05-1072 (Destroyed)

Photograph 11 – H05-1335 (Drilled dry)

Photograph 12 – H05-1375 (Destroyed)

Photograph 13 – H05-2040 (Unused)

Photograph 14 and 15 – H05-2135 (Destroyed)