APPENDIX D5.2

GROUNDWATER ASSESSMENT OF ON-SITE SANITATION FOR THE PROPOSED ACORN CITY MIXED USE TOWNSHIP

GROUNDWATER ASSESSMENT OF ON-SITE SANITATION FOR THE PROPOSED ACORN CITY URBAN MIXED-USE DEVELOPMENT ON PORTION 27 OF THE FARM ARTHURSSEAT 214KU

GEOHYDROLOGICAL REPORT

VERSION 1

CLIENT: DZANA INVESTMENTS (PTY) LTD

DATE: 2 March 2022

PROJECT NUMBER: 22-IS-1047

PROVINCE: Mpumalanga

DISTRICT COUNCIL: Ehlanzeni

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EXECUTIVE SUMMARY

Following the appointment of In-Situ Consulting by Dzana Investments, dated the 17th of January 2022, to conduct a geohydrological risk assessment of the proposed on-stie sanitation for the planned Acorn City mixed-use township development a hydro-census was undertaken on the 25th and 26th of January 2022. The study area will be rezoned for the flowing land uses: Hotel, urban agriculture, business, educational, institutional, fuel filling station, transportation services, private/public open spaces (including sport and recreational uses).

This investigation is in accordance with the guidelines issued by DWAF and contained in "A Protocol to Manage the Potential of Groundwater Contamination from On-Site Sanitation; *Edition 2, March 2003*." The Groundwater Protocol falls under the overall provisions of three government Acts: National Water Act (Act 36 of 1998), the National Environmental Management Act (Act 107 of 1998) and the Environment Conservation Act (Act 73 of 1989).

It is recommended that the existing boreholes on site be rehabilitated, properly capped, and used for monitoring purposes (borehole BR-03008 could not be accessed during the site visit).

The main process of the proposed, submerged, non-invasive sewage and effluent system, EcoSat Bio – Catalytic Sewage Plant (BCSP), is a moveable bed of activated sludge that breaks down BOD (Biochemical Oxygen Demand) using air and naturally grown HydroPure Sewage bacteria. A detailed description of the plant is provided in the Sewage and Effluent Plant report prepared by EcoSat, dated the 27th of September 2021[13]. The proposed BCSP will be installed on a low-lying area of the development area, allowing the sewage and effluent to be gravity fed. The treated wastewater will be released into retention ponds and where possible re-used for irrigation purposes.

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^{+00}m/day to prevent pollution and more than 4.32E^{-01}m/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. From previous studies conducted on similar geology the permeability (k – in house) was calculated as 3.78E^{-04} or 3.3E^{-01} m/day, therefore classify as medium to low permeable soils which will be sufficient in retarding the spread of pollution. Site specific permeabilities was not provided in the geotechnical report.

Measures to reduce the risk of contamination via irrigation (according to the terms of Section 39 of the Nation Water Act 1998, Gazette No. 19182, Notice 1091 - 2013), as stipulated in section 4.5, must be adhered to.

Record-keeping and disclosure of the information must be upheld according to Section 39 of the Nation Water Act 1998, Gazette No. 19182, Notice 1091. The record on the volumes stored should be kept for 5 years to be available for the relevant authorities on request. The water user must ensure the establishment of a monitoring programmes to monitor the quantity and quality of the wastewater to be used for irrigation.

1) The quantity must be metered, and the total recorded monthly.
2) The quality of water irrigated must be monitored monthly, by taking a grab sample at the point where the wastewater enters the irrigation system and analysed for the applicable parameters as listed in Tables 9 to 11 (page 15).

The **overall risk** of contamination based on both risk components is assessed as **high to medium** (take precautionary measures), due to the high volume of wastewater flow, possible irrigation using treated wastewater and the depth to groundwater table. However, taking into consideration that the development will not make use of groundwater to meet its water demand (cognisance of external users), and the proposed treatment system to be implemented the risk is considered as **medium to low**.

It is recommended that mitigation measures include the following:

- A dedicated environmental monitoring program must be put in place (see section 5)
- The stormwater drainage infrastructure must be equipped with strategically placed filters and oil traps.
- Lining or compaction of the underlaying soil (if suitable) of retention pond.
- Management must be put in place for possible excess return flow generated from irrigation when using treated wastewater.
- If at any point excessive sludge build-up occurs, it must be removed and conveyed to a treatment or waste disposal facility, such as Hoedspruit's WWTP.

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1. INTRODUCTION

1.1 Background

Following the appointment of In-Situ Consulting by Dzana Investments, dated the 17th of January 2022, to conduct a geohydrological risk assessment of the proposed on-stie sanitation for the planned Acorn City mixed-use township development a hydro-census was conducted for on the 25th and 26th of January 2022.

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, private/public open spaces (including sport and recreational uses).

The investigation procedures comply with the Department of Water Affairs and Forestry's "*Protocol to manage the potential of groundwater contamination from On-Site Sanitation; Edition 2, March 2003.*" The Groundwater Protocol falls under the overall provisions of three government Acts: National Water Act (Act 36 of 1998), the National Environmental Management Act (Act 107 of 1998) and the Environment Conservation Act (Act 73 of 1989).

In terms of the National Water Act (Act no. 36 of 1998), the following sections are relevant to the application:

- Section 21(e): Engaging in a controlled activity, identified as such in section 37(1)(a): Irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterworks.
- Section 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, or other conduit.

The main process of the proposed, submerged, non-invasive sewage and effluent system, EcoSat Bio – Catalytic Sewage Plant (BCSP), is a moveable bed of activated sludge that breaks down BOD (Biochemical Oxygen Demand) using air and naturally grown HydroPure Sewage bacteria. A detailed description of the plant is provided in the Sewage and Effluent Plant report prepared by EcoSat, dated the 27th of September 2021[13]. The treated wastewater will be released into retention ponds, where possible re-used for irrigation purposes.

Apart from the on-site sanitation system, stormwater should be considered a risk (due to possible irrigation of treated wastewater and the planned fuel station), if not properly managed and treated. According to the Outline Scheme Report[15], *The Provision of Water, Sewar Reticulation, Roads and Storm Water Drainage*, compiled by L&S Consulting Structural and Civil Engineers in July 2021 the post-developed area will consist of approximately 80% hardstand. Internal stormwater runoff will be collected by means of catch pits, field inlets, grid inlets and kerb inlets that is to be installed as part of the internal roadways. The collected stormwater will be discharged into four bio-retention areas with retention ponds, as part of the proposed Sustainable Drainage System (SuDS). Following the current observed natural drainage pattern, water stored in the retention ponds will ultimately be discharged into the tributary watercourse of the Klein-Sandrivier.

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 the groundwater regime by:

- The planned BCSP (where possible, the treated wastewater will be re-used for irrigation if the discharge qualities comply to DWS standards).
- Runoff stormwater and retention ponds.

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.
- Assessment of contamination load.
- Compile an On-Site Sanitation Protocol 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, current status and equipment, depth to groundwater table (static water level), abstraction volumes, etc.
- Chemistry data analysis to establish background chemistry analysis of surface- and groundwater.
  - Wastewater analyses at 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, Mpumalanga 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 page 3).

The proposed BCSP will be installed on a low-lying area of the development area, allowing the sewage and effluent to be gravity fed, as indicated on the layout plan compiled by RAVEN Town Planners, attached as Appendix C.

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).

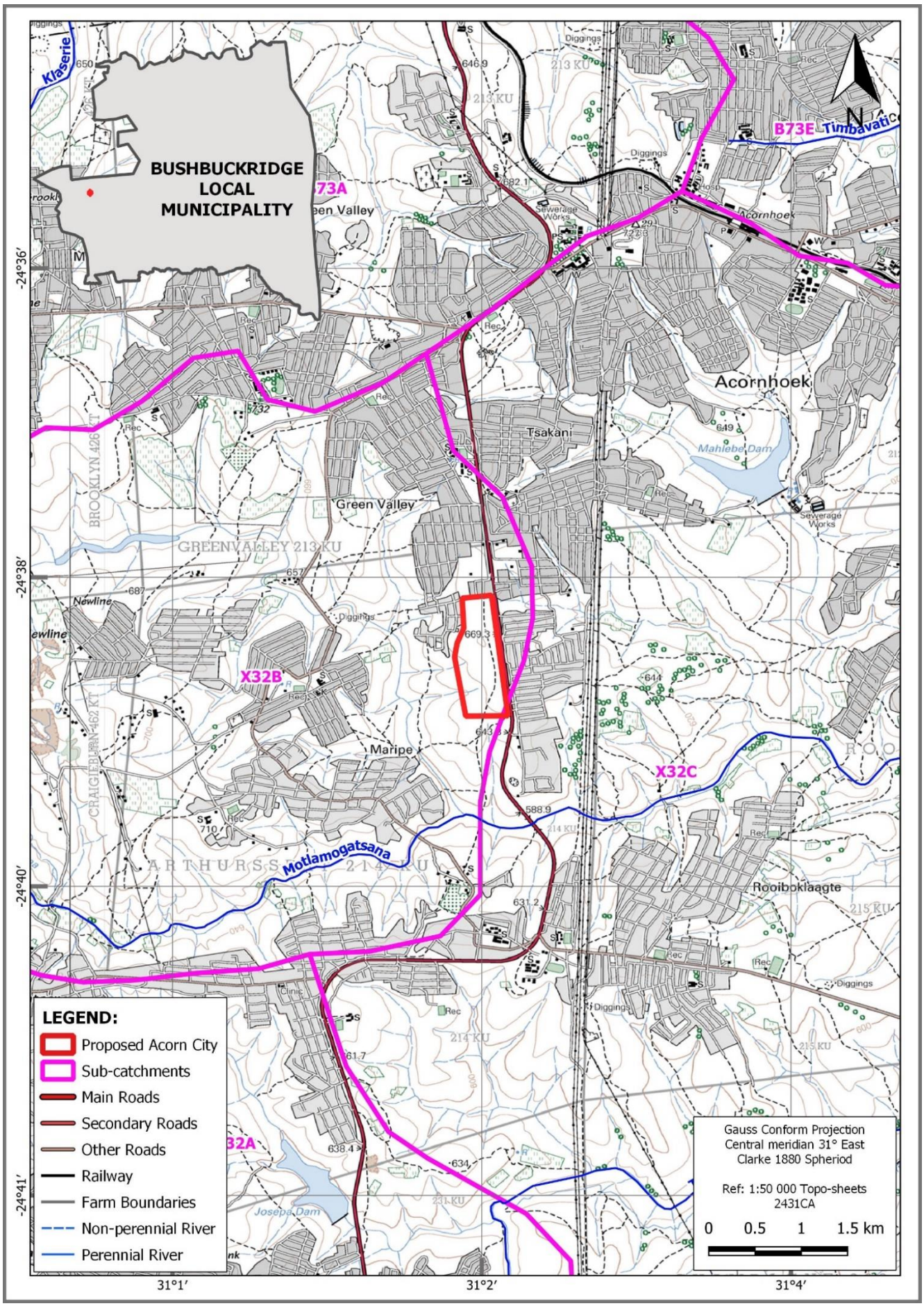

Figure 1. Regional Locality

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 mainly south-west and east towards tributaries of the Klein-Sandrivier/Motlamogatsana 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 (page2). 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, 2330 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 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, in terms 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)

2.4 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).

2.5 Local Geological Setting

A geotechnical investigation was conducted by DVH Consulting[14]. The soil conditions were described as follow: The site is divided into two geotechnical zones, namely Zone S and Zone C2, with no perched water table or zones of seepage in any of the test pits.

The soil profile for Zone S includes Transported Hillwash, overlaying localised Transported Pebble Marker, overlaying Reworked Residual Gneiss, overlaying competent Residual Gneiss. Zone C2 includes Transported Hillwash, overlaying localised Transported Pebble Marker, overlaying thick potentially collapsible Reworked Residual Gneiss, overlaying Residual Gneiss.

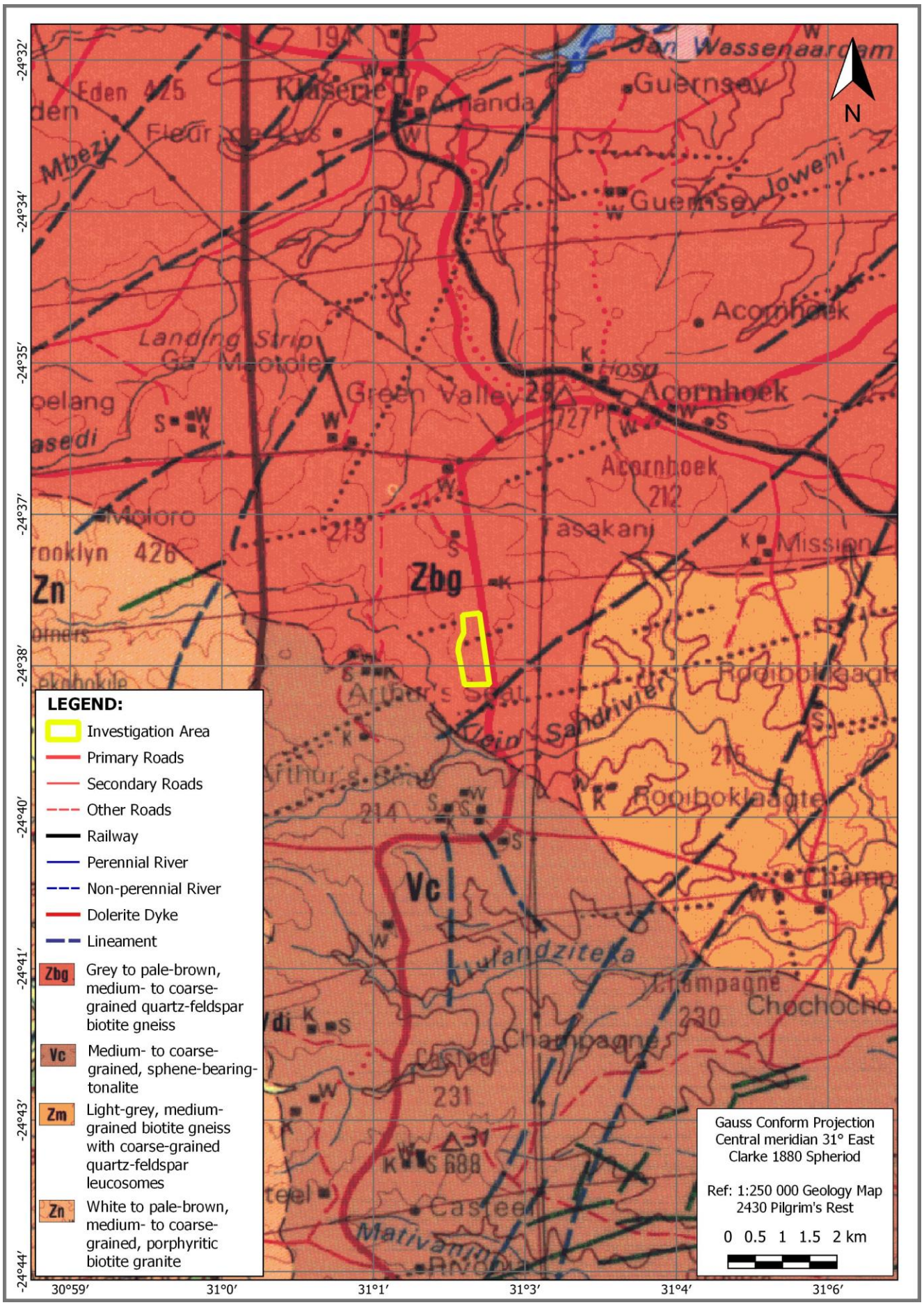

Figure 2. General Geology

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's existing borehole

(dyn) = dynamic water level

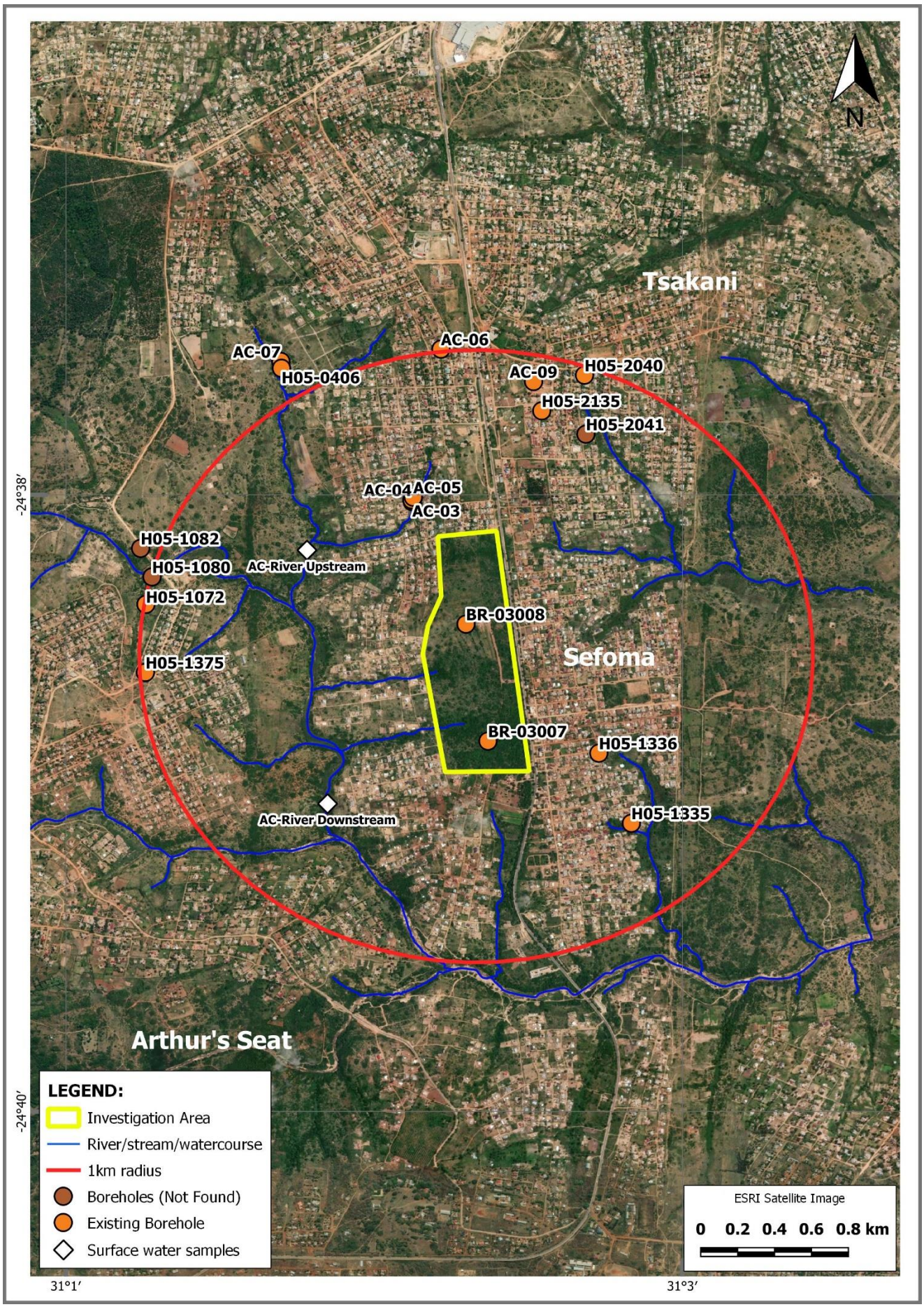

Figure 3. Hydro-census

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 7), 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.

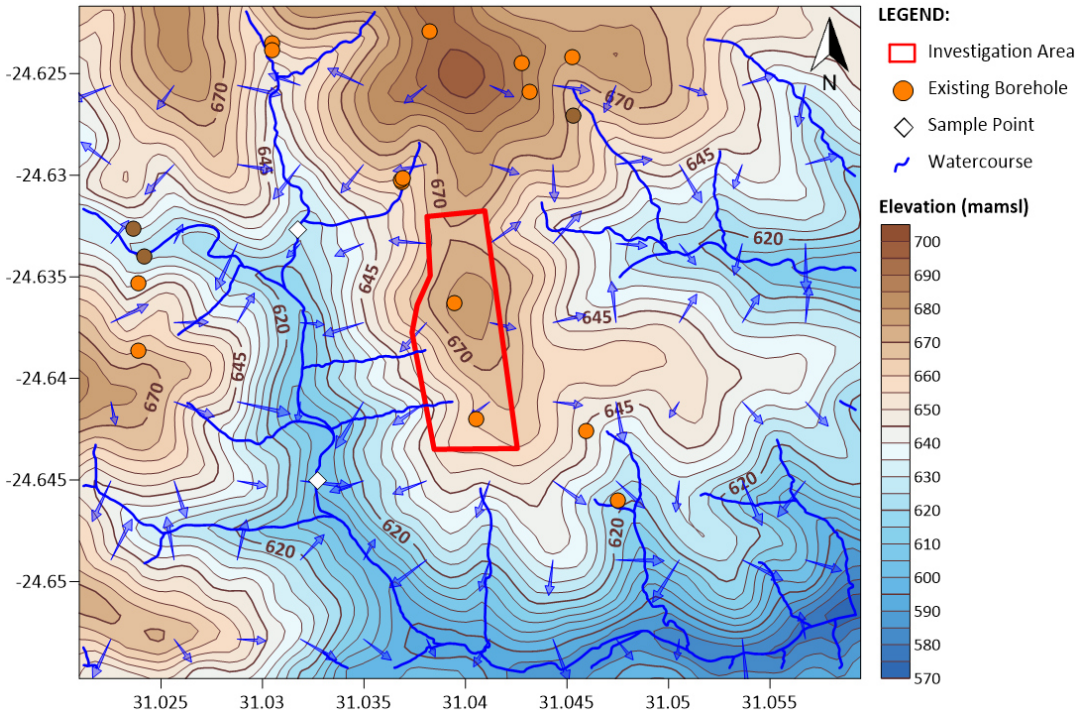

Figure 4a. General Surface Water Flow Direction (2D View)

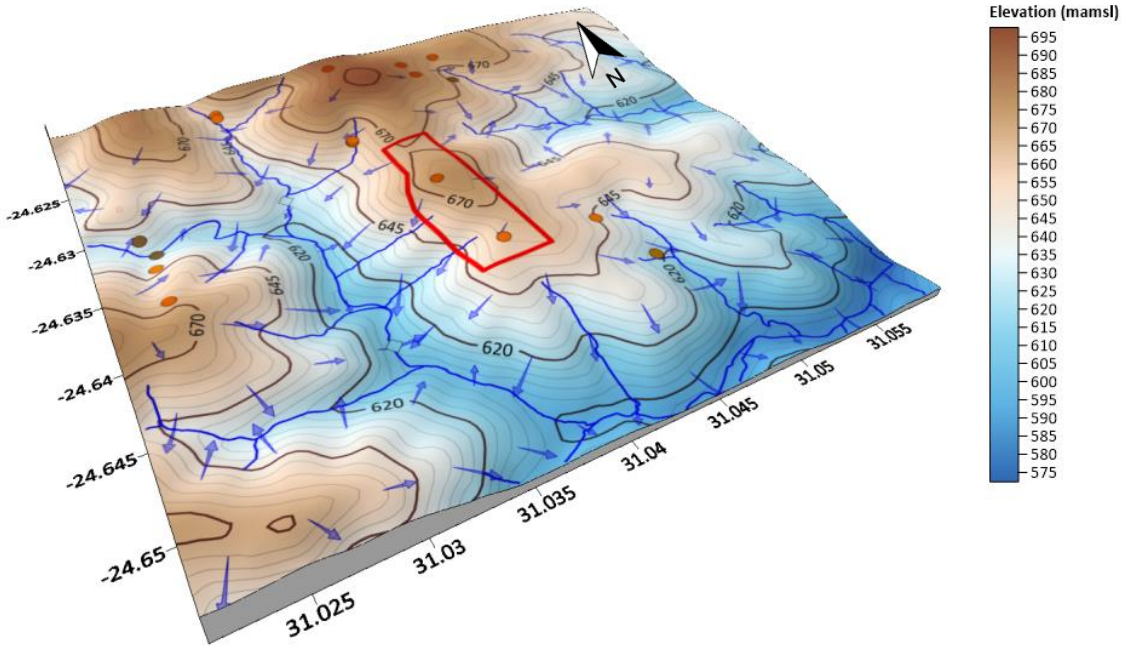

Figure 4b. General Surface Water Flow Direction (3D View)

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, purged, capped, and used for monitoring purposes (borehole BR-03008 could not be accessed). 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. The Benzene, Toluene, EthylBenzene, and Xylenes (BTEX) analysis are applicable to the risk assessment of the proposed fuel station and will therefore not be discussed in this report.

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 1) and a tri-linear Piper diagram (diagram 2).

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.

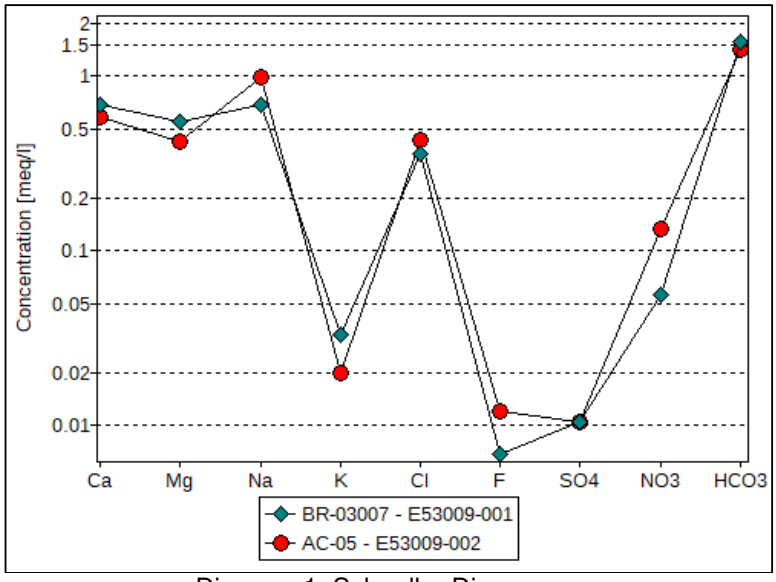

Diagram 1: Schoeller Diagram

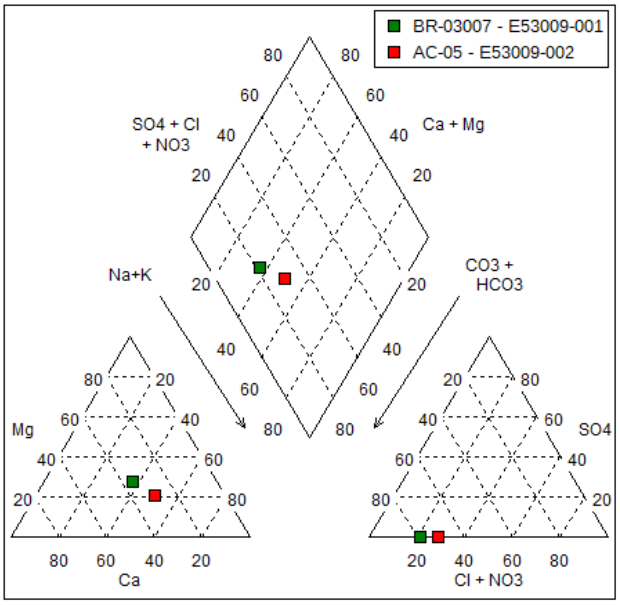

Diagram 2: Piper Diagram

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 chemistry results will be used as background chemistry of the area.

3.2.6 Irrigation Areas

As previously mentioned, the treated wastewater might be used for irrigation purposes if the water quality complies to the DWS standards. It is assumed that irrigation will take place on agricultural zones (22.2215ha) and private/public open spaces (including sport and recreational uses).

The quality of water irrigated must be monitored monthly, by taking a grab sample at the point where the wastewater enters the irrigation system (or retention ponds, if the retention pond water is to be used for irrigation) and analysed for the applicable parameters as listed in Tables 11 to 13 (page 15, next page).

Table 9: Wastewater limit values applicable to the irrigation of any land or property up to 2000 cubic meters

Variables	Limits
pH	Not less than 5.5 or more than 9.5pH units
Electrical Conductivity	Not exceed 70 milliSeimens above intake to a maximum of 150 milliSeimens per meter (mS/m)
Suspended Solids	Does not exceed 25mg/l
Chloride as Free Chlorine	Does not exceed 0.25mg/l
Fluoride	Does not exceed 1mg/l
Soap, Oil and Grease	Does not exceed 2.5mg/l
Chemical Oxygen Demand (COD)	Does not exceed 75mg/l
Faecal Coliforms	Do not exceed 1 000 per 100ml
Ammonia (ionised and un-ionised) as Nitrogen	Does not exceed 3mg/l
Nitrate/Nitrite as Nitrogen	Does not exceed 15mg/l
Ortho-Phosphate as phosphorous	Does not exceed 10mg/l

Table 10: Wastewater limit values applicable to the irrigation of any land or property up to 500 cubic meters

Variables	Limits
pH	Not less than 6 or more than 9pH units
Electrical Conductivity	Not exceed 200 milliSeimens per meter (mS/m)
Chemical Oxygen Demand (COD)	Does not exceed 400mg/l after removal of algae
Faecal Coliforms	Do not exceed 100 000 per 100ml
Sodium Adsorption Ration (SAR)	Does not exceed 5 for biodegradable industrial wastewater

Table 11: Wastewater limit values applicable to the irrigation of any land or property up to 50 cubic meters

Variables	Limits
pH	Not less than 6 or more than 9pH units
Electrical Conductivity	Not exceed 200 milliSeimens per meter (mS/m)
Chemical Oxygen Demand (COD)	Does not exceed 5000mg/l after removal of algae
Faecal Coliforms	Do not exceed 100 000 per 100ml
Sodium Adsorption Ration (SAR)	Does not exceed 5 for biodegradable industrial wastewater

The information depicted in tables 9 to 11 were obtained from Gazette No. 19182, Notice 1091, *"Revision of General Authorisation in terms of Section 39 of the Nation Water Act 1998 (Act No. 36 of 1998) (THE ACT)",* published under Government Notice 665 in Government Gazette 36820, dated 6 September 2013. This general authorisation replaces the need for a water user to apply for a licence in terms of the Act, **provided that the water use is within the limits and conditions** as set out in the above-mentioned document.

Wastewater irrigation, in terms of Section 39 of the Nation Water Act 1998, is only permitted if the irrigation takes place:

a) at least 50m above the 1 in 100-year flood line or riparian habitat whichever is the greatest, or at least further than 500m radius from a borehole that is utilised for drinking or stock watering.
b) on land that is not, or does not, overlie a major aquifer.
c) at least outside 500m radius from the boundary of a wetland.

The wastewater quality must comply with DWS standards for "discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other outlet"; according to Section 21 (f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, or other conduit (Authorisation required). By increasing the irrigation areas, the contamination load will disperse over a larger area, thus minimising the impact to the environment.

3.3 Geotechnical Assessment

The findings of the geotechnical assessment were briefly discussed in section 2.5, local geology. As previously mentioned, the geotechnical investigation was conducted by DVH Consulting[14]. The site is divided into two geotechnical zones, namely Zone S and Zone C2, with no perched water table or zones of seepage in any of the test pits.

The soil profile of Zone S - comprises:

a medium dense, intact, silty sand of TRANSPORTED HILLWASH, depths varying between 0.2 to 0.8m

overlying,

a medium dense, intact, silty sand, with scattered to abundant quartz gravel (TRANSPORTED PEBBLE MARKER), depths varying between 0.3 to 0.9 m (this layer was not identified in test pits TP21, TP25, TP29, TP30 and TP32)

overlying,

a localised medium dense/medium dense to dense, locally loose weakly ferruginous silty sand varying to micaceous, slightly silty, clayey sand of REWORKED RESIDUAL GNEISS, depths varying between 0.7m to 2.2m.

overlying,

a medium dense/medium dense to dense, jointed silty sand/micaceous silty sand RESIDUAL GNEISS, at a depth of 3m (excavation limit)

The soil profile of Zone C2 - comprises:

a medium dense, locally firm, intact, silty sand/slightly silty clayey sand of TRANSPORTED HILLWASH, depths varying between 0.3 to 1.7m

overlying,

a localised medium dense TRANSPORTED PEBBLE MARKER, depths varying between 0.4 to 1.9 m (this layer was only identified in test pits TP3, TP4, TP12 to TP16, TP18, TP19 and TP23)

overlying,

a 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, locally it extends up to depths in excess of 3m (TP3, TP17, TP19 and TP22).

overlying,

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

except for,

TP8, where refusal was reached at 1.3m upon an apparent GNEISS CORESTONE/BOULDER.

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. From previous studies conducted on similar geology the permeability (k – in house) was calculated as $3.78E^{-04}$ or $3.3E^{-01}$ m/day, therefore classify as medium to low permeable soils which will be sufficient in retarding the spread of pollution. Site specific permeabilities was not provided in the geotechnical report.

4. RISK ASSESSMENT

The proposed Acorn City Development will not be reliant on groundwater to meet its water demand; bulk municipal water (pre-treated) will be provided, by the Bushbuckridge Local Municipality, to the proposed township for potable use to all proposed land use facilities and services. A new water main will be installed from the existing Tsakani Bulk water main that is linked to a reservoir adjacent to the Green Valley Primary School.

The local borehole density classifies as high; however, due to dysfunctionality only three (3) of the eighteen (18) listed boreholes are currently in use and therefore borehole density classifies as low. The surrounding area encompasses high density rural settlement and small-scale farming. The average depth to the water table (Section 3.1.1) across the study area is 16.40mbgl.

Table 12: Potential risk to groundwater sources currently in use

Borehole Description	Borehole Number	Pollution Source(s) other than the Proposed Development	Risk Level	Comment
Community water supply	AC-05	High density rural settlement and pit latrines.	Low	Located 240m north, north-west of the proposed development.
Privately owned	AC-06	High density rural settlement and pit latrines.	Low	Water level could not be obtained. Located 1km north of the proposed development.
School water supply	AC-09	High density rural settlement and pit latrines.	Low	Water level could not be obtained. Located 820m north, north-east of the proposed development.

The proposed BCSP wastewater treatment system and lined stormwater retention ponds pose a low risk (if well maintained) to the existing groundwater users. The borehole located closest to the development is AC-05; situated approximately 240m downstream from the proposed development. A groundwater sample was collected from this borehole for background quality. It is recommended that borehole AC-05 form part of the environmental monitoring program to ensure that its water quality remains unchanged.

Table 13: Estimated Flow Rates of the Proposed Development

Erf Size	Infrastructure	Peak Flow (PF)	Daily Flow (DF)
49.403ha	Sewer Reticulation	25.67L/s	589.44kl/day
	Water Reticulation	27.12L/s	595.18kl/day

The estimated flow values listed in table 13 were obtained from the Outline Scheme Report[15], *The Provision of Water, Sewar Reticulation, Roads and Storm Water Drainage*, compiled by L&S Consulting Structural and Civil Engineers in February 2022.

The Department of Water Affairs and Forestry's "PROTOCOL TO MANAGE THE POTENTIAL OF GROUNDWATER CONTAMINATION FROM ON SITE SANITATION, National Sanitation Co-ordination Office, Directorate of Geohydrology, Edition 2, 2003" was used to evaluate the risk of groundwater contamination from on- site sanitation. The following assessment tables were used as part of the evaluation (see tables attached in Appendix D):

- Table 1: Assessment of the reduction of contaminants in the unsaturated zone
- Table 2: Assessment of the flow rate into the soil from different sanitation options
- Table 3: Assessment of contaminant load from other sources

4.1 Assessment of the vulnerability of the underground water resources

The vulnerability of the underground water source is related to the distance that the contaminant must flow to reach the water table, and the ease with which it can flow through the soil and rock layers above the water table. Five broad classes of aquifer vulnerability are defined (Table 14).

Table 14: Underground Water Resources Vulnerability Class.

Vulnerability Class	Measurements	Definition
Extreme (usually highly fractured rock and/or high ground water table)	High risk (table 1) and short distance (< 2m) to water table	Vulnerable to most pollutants with relatively rapid impact from most contamination disposed of at or close to the surface
High (usually gravely or fractured rock, and/or high-water table)	High risk (table 1) and medium distance (2-5m) to water table	Vulnerable to many pollutants except those highly absorbed, filtered and/or readily transformed
Medium (usually fine sand, deep loam soils with semi-solid rock and average water table (>10m)	Low risk (table 1) and medium to long distances to water table	Vulnerable to inorganic pollutants but with negligible risk of organic or microbiological contaminants
Low (usually clay or loam soils with semi-solid rock and deep-water table (>20m)	Minimal and low risk (table 1), and long to very long distance to water table	Only vulnerable to the most persistent pollutants in the very long term
Negligible (usually dense clay and/or solid impervious rock with deep water table)	Minimal risk (table 1) with confining layers	Confining beds present with no significant infiltration from surface areas above aquifer

Based on the entire foregoing the proposed developments **"Underground Water Resources Vulnerability Class"** is classified as **medium to low**.

4.2 Assessment of the contamination load from the onsite sanitation system and other sources

The waste disposal load depends on the density of systems per hectare and the number of people utilising each facility. Muller (1989) defined population densities as follows:

50 houses/ha	:	Low
50 - 150 houses/ha	:	Medium
150 - 300 houses/ha	:	High
> 300 houses/ha	:	Very high

The population density of the proposed development is unknown as this project is still in a planning phase, a potential high residential density should be taken into consideration. According to the sewage and effluent plant report prepared by EcoSat, dated the 27th of September 2021[13] the proposed plant can process up to 600kl/day. As previously mentioned, the proposed Acorn City Development will not be reliant on groundwater to meet its water

demand. Local borehole density is low due to dysfunctionality, the surrounding areas encompasses high density rural settlements, and small-scale farming.

According to **Table 1** (the assessment of the reduction of contaminants in the unsaturated zone in relation to the condition/composition of the unsaturated zone, DWS 2003) for weathered or fractured granites (similar unsaturated zone conditions as gneiss) will act as a fair barrier to the movement of biological contaminants, but little reduction in chemical contaminants is anticipated. The flow rate in the unsaturated zone is expected to be slow to medium (0.01-10m/d) and the capacity to absorb media is minimal to medium. The capacity to create an effective barrier to contaminants is generally minimal to low. Taking into the beforementioned into consideration a **medium to low risk** is assigned to the unsaturated zone.

Table 2 (assessment of the flow rate into the soil from different sanitation options, DWS 2003) indicates a **high contamination risk** for the proposed sanitation system. Due to the expected volume of sewage to be treated; if there is leakage or treated wastewater, that is not compliant with DWS standards, is released into the planned retention ponds and the retention ponds overflow, the risk will be **high**. The normal flush latrine with on-site disposal were used for this assessment as it is most similar to the current sanitation setup listed in the table. Note, that if the on-site system is well maintained the risk will be **minimal.**

Table 3 attached in Appendix D indicate the hydraulic load associated with various contamination sources, within a one-kilometre radius of the development. **On-site grey water disposal** might occur to a limited degree on neighbouring properties, the typical hydraulic load range between 0 - 10 mm/d with street taps and 5 – 20 mm/d with yard connections while the typical time to travel 1m (shorter times in fractured rock) is indicated as >50 days. Factors affecting contaminant loading such as the number of people or units can be incorporated by adding 1mm/day for every additional 5 persons above 10. The **risk is minimal for on-site grey water disposal**.

Twenty-one (21) burial sites with thirty-one (31) graves, older than 50 years, were identified within the investigation area. The possibility of a small on-site cemetery was considered to accommodate the relocation of the thirty-one (31) graves. The assessment according to table 3 is negligible. Cemeteries poses a **negligible threat** to groundwater due to the very slow rate of decay and the rapid die-off of bacteria and viruses.

Based on all the foregoing, the contamination load from the particular sanitation system and possible future high density residential activities is assessed to be a **minimal to high risk (flow rates)** of contamination. If the proposed BCSP wastewater treatment system is well maintained, the risk will be **medium to minimal.**

Regarding irrigation with treated wastewater, even though the recorded evaporation outweighs the rainfall as indicated in section 2.1.2, return flow may be generated. If return flow is generated management must be put in place for the excess water to be redirected to the retention ponds.

4.3 Overall Risk

Table 15, provides an overall assessment of the risk based on the aquifer vulnerability (**negligible to extreme**) and the contamination load from the sanitation system and the other contamination sources (**minimal to high** risk of contamination).

Table 15: Overall risk of contamination of the groundwater.

Aquifer Vulnerability	Contaminant load risk		
	high	**medium**	**minimal**
Extreme	very high (obtain alternative water source or ensure treatment)	high (implement remedial measures)	high (implement remedial measures)
High	high (implement remedial measures)	high (implement remedial measures)	medium (take precautionary measures)
Medium	high (implement remedial measures)	medium (take precautionary measures)	low (no action required)
Low	medium (take precautionary measures)	low (no action required)	minimal (no action required)
Negligible	low (no action required)	minimal (no action required)	minimal (no action required)

The **overall risk** of contamination based on both risk components is assessed as **high to medium** (take precautionary measures), due to the high volume of wastewater flow, possible irrigation using treated wastewater and the depth to groundwater table. However, taking into consideration that the development will not make use of groundwater to meet its water demand (cognisance of external users), and the proposed treatment system to be implemented the risk is considered as **medium to low**.

4.4 Strategic Classification of the Groundwater

The strategic value of the groundwater is a function of the potential yield of the aquifer, the present or probable future use of the groundwater, and the existence of alternative water sources. Table 16 provides a simplified classification of the strategic value and the impacts of a sanitation system based on the strategic use of the groundwater. The potential yield at the point of abstraction (AC-05, currently in use for community water supply) is between 0.1 - 1Ml/d (important aquifer to local communities); and in terms of Table 18, the relevance of threat of contamination from bacteria and viruses is indicated as a high risk (often inadequate treatment), while nitrate contamination is indicated as medium risk (no treatment) and chloride is indicated as minimal risk.

Table 16: Water Resources Vulnerability Class.

Strategic value			Relevance of threat of contaminants		
Groundwater Use (present or future)	**Potential Yield**	**Comment**	**Bacteria and viruses**	**Nitrates**	**Chlorides**
Domestic use (drinking water)	> 1 Mℓ/d	very important aquifer, should be protected even in remote areas	Medium risk but can be treated	High risk – cannot be easily treated	Minimal risk
	0.1 – 1 Mℓ/d	important aquifer to local communities	High risk – often inadequate treatment	Medium risk – no treatment	Minimal risk
	< 0.1 Mℓ/d	could be important to single community	High risk – often no treatment	Medium risk – no treatment	Minimal risk
Agricultural use (animal drinking water)	> 1 Mℓ/d	very important aquifer, but sanitation contaminants unlikely to pose a threat	Low risk	Minimal risk	Minimal risk
	0.1 – 1 Mℓ/d	important aquifer to local communities	Low risk	Minimal risk	Minimal risk
	< 0.1 Mℓ/d	could be important to single community	Low risk	Minimal risk	Minimal risk

Strategic value			Relevance of threat of contaminants		
Groundwater Use (present or future)	**Potential Yield**	**Comment**	**Bacteria and viruses**	**Nitrates**	**Chlorides**
Agricultural (irrigation) or industrial use	> 1 Mℓ/d	very important aquifer, but sanitation contaminants unlikely to pose a threat	Low risk	Minimal risk	Low risk to some crops
	0.1 – 1 Mℓ/d	important aquifer to local communities	Low risk	Minimal risk	Low risk to some crops
	< 0.1 Mℓ/d	could be important to single community	Low risk	Minimal risk	Low risk to some crops

4.5 Recommendations and Assessment of Measures to Reduce the Risks

Available bacteriological and chemical results from boreholes BR-03007 (AC-01), indicates elevated Faecal Coliforms (cfu/100ml) and e.Coli (cfu/100ml) is an indication of possible pollution, it does however fall below the sewage limit. As previously discussed, the elevated bacteriological activities could be as a result of the borehole not been properly capped. Prevention is best practice when dealing with possible contaminants.

Measures to reduce the risk of contamination from the on-site sanitation systems and treated wastewater to be released in retention ponds or used for irrigation, are already in the planning phase, in the form of the proposed EcoSat Bio – Catalytic Sewage Plant (BCSP) and Sustainable Drainage System (SuDS). Mitigation actions that include design, management and maintenance of sewage treatment plant's details will be provided by EcoSat and included in the EIA.

Measures to reduce the risk of contamination via irrigation are as follows (according to the terms of Section 39 of the Nation Water Act 1998, Gazette No. 19182, Notice 1091 - 2013):

1) The water user must follow acceptable construction, maintenance, and operational practices to ensure the consistent, effective, and safe performance of the wastewater irrigation system, including the prevention of –
   (a) Waterlogging of the soil and pooling of wastewater on the surface of the soil.
   (b) Nuisance conditions such as flies or mosquitoes, odour, or secondary pollution.
   (c) Waste, wastewater, or contaminated stormwater entering into the water resources.
   (d) The contamination of run-off water or stormwater.
   (e) The unreasonable chemical or physical deterioration of, or any other damage to, the soil of the irrigation site.
   (f) The unauthorised use of the wastewater by members of the public; and
   (g) People being exposed to the mist originating from the irrigation of the wastewater.
2) Suspended solids must be removed from any wastewater, and the resulting sludge disposed of according to the requirements of any relevant law or regulation, including the document Guidelines for the Utilisation and Disposal of Wastewater Sludge, Volume 1-5, Water Research Commission Reports TT 261/06, 262/06, 349/09, 350/09, 351/09, as amended from time to time (obtainable from the responsible authority upon written request.)
3) All reasonable measures must be taken to provide for mechanical, electrical, operational, or process failures and malfunctions of the wastewater irrigation system.
4) All reasonable measures must be taken for storage of the wastewater used for irrigation when irrigation cannot be undertaken, of which the storage must be in accordance with the general authorisation in section 3 of this Notice.
5) All reasonable measures must be taken to collect contaminated stormwater or runoff emanating from the area under irrigation and to retain it for disposal of which the disposal must be in accordance with general authorisation in section 3 of this Notice.
6) Upon the written request of the responsible authority the registered user must ensure the implementation of any additional construction, maintenance and operational practices that may be require in the opinion of the responsible authority to ensure the consistent, effective, safe, and sustainable performance of the wastewater irrigation system

Record-keeping and disclosure of the information must be upheld according to Section 39 of the Nation Water Act 1998, Gazette No. 19182, Notice 1091. The record on the volumes stored should be kept for 5 years to be available for the relevant authorities on request. The water user must ensure the establishment of a monitoring programmes to monitor the quantity and quality of the wastewater to be used for irrigation.

1) The quantity must be metered, and the total recorded monthly.
2) The quality of water irrigated must be monitored monthly, by taking a grab sample at the point where the wastewater enters the irrigation system and analysed for the applicable parameters as listed in Tables 9 to 11 (page 15).

If at any point there is excessive sludge build-up, it must be removed and conveyed to a treatment or waste disposal facility, such as the Hoedspruit's WWTP. The stormwater drainage infrastructure must be equipped with strategically placed filters and oil traps that is maintained on a regular basis.

5. ENVIRONMENTAL MONITORING SYSTEM

Formal or procedural aspects of sampling are strictly controlled in terms of current legislation. This includes not only authorisation, permit, license, and exemption conditions but also encompasses certain statutory provisions. These parameters have been integrated into the proposed monitoring protocol set out below in support of the proposed groundwater resource protection objectives.

Table 17: Proposed Monitoring Points for the planned AcornCity Development

Monitoring System	Monitoring Point	Sampling Horizon (mbc)	Description
Groundwater	BR-03007	Purge and Pump	Observation Borehole
	BR-03008	Purge and Pump	Observation Borehole
	AC-05	Pump	Community Water Supply
Surface water	AC-River Upstream	Below surface	Klein-Sandrivier upstream
	AC-River Downstream	Below surface	Klein-Sandrivier downstream
Treated Wastewater	To be confirmed	Grab Sample	Treated wastewater

Table 18: Proposed Monitoring Schedule for the planned AcornCity Development

Monitoring System	Monitoring Point	Weekly	Monthly	Quarterly	Annually
Groundwater	BR-03007 BR-03008			[*] Table 19	[*] Table 20
	AC-06				[*] Table 20
Surface water	AC-River Upstream AC-River Downstream			Table 19	Table 20
Treated Wastewater	at the point where the wastewater enters the irrigation system		[#] Tables 9 to 11	[#] Tables 9 to 11	[#] Table 20

[*] = Monitor water level
[#] = Monitor metered intake & discharge volume

Table 19: Proposed Lists of Variables for Analyses

PARAMETER ANALYSIS LIST
pH, EC, TSS, SO_4, NO_3, NH_4, PO_4,
Faecal Coliforms and E. coli (per 100 ml)

Table 20: Proposed Lists of Variables for Analyses (Comprehensive)

COMPREHENSIVE PARAMETER ANALYSIS LIST
pH, EC, TDS, TSS, Ca, Mg, Na, K, Si, T.Alk, Cl, SO_4, F, NO_3, NH_4, PO_4,
Chemical Oxygen Demand (COD),
Faecal Coliforms and E. coli (per 100 ml),
ICP metals scan,
Herbicide & Pesticide scan

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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 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

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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

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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: **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.
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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.**

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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.

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YANKA LABORATORIES

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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.*
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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, please see http://www.yanka.co.za/TestsAndStandards.htm . For ranges, uncertainties, etc., please contact us.**

YANKA LABORATORIES

MICROBIOLOGY TEST RESULTS

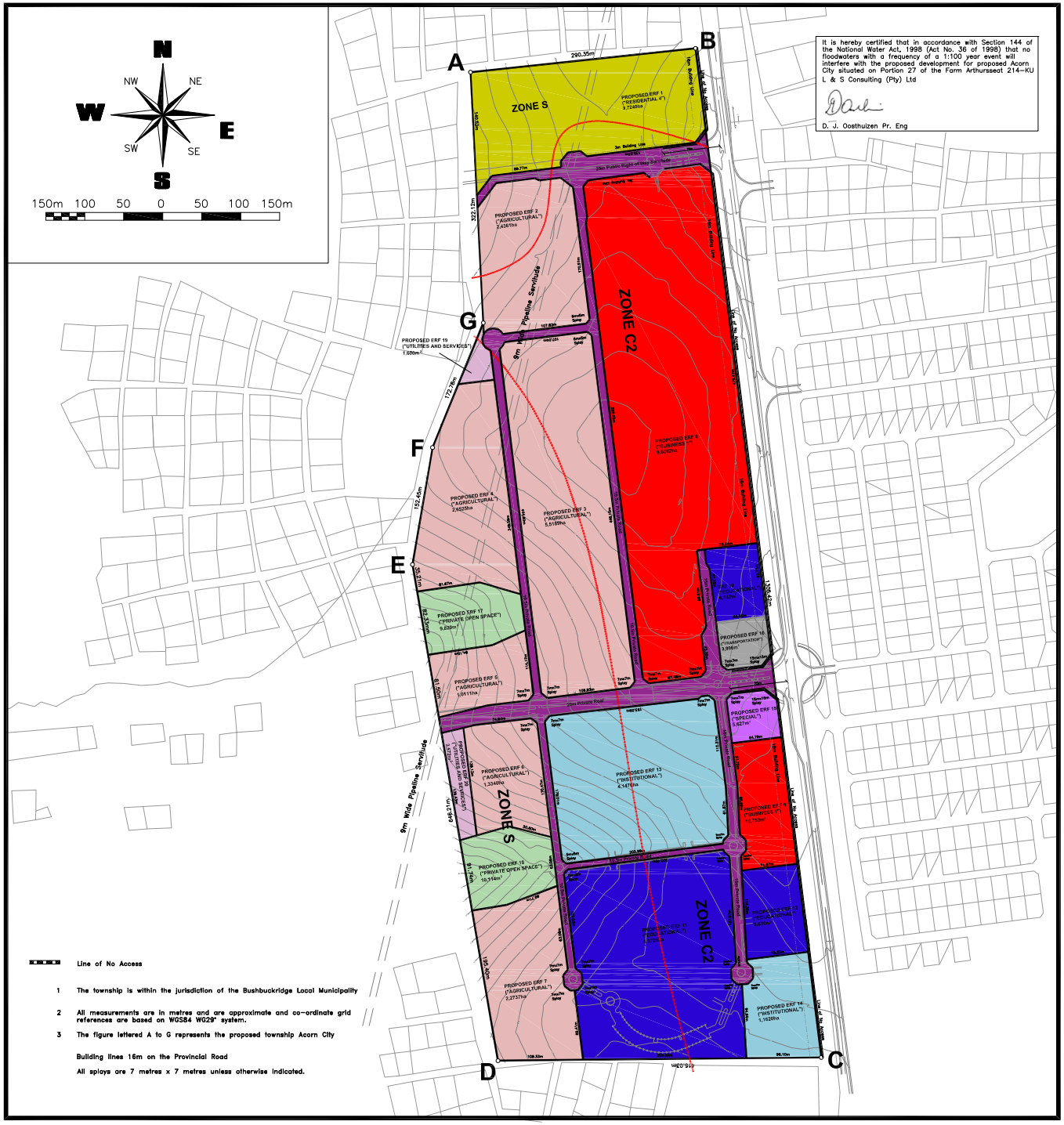
LABORATORY NUMBER			SpInSitu 1	SpInSitu 2	STANDARD LIMIT SANS 241:2015	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance 4% of	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance of 1% of	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION			AC - 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.*

APPENDIX C

LAYOUT PLAN – RAVEN TOWN PLANNERS



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.

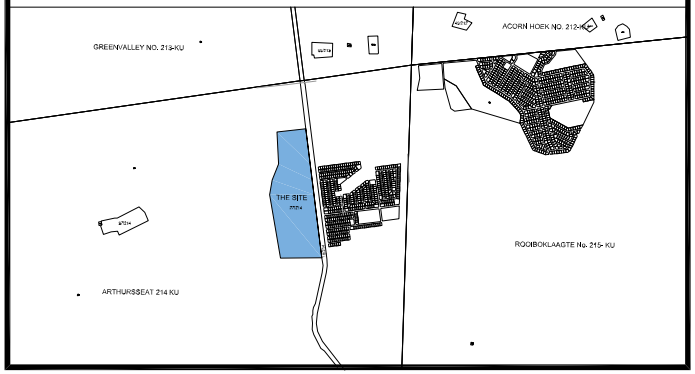
LAYOUT PLAN OF PROPOSED TOWNSHIP

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
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SAXONWOLD
2132

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

PLAN: RR2162-5 Updated February 2022

APPENDIX D

TABLES 1 TO 3 – RISK ASSESSMENT

- ***TABLE 1:*** *ASSESSMENT OF THE REDUCTION OF CONTAMINANTS IN THE UNSATURATED ZONE*
- ***TABLE 2:*** *ASSESSMENT OF THE FLOW RATE INTO THE SOIL FROM DIFFERENT SANITATION OPTIONS*
- ***TABLE 3:*** *ASSESSMENT OF CONTAMINANT LOAD FROM OTHER SOURCES*

TABLE 1 : ASSESSMENT OF THE REDUCTION OF CONTAMINANTS IN THE UNSATURATED ZONE

Unsaturated zone conditions	Factor affecting reduction			Contaminant reduction			Comments
	Rate of flow in unsaturated zone	Capacity of the media to absorb contaminants	Capacity to create an effective barrier to contaminants	bacteria and viruses	nitrates and phosphates	chlorides	
clay	very slow <10mm/d	high	high	very high reduction	high reduction	high reduction	Very good barrier to the movement of contaminants. May have problems with water retention in pit.
massive shales	very slow <10mm/d	high	high	very high reduction	high reduction	high reduction	Very good barrier to the movement of contaminants. May have problems with water retention in pit.
solid granites	very slow <10mm/d	minimal	high	high reduction	high reduction	high reduction	Good barrier to the movement of contaminants. Horizontal flow may be more relevant than vertical flow.
silt	slow 10-100mm/d	medium	high	high reduction	some reduction	minimal reduction	Good barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
sandy loam	slow 10-100mm/d	medium	high	high reduction	some reduction	minimal reduction n	Good barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
bedded shales	slow 10-100mm/d	high	high	very high reduction	some reduction	minimal reduction	Good barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
weathered or fractured granites	slow to medium 0.01-10m/d	minimal to medium	minimal to low	high reduction	minimal reduction	minimal reduction	Fair barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
fractured or weathered sandstones	medium 0.1-10m/d	medium	medium	high reduction	minimal reduction	minimal reduction	Fair barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
cavernous limestones/ calcretes	medium 1-100m/d	medium	medium	high reduction	some reduction	minimal reduction	Good barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
fine sand	medium 0.1-10m/d	minimal	high	high reduction	minimal reduction	minimal reduction	Good barrier to the movement of biological contaminants, but little reduction in chemical contaminants.
coarse sand and gravels	fast 10-1000m/d	minimal	low	some reduction	minimal reduction	minimal reduction	Poor barrier to the movement of contaminants.

Note: light shading = minimal risk of contamination medium shading = low risk of contamination dark shading = higher risk of contamination

TABLE 2 : ASSESSMENT OF THE FLOW RATE INTO THE SOIL FROM DIFFERENT SANITATION OPTIONS

Type of sanitation system	Typical hydraulic output	Typical time[2,3] to travel 1m	Factor affecting flow rate			Impact of contaminants on normal flow through unsaturated and saturated zones			Comments
			No of people using latrine	Density of settlement	Age of sanitation system	flow rate	filtration and adsorption	dilution in saturated zone	
Eco-San systems (i.e. separation, drying or composing)	0 – 1 mm/d (min. risk)	>100 d	no effect	no effect	minimal effect	no impact	no impact	no impact	The choice of Eco-San sanitation systems will not result in any measurable contamination of the groundwater except if the pit or collection chamber is submerged
VIP, SanPlat and normal pit latrines	10 – 30 mm/d (min. risk)	30 days	minimal effect	minimal effect	minimal effect	no impact	high organic load may block pores	no impact	The choice of dry pit latrine sanitation systems will not result in significant flows in the unsaturated zone except if the pit becomes submerged.
low-flush or pour flush on-site latrines	20 – 80 mm/d (low risk)	12 days	add 0.1 mm/d for every additional person above 5	drainage may be inadequate in high density areas	minimal impact	poorly drained zones may not cope with load	may be reduction in filtration and/or adsorption capacity with time	lower dilution in high density areas	The choice of low flush type sanitation systems should not result in problems except in poorly drained soils and when submerged.
normal flush latrines with on-site disposal and in-house plumbing	80 – 250 mm/d (high risk)	5 days	add 5 mm/d for every additional person above 5	drainage may be inadequate in high density areas	minimal impact	poorly drained zones may not cope with load	likely to be reduction in filtration or adsorption capacity with time	lower dilution in high density areas	The choice of full flush type sanitation systems with on-site disposal including grey water could result in problems especially in poorly drained soils and high density areas. Horizontal flow is likely to be a significant flow path.
normal flush latrines with in-house plumbing and off-site disposal	0 mm/d on-site, (new system well maintained) (min. risk)	> 1,000 d	possibility of more frequent pipe blockages	possibility of more frequent pipe blockages	Older systems generally have significant point losses in reticulation system due to pipe damage	poorly drained zones may not cope with load at pipe leak zones or manhole overflows	likely to be reduction in filtration or adsorption capacity at pipe leak zones or manhole overflows	minimal dilution in zones close to pipe leaks and manhole overflows	The choice of full flush type sanitation systems with off-site disposal including grey water could result in significant problems due to pipe damage and major leakage of untreated sewage into the ground or surface water systems, especially with low maintenance and when reticulation system is older than 10 years.
	up to 500mm/d at pipe leaks or overflowing manholes (v. high risk)	< 2 days							

Note 1: light shading = minimal risk of contamination medium shading = low risk of contamination dark shading = high risk of contamination

Note 2: Typical time to travel 1m assumes that the permeability of the soil or rock media is greater than the load. Where this is not the case, the travel time should be reduced based on the actual permeability rate.

Note 3: Shorter flow times and hence higher risk will occur in highly porous gravels and fractured rock.

TABLE 3 : ASSESSMENT OF CONTAMINANT LOAD FROM OTHER SOURCES

Contamination source	Typical hydraulic load	Typical time to travel 1m (shorter times in fractured rock)	Factor affecting contaminant loading			Impact on normal flow through unsaturated and saturated zones			Comments
			Number of people or units	Density of settlement	Age of facility	flow rate	filtration & adsorptn	dilution in saturated zone	
Solid waste dumpsites, including household waste pits.	0 – 1 mm/d in dry season up to 100mm/d in wet season	> 100 days 10 days	some effect – increased load during wet season	some effect – increased load during wet season	some effect – increased load with age	high organic load may partially block pores	higher adsorption in surface zone	Dilution may be reduced in high density areas	The organic component of solid waste will often contain harmful bacteria and viruses, and not be subjected to an adequate degradation before entering the soil profile through leaching.
On-site grey water disposal systems	0 - 10 mm/d with street taps, 5 – 20 mm/d with yard connections	> 50 days	add 1 mm/d for every additional 5 persons above 10	a high density of households could result in a significant hydraulic load	minimal effect	poorly drained soils will result in more surface run-off	higher adsorption in surface zone	Dilution may be reduced in high density areas	The disposal of grey water on-site may be through a soak pit or simply by surface disposal in the garden. Seepage into the groundwater will usually be far more than from dry sanitation systems.
Cattle kraals or feedlots where cattle and other livestock are kept within confined spaces.	1 – 10 mm/d in dry season up to 100 mm/d in wet season	> 100 days 10 days	add 1 mm/d for every additional 20 cattle above 50	a high density of cattle kraals could result in significant contamination during the wet season	older cattle kraals will result in higher loads	high organic load may block pores	higher adsorption in surface zone	Dilution may be reduced in high density areas or with large feedlots esp. during the wet season	The choice of low flush type sanitation systems should not result in problems except in poorly drained soils and when submerged.
Cattle dip tanks. Some surface runoff when in use, or significant if being emptied.	0.1 – 10 mm/d as point source at site periodically	100 days	add 1 mm/d for every additional 100 animals above 500	no effect	old tanks may leak resulting in point source pollution	poorly drained soils will result in more surface run-off	minimal impact	minimal impact	Cattle dip tanks are usually used seasonally and periodically, but could result in point loads. Soils with a high adsorption capacity will usually minimise the transmission of organic poisons.
Graveyards	0 – 0.1 mm/d	> 1,000 days	negligible	negligible	negligible	negligible	negligible	negligible	Cemeteries pose a negligible threat to groundwater due to the very slow rate of decay and the rapid die-off of bacteria and viruses.
Small industries, especially motor vehicle repairs, food stalls and shops, and small manufacturing .	0 – 20 mm/d on-site	> 50 days reduce for high water users	add 0.1 mm/d for every 20 customers/d above 20,	no effect	no effect	high organic load may block pores	higher adsorption in surface zone	Dilution may be reduced in high use areas	Small industries and commercial centres can generate significant wastes, which may rely on the on-site disposal in shallow pits. The type of waste is dependent on the industry, but will often include organic wastes which may be toxic. Contamination usually as point source.
Poorly constructed boreholes where surface water is able to flow into hole	up to 100 mm/d or more at borehole	< 10 days	higher hydraulic load at handpumps with increased use	no effect	may be higher leakage rate with older pumps	no effect	no effect	lower dilution at pump esp. with increased use	Boreholes without a proper sanitary seal (>5m) can be easily contaminated by surface flow entering the borehole. Such surface waters will often be bacterially contaminated and enter the borehole with minimum resistance or filtration.

Note: light shading = minimal risk of contamination medium shading = low risk of contamination dark shading = high risk of contamination

APPENDIX E

PHOTOGRAPHS

PROPOSED ACORN CITY - HYDRO-CENSUS INVESTIGATION - PHOTOGRAPHS

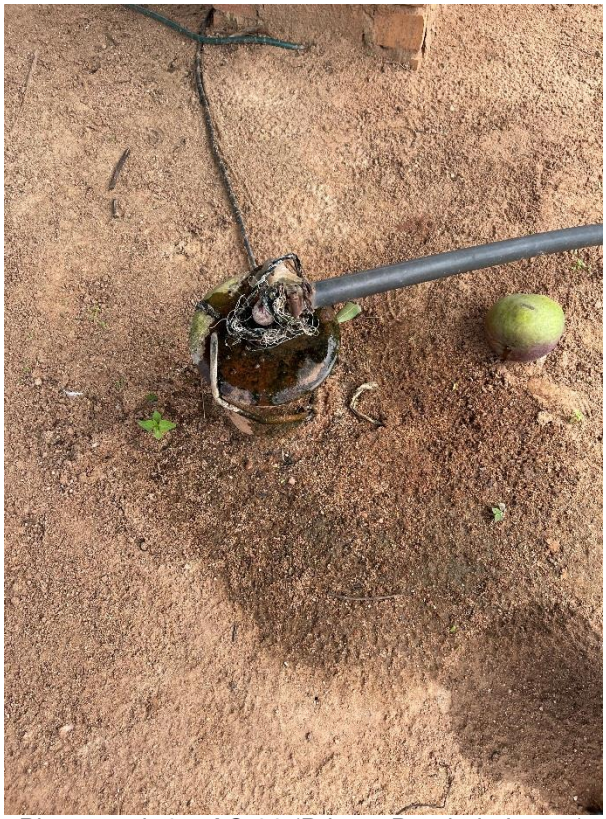
Photograph 1 – BR-03007 (Unused)

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)