HYDROCENSUS SURVEY REPORT:

PROPOSED CAPITAL PARK FILLING STATION

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EXECUTIVE SUMMARY

Fargofin (Pty) Ltd (herein referred to as Fargofin) has appointed Strategic Environmental Focus (Pty) Ltd (SEF), an independent Environmental Consultant, to undertake the hydrocensus survey at Capital Park which is 2.5 km north of Pretoria's Central Business District (CBD).

The hydrocensus survey forms part of the specialist studies in support of the Environmental Impact Assessment (EIA) Report. The proposed activity has a potential to contaminate the groundwater through possible accident of leakage and infiltration to the sub-surface. Chapter 3 of the National Water Act (Act 36 of 1998) requires that a person who owns, control, occupies, uses the land is responsible for preventing pollution of water resources and is also responsible to remedy (correct) the effects of the pollution. It is with this basis that the hydrocensus was deemed necessary for the site to gather all relevant information related to groundwater and its related potential impacts.

In order to achieve the purpose of the study, the following scope of work has been formulated:

- Perform site assessment and hydrocensus survey;
- Sampling and lab results analysis;
- Desktop study; and
- Technical reporting of the above.

The underground storage tanks with the capacity of 92$m^3$are proposed for the filling station. Other related facilities for the proposed filling station will include but not be limited to:

- A convenience store with an in-house Burger King facility;
- Ablution facilities;
- Pump islands in forecourt; and
- Car parking areas with an estimate of 24 parking spaces.

A geohydrological baseline condition was established in the form of a hydrocensus survey. The hydrocensus survey entails gathering of water use, quality and quantity within the study area.

The above technical assessment approach has been formulated to assist in the collection of baseline information regarding the groundwater status of the study area. The outcome of the study provides recommendations in terms of future groundwater monitoring as it relates to water quality. The hydrocensus survey was performed in March 2014 and three boreholes were located and grab sampled from the borehole outlet points. However, during sampling, all the three boreholes were sealed and found to be equipped with submersible pumps. This presented a limitation in terms of access for the taking of water levels. The following information was recorded during the hydrocensus survey:

- Collected water samples;
- Coordinates; and
- Elevations.

The samples were sent to the South African National Accreditation Standards (SANAS) accredited lab for analysis and all three boreholes were in compliance of the SA Water Standard Drinking 241 of 2011 except BH01 and BH03 with minor exceedance on Iron (Fe) and Manganese (Mn). Based on the fact that the proposed activity will generate hydrocarbons, the samples were also analysed for Volatile Organic Compounds (VOCs) and the results indicated no exceedances for hydrocarbon parameters.

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ACRONYMS, SYMBOLS AND DEFINITIONS

Symbol/Acronym	Description
≤	Less than or equal to
≥	Greater than or equal to
Aquifer	A stratum which contains intergranular interstices or a fissure/fracture or a system of interconnected fissures/fractures capable of transmitting groundwater rapidly enough to directly supply a borehole or spring.
CBD	Central Business District
Confined groundwater	Groundwater under pressure significantly greater than that of the atmosphere and whose upper surface is a bottom of a layer of distinctly lower permeability than the material in which the water occurs.
DWA	Department of Water Affairs
GPS	Geographical Positioning System
Groundwater recharge	The processes involved in the absorption and addition of water to the zone of saturation.
LNAPLs	Light Non-Aqueous Phase Liquids
mamsl	meters above mean sea level
MAP	Mean Annual Precipitation
mbgl	meters below ground level (i.e. depth to water level)
mg/l	milligrams per litre
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act 36 of 1998)
SANAS	South African National Accreditation Standards
TDS	Total Dissolved Solids
WRC	Water Research Commission
Chemical elements/compounds	
Ca	Calcium
Cl	Chloride
Fe	Iron
HCO_3^-	Bicarbonate anion
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
SO_4	Sulphate
T. Alk	Total Alkalinity
VOCs	Volatile Organic Compounds

1. INTRODUCTION

Fargofin (Pty) Ltd (herein referred to as Fargofin) has appointed Strategic Environmental Focus (Pty) Ltd (SEF), an independent Environmental Consultant, to undertake the hydrocensus survey.

The proposed activity has a potential to contaminate the groundwater through possible accident of leakage and infiltration to the sub-surface. The proposed study area is located in the residential zone and any possible groundwater pollution will have impact on down-gradient located external user's boreholes.

Chapter 3 of the National Water Act (Act 36 of 1998) requires that a person who owns, control, occupies, uses the land is responsible for preventing pollution of water resources and is also responsible to remedy (correct) the effects of the pollution. It is with this Act that the hydrocensus was deemed necessary for the site to gather all relevant information related to groundwater and its related potential impacts.

The proposed filling station is situated in Capital Park (see Figure 1-1) on Erf 1869, Erf 1860 (Remainder of Erf 1341 and Remainder of Erf 1342), to be consolidated as Erf 1869, within the City of Tshwane Metropolitan Municipality (CoT), in the Gauteng Province.

The proposed filing station will have underground storage tanks with a combined capacity of 92m^3. Other related facilities will include but not limited to:

- A convenience store with in-house Burger King facility;
- Ablution facility;
- Pump islands in forecourt; and
- Car parking areas with an estimate of 24 parking bays.

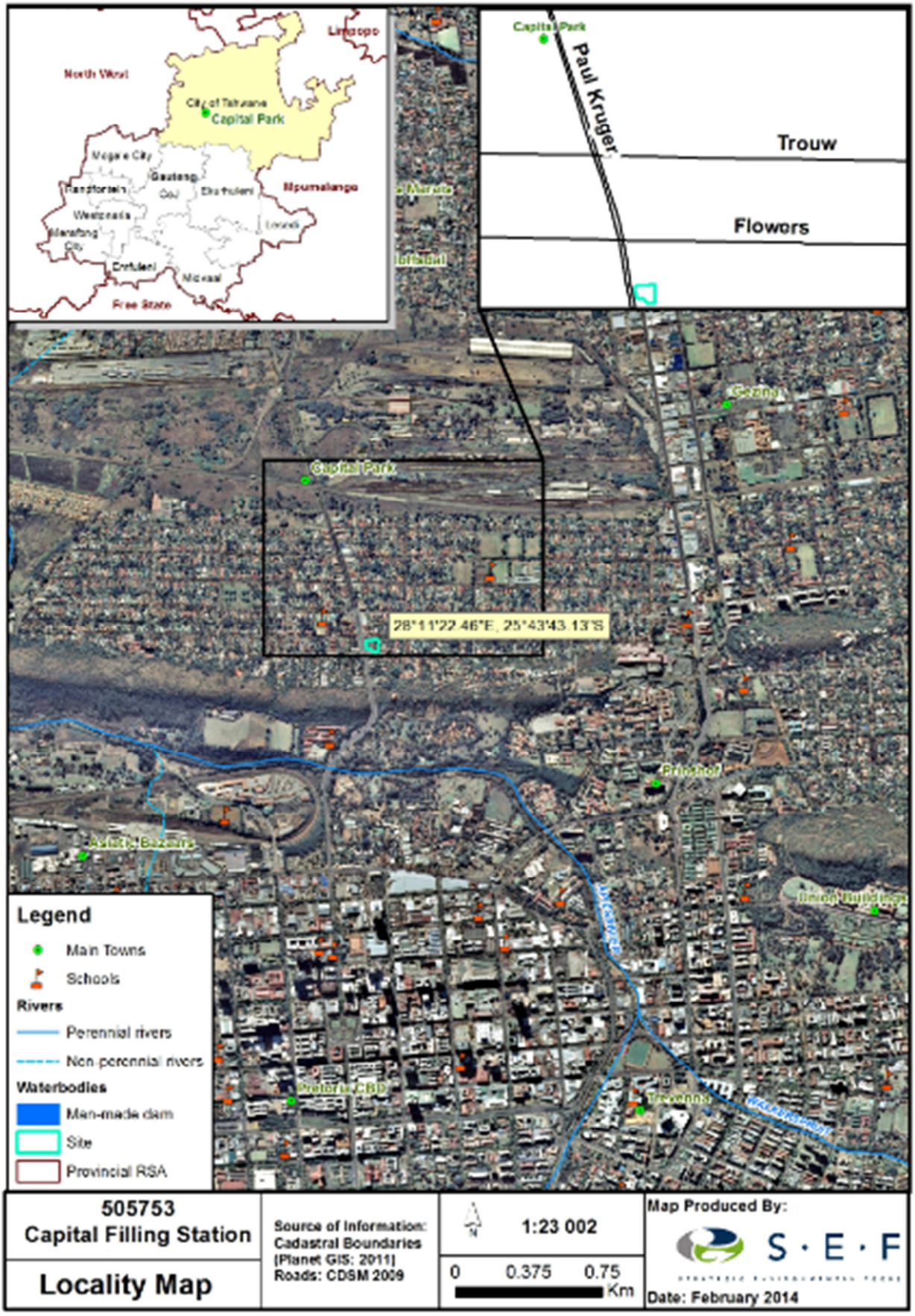


Figure 1-1: Locality map of the study area

1.1. OBJECTIVES

The objective of the study was to perform a hydrocensus survey with the following components:

- Desktop study;
- Fieldwork to gather the following information:
  - Recording of the existing water users;
  - Taking coordinates of water sources such as boreholes using handheld Geographical Positioning System (GPS) (Garmin Montana 650);
  - Record elevation in meters above mean sea level (mamsl); and
  - Taking water samples and other related information.

A hydrocensus survey and desktop study was undertaken to generate data for the assessment of the study area in terms hydrogeological evaluations and provide recommendations in terms of groundwater monitoring of the activities on site (i.e. monitoring underground fuel tank stores).

2. DESKTOP STUDY

A desktop study was performed in order to gather all related information about the study area. The following information was collected:

- Geohydrological maps from Department of Water Affairs (DWA) and the Water research Commission (WRC);
- Climatic data of the study area; and
- Geology of the area.

2.1. DESKTOP STUDY INFORMATION

Various existing documents including Water Research Commission (WRC) maps and report (2001) were used for gathering geohydrological data for the study area. The following information was collected for the site:

2.1.1. Water quality/type

The following information was collected and has relevance:

- Total Dissolved Solids (TDS) <300 mg/l;
- Hydrochemical type (image) is B with (Ca, Mg)(HCO3)2; and
- More than 60% of analysed samples are of type B which dominated by calcium or magnesium carbonate ($CaMg(HO_3)_2$).

2.1.2. Groundwater

According to the WRC report (2001) the following key information is noted about the study area:

- Depth to water table is 10-20m;
- Mean Annual Recharge is 75-110mm;
- Base flow is 10-25mm;
- Storage coefficient of <0.001;
- Recommended drilling depth is <20m;
- Saturated interstices type is described as “Fractures restricted principally to a zone directly below groundwater level”;
- Formation mainly comprises of compact sedimentary rocks excluding dolomite and limestone;
- Drilling success rate is 40-60%;
- Exploitability is 30-40%; and
- Accessibility is 40-60%.

3. FIELDWORK: HYDROCENSUS SURVEY

A hydrocensus survey was conducted during the month of March 2014 at the Capital Park area in a 1km radius from the study area. The main objective of the survey was to gather the existing borehole information within the study area and to provide technical recommendations for additional monitoring boreholes to be drilled at the proposed filling station. The actions performed during the fieldwork included:

- Locating existing neighbouring boreholes;
- Site walk to identify possible groundwater pollution sources;
- Perform hydrocensus survey with the following recordings:
  - Taking coordinates of the boreholes using handheld GPS (Garmin Montana 650);
  - collecting water samples for each borehole; and
  - Taking photographs of the area (see APPENDIX I).

All three boreholes (BH01, BH02 & BH03) were found sealed in order to secure the equipment used for water abstraction. As a result of this limitation, water levels could not be recorded. Table 3-1 indicates recorded borehole information within the study area.

Table 3-1: Recorded borehole positions within the study area

BH_ID	Lat (S)	Long (E)	Owner	Address/Contact details	Altitude (mamsl)	Water usage	Date recorded (sampled)
	Decimal degree (WGS 84)						
BH01	25.7299 °	28.1875 °	Capital Park Primary School	School Principal: W J Pretorius Tel: 012 323 1436 Email: willem.pretorius1@gmail.com	1305.5	Garden/lawn irrigation	18/03/2014
BH02	25.7278 °	28.1876 °	A H Barnard	185 Venter Street, Capital Park	1302.4	Garden/lawn irrigation and domestic usage*	18/03/2013
BH03	25.7294 °	28.1894 °	Pieter Gertenbah	203 Venter Street Capital Park Email: charmique@gmail.com	1312.5	Garden/lawn and to fill up the jacuzzi	19/03/2014

*Domestic usage is only used as backup if no municipal water is available during that particular time

4. CLIMATE OF THE STUDY AREA

The climate of the study was interpreted based on the available data and previous studies of the area. World map data has also been utilised to interpret detailed climate conditions in the surroundings. Table 4-1 enlist the weather stations found in the vicinity of the study area.

Table 4-1: Weather station in the vicinity of the study area

Weather station name[1]	Distance from study area	Owner	COORDINATES	
			Lat	Long
-	200m	SSWCT[2]	-25.72715°	28.18929°
0031	1.5km	SSWCT[2]	-25.72200°	28.20320°

[1]Approximate positions.
[2]Sam SamWater Climate Tool (Lister et al, 2002)

The acquired rainfall data for 2002 was obtained through usage of the internet weather tool called Sam SamWater Climate Tool (Lister *et al*, 2002) in which one selects the desired area on a map and it provides rainfall data of that particular area. Since rainfall records for the past 10 years were not obtained, the Sam SamWater Climate tool was used. Figure 4-1 indicates the distribution of weather stations in the vicinity of the site.

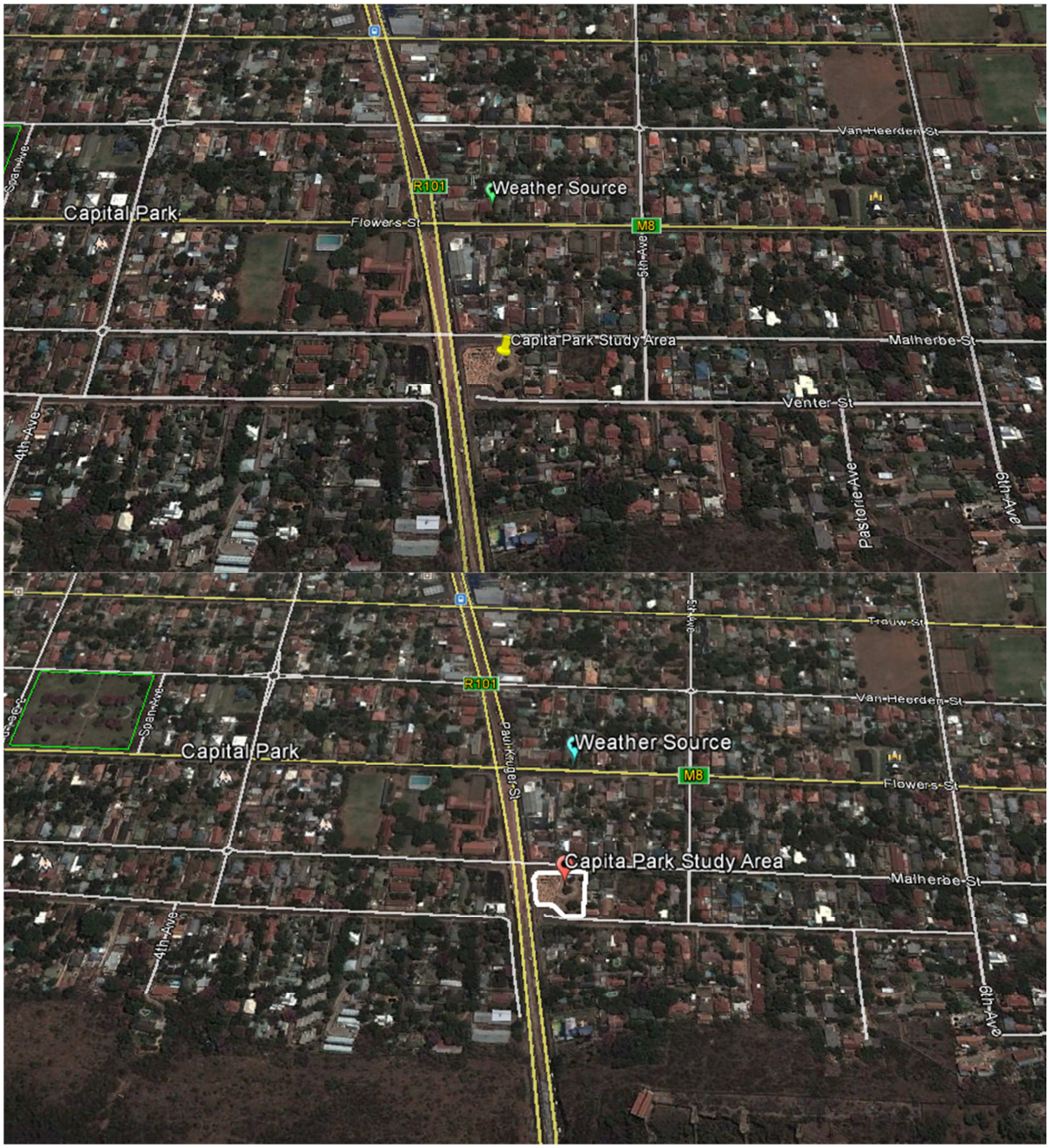
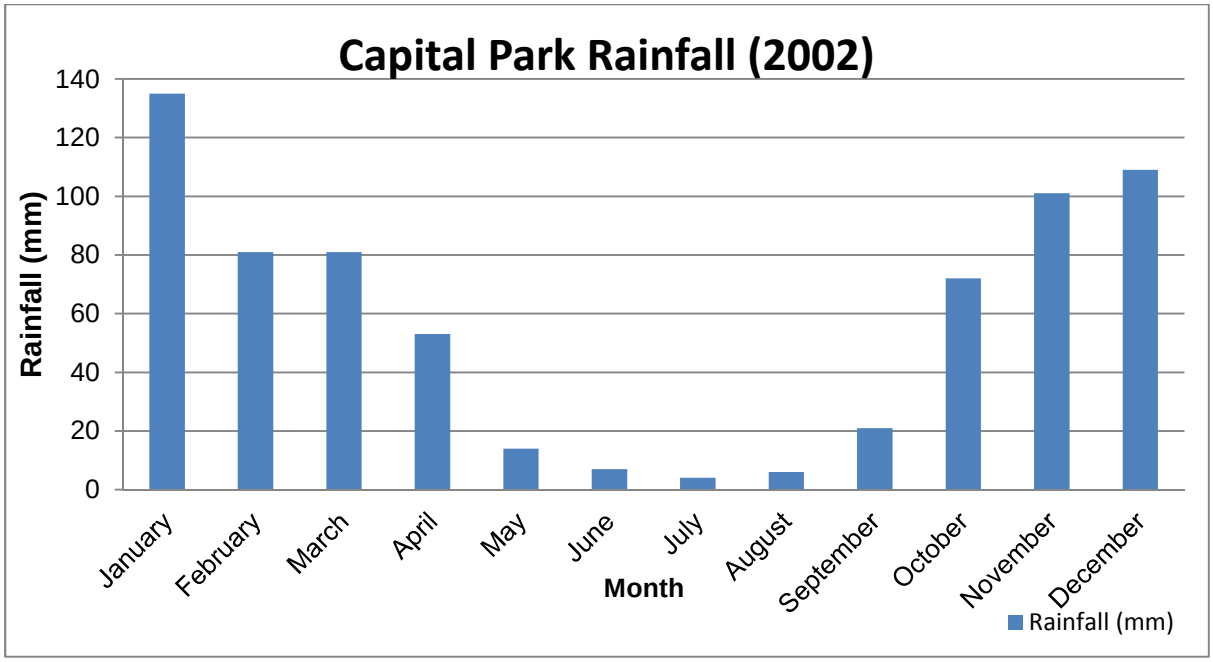


Figure 4-1: Approximate location where rainfall data was acquired (weather station)

Error! Reference source not found. provides rainfall data for year of 2002. It can be observed that in the study area the highest rainfall is experienced during the month of January with an average rainfall of 135 mm. The lowest average rainfall is in winter (July) with an average value of 4mm. The Mean Annual Precipitation (MAP) of 697mm as observed from the study area.

The pattern of the rainfall indicates the time in a year expected to observe rise of water table due to the recharge in the aquifer. However, the variation in groundwater fluctuation can only be observed in a continuous water level monitoring throughput the wet and dry seasons.



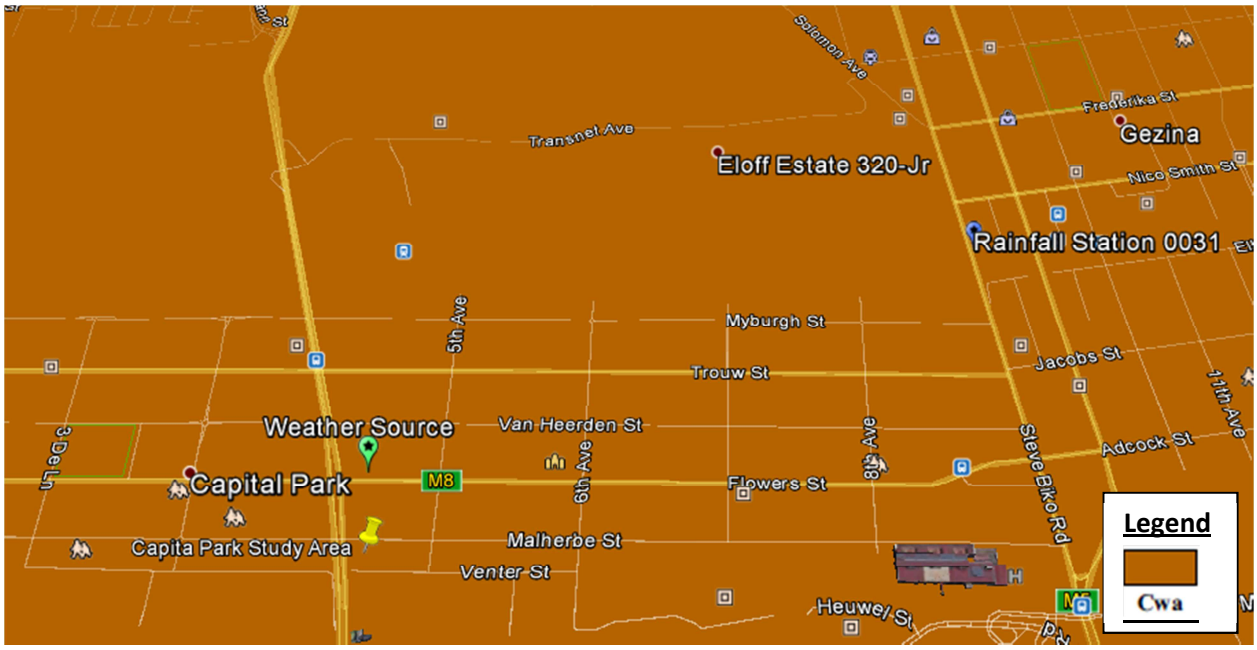
Source: Lister *et al*, 2002

Figure 4-2: Rainfall plot for the weather station near study area

The Köppen-Geiger climate classification system was also used to compare the climate of the area. The Köppen-Geiger system is based on a large global data set of long-term monthly precipitation and temperature station time series. Climatic variables used in the Köppen-Geiger system were calculated at each station and interpolated between stations using a two-dimensional (latitude and longitude) thin-plate spline with tension onto a 0.1^{o} X 0.1^{o} (degrees; latitude and longitude) grid for each continent (Peel, 2007). The system is also based on the concept that native vegetation is the best expression of climate.

Additional data sets obtained from www.climate-data.org for Pretoria as the nearest City indicated similar patterns of climate as the one plotted in Source: Lister *et al*, 2002
Figure *4-2*. It was also observed from www.climate-data.org that the MAP is 697mm.

Figure 4-3 indicates a plot of the updated world map of the Köppen-Geiger climate classification used on Google Earth to plot climatic conditions of the site (Source: Google Earth and Peel et al, 2007
Figure *4-3*). Table 4-2 provides explanation of the symbols used in Source: Google Earth and Peel et al, 2007
Figure *4-3*



Source: Google Earth and Peel et al, 2007

Figure 4-3: Map depicting type of climate of the study area

The explanation of the type of climate for the study area is provided in Table 4-2.

Table 4-2: Köppen-Geiger climate classification explanation note

Main climates	Precipitation*	Temperature	Criterion*
A: equatorial	**W**: desert	**a**: hot summer	Tmax ≥ +22 °C
B: arid	**S**: steppe	**b**: warm summer	not (a) and at least 4 Tmon ≥ +10 °C
C: warm temperate	**f**: fully humid	**c**: cool summer	not (b) and Tmin > −38 °C
D: snow	**s**: summer dry	**d**: extremely continental	like (c) but Tmin ≤ −38 °C
E: polar	**w**: winter dry	**F**: polar frost **T**: polar tundra	-

*Tmax = Maximum temperature; Tmin = minimum temperature and Tmon = Monthly temperature in ^{o}C

Based on Table 4-2 and Source: Google Earth and Peel et al, 2007

Figure *4-3*, it has been observed that the climate for the study area falls within a temperate climate with dry winters and hot summers. Therefore, groundwater recharge and raised water table is expected to be during summer period (i.e. wet season).

5. HYDROGEOLOGICAL EVALUATIONS OF THE STUDY AREA

It should be noted that this section is not a detailed hydrogeological evaluation but a brief description of the study area. It is anticipated that the collected information during this hydrocensus survey will be used during construction phase, particularly for drilling and subsequent further hydrogeological assessment as indicated in the recommendation section.

5.1. GEOLOGICAL SETTINGS

5.1.1. Regional geology

The regional geology indicates to be of Pretoria Group which mainly comprises of:

- Quartzite shale;
- Conglomerate;
- Diabase synite;

- Diabase dykes; and
- Diacmictite.

Figure 5-1 provides geological map of the study area which indicates that the three boreholes are located in geology which is mainly underlain by quartz and shale with interbedded quartzite slate. There was no outcrop extrusions observed during the site assessment and no lineament was observed from the geological map. However, further studies to be undertaken during the drilling of the monitoring boreholes will provide detailed geologic logs of the site.

5.1.2. Local geology

The geology of the study area is comprised of the following:

- Andesite;
- Diabase, Synite and Pyroxene;
- Ferruginous shale and shale;
- Quartzite; and
- Shale with interbedded quartzite slate.

It is noted that the local geology, where boreholes are located, is quartzite and shale with interbedded quartzite slate. The two boreholes (BH01 & BH03) are located in quartzite while BH02 is located in shale with interbedded quartzite slate (Figure 5-1). However, the presence of the ferruginous shale and synite in the general geology of the site provides an interesting evidence of natural elevated values of iron (Fe) in the hydrochemical results obtained from the site.

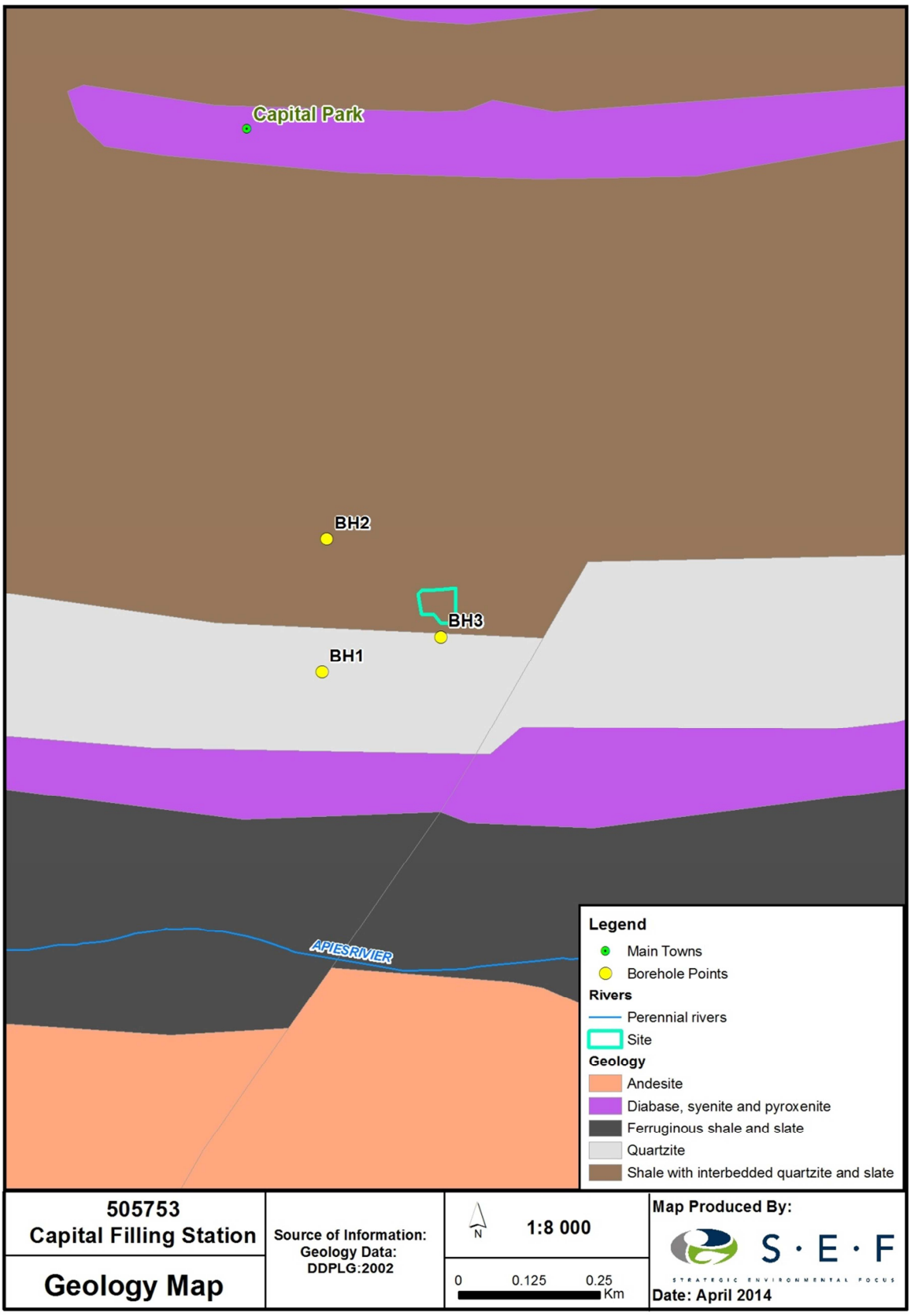


Figure 5-1: Map indicating geology of the study area

5.2. REGIONAL HYDROGEOLOGY

Maps (sheet 1 & 2) from the WRC (2001) and Vegter (1995) were utilised in terms of assessing the geohydrological conditions of the study area. The following information was extracted:

- Mean Annual Recharge is 75-110mm;
- Depth to groundwater level is between 10 and 20*mbgl*;
- Mean annual flow Groundwater River (baseflow) is between 10 and 25mm;
- The saturated interstices provided the following information:
  - Recommended drilling depth below groundwater level is 30-50*m*;
  - Storage coefficient is <0.00;
  - The storage medium is disintegrated/decomposed or partly decomposed rock and fractures which are principally restricted to a zone directly below groundwater level;
- Drilling success rate (accessibility) is 40-60%;
- The probability of drilling a successful borehole yielding greater than 2*l/s* (exploitability) is 30-40%; and
- The formations are mainly comprised of compact sedimentary rocks excluding dolomite and limestone.

5.2.1. Regional groundwater quality

The regional water quality has been discussed based on hydrogeological maps provided by WRC (2001) for the regional hydrogeology

The WRC (2001) provides the following information regarding background water quality:

- Total dissolved solids (TDS) are less than 300mg/l with range between 500 and 1000 mg/l in terms of the geometric standard deviation;
- Hydrochemical type is type B with:
  - dominant cations: Ca^{2+} and/or Mg^{2+}; and
  - dominant anions: HCO_3^-

In general, there is a single water type (i.e. type B) in the area dominated by calcium or magnesium carbonate ($CaMg(HO_3)_2$). This type of water quality was based on more than 60% analysis samples (WRC, 2001) of the area regional (not this study). However, the hydrochemical results from the three sampled boreholes also confirmed the similar type of water as provided in the WRC report (2001)

5.2.2. Local hydrogeology

Local hydrogeology of the area was assessed based on the geological setting of the area and associated recharge conditions. The following comments about the site are relevant:

- Site falls with the quaternary catchment A23E;
- The general surface and groundwater flow is towards the north-west to Apies River which eventual flow to the north (Figure 5-3);
- Apies River is located about 1.73km west to north-west of the site and flows to the north;
- The ridge to the south of the study area serves as a water divide and any groundwater recharge to the south will flow through the study area;
- The three recorded boreholes during the hydrocensus survey have the following positions in terms of the groundwater flow:
  - BH03 is located on the upper-gradient (1312.5 mamsl) representing the background water quality of the site (1294.9 mamsl);
  - BH02 is located 300m down-gradient, north-west of the study area (at Capital Park Primary School) representing the perceived area of intercepting the likely or possible pollution; and

- BH01 is located some 200m south-west of the study area which can still serve as background water quality as it is also located on upper gradient (1305.5 mamsl).

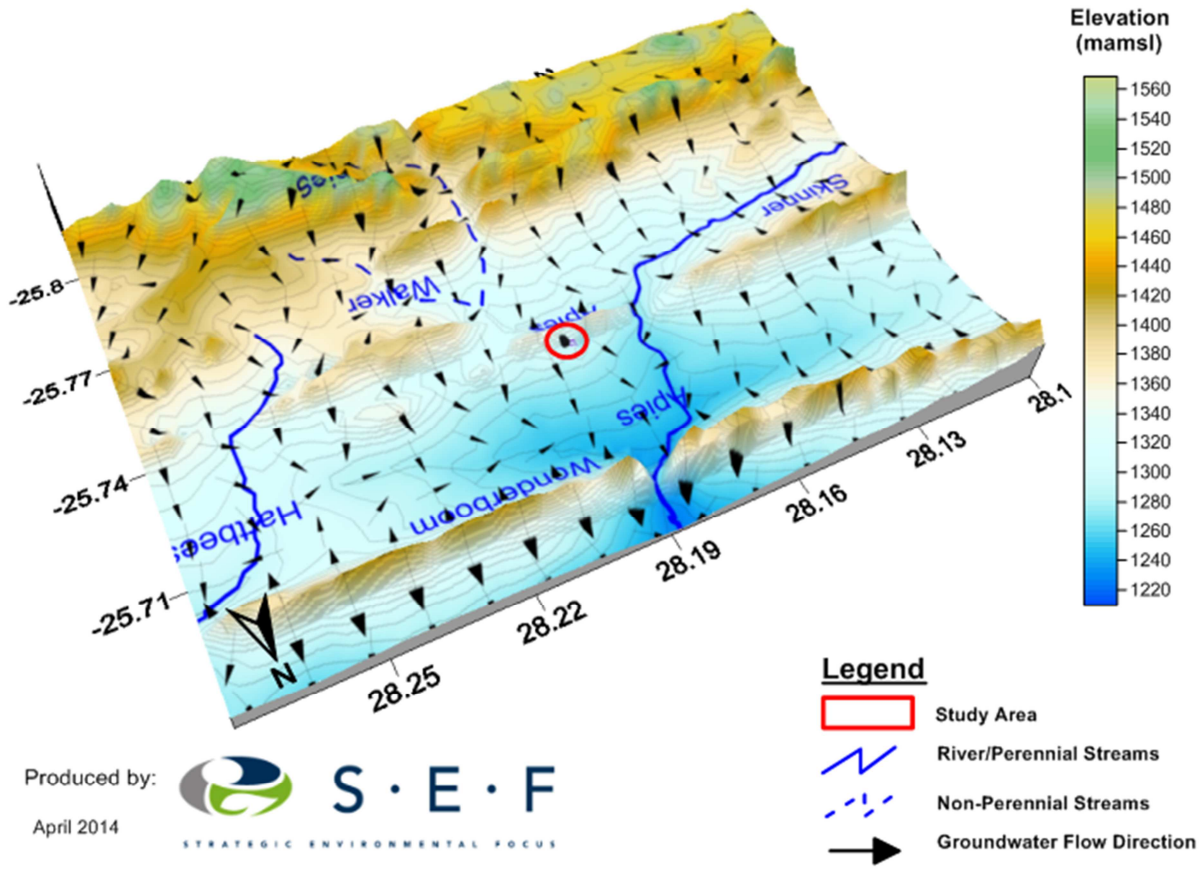


Figure 5-2: Digital Elevation Model illustrating direction of water flow

The likely receptors of the possible pollution will be anticipated to be at the down-gradient of the site (i.e. intercepting boreholes in the preferential flow zone if any) and eventual the Apies river. However, the installation of the underground tank storage will follow proper guidelines from The South African Bureau of Standards, SABS-089-3 (1999) which will help to avoid any possible escape of the leakage.

5.2.3. Groundwater levels

As indicated earlier there was no access to record water levels due to the fact that the three boreholes were sealed (equipped with submersible pumps). However, some information was obtained from the WRC (2001) report concerning water levels of the study area. The following information should be noted:

- The mean depth to water level is 10-20mbgl;
- The standard deviation for water levels ranges from 15 to 25mbgl;
- The above figures are regional values and not site specific; and
- Actual groundwater levels need to be confirmed from the existing boreholes for proper planning. It is also recommended to take rest groundwater a few days after drilling has taken place on site.

5.2.4. Water quality from hydrocensus survey

Groundwater quality of the study area has been assessed based on collected data/samples from the hydrocensus survey and compared with the general water quality provided in WRC (2001) hydrogeological maps. The samples were collected from the immediate discharge points from the boreholes after running the water out for approximately 10min to obtain representative samples. The collected water samples from the field were submitted to the SANAS accredited lab for quality analysis.

The following major parameters were analysed during the hydrocensus of March 2014:

- Major ions: Mg; Ca; K; Na; Cl; SO_4; Fe; NO_3; NO_2; F;
- Physical parameters: pH; EC; TDS and Total Alkalinity;
- Bacteriological parameters (*E. Coli* and faecal coliforms); and
- Volatile organic compounds (VOCs) for selected monitoring points.

The above parameters were selected based on the assessment of the site in terms of possible future sources of contamination from the proposed filling station which will have Light Non-Aqueous Phase Liquids (LNAPLs). Furthermore, selection of points sampled for VOCs and bacteriological parameters was based on the study area being located in the residential area (bacteriological) and type of chemistry the proposed activities will have.

The following groundwater quality assessment has been made:

- It is observed that the three samples fall within type B hydrochemical type as indicated as by WRC (2001). Type B hydrochemical facies indicate calcium-carbonate (Mg^{2+}, Ca^{+2} & HCO_3^- being dominant);
- Although the TDS were within the South African Drinking Water Standard limit241 (2011) (see Table ***5-1***). It was noted that the Capital Park Primary School borehole (BH02) was 350mg/l greater than the value of <300mg/l provided by WRC (2001) for the area (i.e. regional figure);
- The following exceedances were observed for Boreholes BH01 and BH03:
  - BH01: Iron (Fe) is 1.43 mg/l (acute) and Manganese (Mn) is 0.26 mg/l both for acute. However, this is within the limit in terms of aesthetics.
  - BH03: Iron (Fe) is 14.00 mg/l (acute) and Manganese (Mn) is 0.41 mg/l both for acute. However, this is within the limit in terms of aesthetics. The value of Fe is also exceeding the marginal scale;
- The above exceedances can be attributed to natural dissolution from the geology within the area as no observed activity could have triggered the higher values for both Fe and Mn. It should be noted that both BH01 and BH03 are located in the same geology (quartzite) as compared to BH02 located in the shale with interbedded quartzite and slate; and
- All parameters were within the standard limit including the VOCs assessed though DWA Water Resource Quality Objective (2009).

Table 5-1: Capital Park Hydrochemical results (groundwater)

Analyses in mg/ℓ (Unless specified otherwise)	Guideline values		Sample Identification:		
	SANS: 241: 2011	DWA - WRQO (2009)*	BH01	BH02	BH03
Sampling Date			18/03/2014	18/03/2014	19/03/2014
pH – Value at 25°C	≥5 - ≤9.7	6.5-8.5	8.10	7.70	7.30
Electrical Conductivity in mS/m at 25°C	≤ 170	≤ 70	34.70	54.40	20.80
Total Dissolved Solids at 180°C *	≤ 1200		210.00	350.00	118.00
Total Alkalinity as $CaCO_3$	-	-	12.00	152.00	36.00
Chloride as Cl	≤ 300	≤ 150	59.00	63.00	41.00
Sulphate as SO_4	≤500[a]; ≤ 250[b]	≤ 300	39.00	20.00	10.00
Fluoride as F	≤ 1,5		<0.2	<0.2	<0.2
Nitrate as N	≤ 11		6.40	7.20	0.30
Nitrite as N	≤ 0.9*		<0.1	<0.1	<0.1
Biochemical Oxygen Demand as O_2 *		≤ 130	<10	<10	<10
Chemical Oxygen Demand as O_2 (Total)		≤ 35	<10	<10	<10
Total Coliform Bacteria / 100 mℓ *			23.00	4.00	0.00
Faecal Coliform Bacteria / 100 mℓ *			0.00	0.00	0.00
E. Coli / 100 mℓ *			0.00	0.00	0.00
Free & Saline Ammonia as N			<0.2	<0.2	0.60
Sodium as Na	≤ 200		35.00	15.00	28.00
Potassium as K	-		9.20	<1.0	1.20
Calcium as Ca	-		13.00	47.00	6.00
Magnesium as Mg	-		6.00	32.00	4.00
Iron as Fe	≤ 2[c] ; ≤ 0.3[b]		1.43	0.04	14.00
Manganese as Mn	≤0.5[a]; ≤0.10[b]		0.26	<0.025	0.41
% Balancing			95.50	99.00	94.20
TPH – BTEX / GRO *					
MTBE *			<0.005	<0.005	<0.005

Analyses in mg/ℓ (Unless specified otherwise)	Guideline values		Sample Identification:		
	SANS: 241: 2011	DWA - WRQO (2009)*	BH01	BH02	BH03
Benzene *		≤ 0.95	<0.005	<0.005	<0.005
Toluene *		≤ 1	<0.005	<0.005	<0.005
Ethylbenzene *		≤ 10	<0.005	<0.005	<0.005
m- & p-xylene *		≤ 1.5	<0.005	<0.005	<0.005
o-xylene *			<0.005	<0.005	<0.005
1,3,5 - Trimethylbenzene *			<0.005	<0.005	<0.005
1,2,4 - Trimethylbenzene *			<0.005	<0.005	<0.005
Naphthalene *		≤ 0.40	<0.005	<0.005	<0.005
C6 *		≤3.5	<0.005	<0.005	<0.005
C7 *			<0.005	<0.005	<0.005
C8 *			<0.005	<0.005	<0.005
C9 *			<0.005	<0.005	<0.005
C10 *			<0.005	<0.005	<0.005
C11 *			<0.005	<0.005	<0.005
C12 *			<0.005	<0.005	<0.005
Sum of GRO-TPH (C6 – C12) *			<0.010	<0.010	<0.010
TPH - DRO [s]					
Sum of DRO-TPH (C16-C36) [s]		≤10	0.10	0.38	0.10
Organic Analyses: PAH [s]					
Naphthalene [s]		≤ 0.01	<0.001	<0.001	<0.001
2-Methyl naphthalene [s]			<0.001	<0.001	<0.001
1-Methyl naphthalene [s]			<0.001	<0.001	<0.001
Acenaphtylene [s]			<0.001	<0.001	<0.001
Acenaphthene [s]			<0.001	<0.001	<0.001
Fluorene [s]			<0.001	<0.001	<0.001
Anthracene [s]			<0.001	0.00	<0.001

Analyses in mg/ℓ (Unless specified otherwise)	Guideline values		Sample Identification:		
	SANS: 241: 2011	DWA - WRQO (2009)*	BH01	BH02	BH03
Phenanthrene [s]			<0.001	0.01	<0.001
Fluoranthene [s]			<0.001	0.01	<0.001
Pyrene [s]			<0.001	0.01	<0.001
Benz (a) Anthracene [s]			<0.001	<0.001	<0.001
Chrysene [s]			<0.001	<0.001	<0.001
Benz (b) Fluoranthene [s]			<0.001	<0.001	<0.001
Benz (k) Fluoranthene [s]			<0.001	<0.001	<0.001
Benz (a) Pyrene [s]			<0.001	<0.001	<0.001
Benzo (g,h,i) Perylene [s]			<0.001	0.01	<0.001
Dibenz (a,h) Anthracene [s]			<0.001	<0.001	<0.001
Indeno (1,2,3-c,d) Pyrene [s]			<0.001	<0.001	<0.001

Legend:

3.60 Equals to/exceeding the limit (Aesthetic value used where applicable);

* Nitrite limit value;

a Acute health – 1;

b Aesthetic;

c Chronic health; and

— No Standard limit/data.

* Water Resource Quality Objective for the Rietspruit catchment (DWA, 2009)

6. DISCUSSION

The site has no drilled boreholes for preliminary geohydrological assessment and as a result a hydrocensus survey was performed to generate the baseline information to support future studies. It is further recommended that drilling of at least three boreholes be undertaken prior the installation of the underground tank storages. This will assist the drilling rig to get proper access for the drilling work and also avoid disturbance on already erected structures. The proposed monitoring boreholes will need to meet specifications such as the perforation of the casing to the above water table to capture LNAPLs.

The following comments are made for the discussion and conclusion:

- Performing a hydrocensus survey in a congested urban area can be a challenging job due to access limitations as owners are very reluctant to provide access or data;
- Furthermore, most private property owners were found to be at work during the time of the survey;
- The general usage for groundwater in the area is related to the irrigation of gardens and domestic use when no municipal water is available;
- Groundwater usage may increase during the dry season for garden/lawn irrigation. Estimated usage ranges from 0.8 to 2.7 l/s (Pers. Comm. various landowners);
- There is a need to update the hydrocensus survey data after construction of the proposed filling station in order to include measured water levels from the drilled boreholes on site. The water levels will help to assess the vulnerability of the aquifer in case of shallow water table. This can be achieved through detailed geohydrological assessment of the area which will utilise hydrocensus data and field data such as geologic logs from the drilling of monitoring boreholes; and
- The geotechnical studies need to include soil analysis in terms of total petroleum hydrocarbons as to provide baseline values prior to the installation of the underground fuel stores. The results from soil sample will assist comparison purposes in future.

7. RECOMMENDATIONS

The following recommendations are relevant:

- There is a need to verify groundwater levels from the boreholes identified by the hydrocensus through negotiations with owners in terms of creating access holes for the dip-meter (water level meter);
- At least three monitoring boreholes should be drilled around the underground fuel storage tanks. The boreholes need to be perforated as to capture LNAPLs;
- Groundwater monitoring programme/plan need to be developed for the groundwater management of the area to monitor the potential leakage of contaminants and spillages and it should include a remedial approach. Leak detection and sorbent material such as Drizit and Zorbit; and
- Monitoring boreholes to be drilled need to be perforated as to capture LNAPLs.

8. REFERENCES

- Department of Water Affairs (2012): Aquifer classification map of South Africa
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9. APPENDIX I: RECORDED PHOTOS FROM SITE

Plate1: BH03: Switch and borehole position (cover)

Plate2: BH03: Equipment on the outlet (submersible pump)

Plate3: BH02: Capital Park Primary School

Plate4: BH02: Capital Park Primary School

Plate5: The proposed site (no existing borehole was found)