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Hydrocenus and Impact Assessment

for

Proposed Fuel Station at President Park

Compiled for:

AdiEnvironmental cc

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Disclaimer:

The results and conclusions of this report are limited to the Scope of Work agreed between GEM-GPT and the Client for whom this investigation has been conducted. All assumptions made and all information contained within this report and its attachments depend on the accessibility to and reliability of relevant information, including maps, previous reports and word-of-mouth, from the Client and Contractors.

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I hereby declare:

- I have no vested interest (present or prospective) in the project that is the subject of this report as well as its attachments. I have no personal interest with respect to the parties involved in this project.
- I have no bias with regard to this project or towards the various stakeholders involved in this project.
- I have not received, nor have I been offered, any significant form of inappropriate reward for compiling this report.

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Customer Satisfaction:

Feedback regarding the technical quality of this report (i.e. methodology used, results discussed and recommendations made), as well as other aspects, such as timeous completion of project and value of services rendered, can be posted onto GPT's website at www.gptglobal.com.

EXECUTIVE SUMMARY

Geo Pollution Technologies - Gauteng (Pty) Ltd (GPT) was appointed by AdiEnvironmental cc to conduct a hydrogeological impact assessment for the Proposed Fuel Station at President Park. The assessment must determine the groundwater status in the area of interest. Further assess the potential impacts of the proposed development on the groundwater resource and propose mitigation measures on the potential impacts.

Site Location, Topography and Drainage: The site is located on the President Park (Emalahleni) Ext 6 which is located within Emalahleni in the Mpumalanga Province. The area forms part of quaternary catchment B11J of the Olifants Water Management Area. The area is characterised by a generally flat topography and in the area of the site the slope is more or less in the order of 0.3 %. Drainage is towards the tributary (unnamed stream) of the Olifants River, approximately 200 m northeast of the proposed site, that flows from south to north. On a larger scale, drainage is towards the Olifants River that flows from south to north (flowing from the Doornpoort Dam) to the north of the site.

Geology: The investigated area falls within the 2528 Pretoria 1:250 000 geology series maps. The proposed development falls within the Selonsrivier Formation of the Rooiberg Group. The rocks of the Selonsrivier Formation mainly consist out of porphyritic amygdoidal red rhyolite, black rhyolite, agglomerate as well as sandstone and quartzite. These rocks dip slightly to the north east.

Hydrogeology: The porphyritic rhyolite and felsite associated with this unit represent acidic lava having a greater resistance to weathering than rock types which represent basic lava. The nature of these rocks and their weathering product is similar to that of granite, so that groundwater is usually encountered in the transition zone between weathered and more solid rock. Breccia and joint zones as well as lithological and dyke contact zones also contribute to a groundwater yield potential that is classed as poor on the basis that 86% of the available borehole yield records report a value of less than 2 l/sec. The groundwater rest level typically occurs between 10 m and 30 m below surface. Generally excellent water quality of the groundwater as borne out by the average EC value of 34 mS/m and a mean pH value of 7.1. Elements that show a substantial coefficient of variation are sulphate and nitrate. The latter indicates that although a small measure of caution is required when considering this water for human consumption, it is generally suitable for all use.

Groundwater Levels: Five neighbouring properties within a 500 m radius were visited during the hydrocensus. During the hydrocensus, except for the 1 newly drilled borehole, no additional groundwater level measurement could be measured. Only one additional borehole was found (Highveld View), however, no access was available to measure groundwater level. Based on the information collected during the hydrocensus, the borehole is used by Highveld View (private borehole) for irrigating the gardens, using as swimming pool water as well as drinking water.

Groundwater quality: Both samples comply with the SANS 241-1:2015 Standards for Domestic Use. The concentrations of all organic constituents were below detection in both boreholes and no potential health risks are associated.

Hydraulic Conductivity: Based on the flow velocity calculated for MW1, groundwater on-site is expected to travel approximately 2.2 m per year in a northern direction under steady state conditions (if no preferential flow paths exist).

Conceptual Site Model: Groundwater contamination susceptibility is evident in the proposed development area. Groundwater contamination migration can occur directly from surface contamination or mobilize into the subsurface, along weathered fractured bedrock, bedding plane fractures and joints. However, based on the hydrocensus and the aquifer classification map of South

Africa, the aquifer underlying the site is a minor aquifer system (moderately-yielding aquifer system of variable water quality). The impact assessment identified that both the construction and operational phases, without mitigation can have an impact of medium significance (construction) and medium to high significance (operational) on the groundwater in the area. The proposed operation can continue from a hydrogeological perspective, however protection to the aquifer must be prioritized by following the prescribed mitigation, recommendations, management and monitoring procedures stipulated below.

Mitigation Measures Construction Phase:

The following mitigation are proposed for the construction phase:

- Drip trays should be used when servicing machinery; that all contaminated material be removed off-site and disposed of in a responsible manner.
- No fuel storage should take place during construction onsite.
- During the drilling phase of MW1, seepage was encountered at approximately 16 mbgl, and the static water level is 5.31 mbgl. It is unlikely that dewatering will be required based on the depth where seepage was encountered and based on the static water level of the newly drilled borehole on site.

Mitigation Measures Operational Phase:

The following mitigation are proposed for the operational phase:

- Areas susceptible to contamination or tanker off-loading points, should be impermeable to hydrocarbons. Run off should be controlled by appropriate drainage to a separator connected to a sewer.
- All dispensers should be fitted with a leak proof drip tray or membrane arrangement beneath the dispenser. To avoid subsurface contamination, under pump sumps should be impervious to fuels, adequately protected against corrosion, and sealed at all pipe entries, fitted with appropriate leak detector devices, designed to allow any removal of fuel.
- It is essential that any pipework has protection against corrosion. Joints for pipework may be mechanical. The pipework should always be connected to tanks or dispensers using flexible connections. The use of enclosed systems within conduits that drain to inspection manholes or double walled piping underground, should be considered, since such mitigation measurements would further reduce the risk of spills to ground.
- Fuel storage tanks installed below the ground should be of corrosion resistant double skin or composite type and incorporate leak detection monitoring. The manholes should have secondary containment.
- Observation wells should be installed vertically without any curvature to the pipe adjacent to fuel tanks for monitoring purposes.
- Fillers should be sited that surface water and soil are prevented from entering the filler box. The filler box should be leakproof, able to contain the contents of a bulk delivery vehicle discharge hose and have secondary containment.
- Care shall be taken to ensure that the basic indication that an overfill has occurred or is imminent, is not the spilling of the product out of the dip pipe, but a slowing down or stoppage of the delivery flow. To achieve this, a back pressure must develop in the storage tank.

Management and Monitoring Requirements:

The following management and monitoring requirements are foreseen:

- All new underground petroleum storage systems should require automatic tank gauging.
- USTS must be dipped daily and reconciled against volume to check for losses due to leakage.
- All existing underground petroleum storage systems will require a leak monitoring system for tanks and piping where practicable. Where it is not practicable to implement such a system, a suitable alternative process to check for any loss from the system on a regular basis must be implemented.
- Leak detection installed including observation wells situated around the tank farm to facilitate early warning that a leak has arisen.
- SANS codes must be applied during the construction of the development.
- Installation must comply with local authority bylaws.
- Mitigation Measures included in the report to be included in the Draft Environmental Management Programme.
- Surface spillages that occur must be directed to separator before discharge into municipal sewer.
- Regular inspections on oil interceptors to ensure proper functioning. Should any information come to light that a possible leak or spill has occurred, the extent of the contamination in the subsurface needs to be determined through a site assessment, a hydrocensus that includes sampling should be completed and the relevant authorities need to be notified.
- Assessment during the dewatering design phase will assist in the determination of the most appropriate operational methodology, tanked or sump and pump, and the corresponding monitoring method. This will assist incompliance with legislative requirements and addressing potential impacts on the completed structure after construction.
- To ensure that any potential environmental harm is managed correctly and to enable the proponent to demonstrate compliance, regular monitoring of water quality parameters must continue in a manner advised by the local council by laws. The monitoring regime will depend on the wastewater quality, water treatment methods (oil/water separators) and point of discharge (stormwater or sewers).

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LIST OF ABBREVIATIONS

BDL	=	Below detection limit
BTEXN	=	Benzene, Toluene, Ethyl-benzene, Xylenes, Naphthalene
CSM	=	Conceptual Site Model
DRO	=	Diesel Range Organics
DWAF	=	Department of Water Affairs and Forestry
EC	=	Electrical Conductivity
GPT	=	Geo Pollution Technologies
GRO	=	Gasoline Range Organics
HP	=	Heap
l	=	litres
L	=	Length
LNAPL	=	Light Non-Aqueous Phase Liquid
LRP	=	Lead Replacement Petrol
m^3	=	cubic meters
mamsl	=	metres above mean sea level
mbgl	=	metres below ground level
NA	=	Not applicable or No information
NGA	=	National Groundwater Archive
ORP	=	Oxidation Reduction Potential
PAH	=	Poly Aromatic Hydrocarbons
pH	=	power of Hydrogen
PID	=	Photo Ionization Detector
ppb	=	parts per billion
ppm	=	parts per million
PSH	=	Phase Separated Hydrocarbons
RBSLs	=	Risk Based Screening Levels
SIS	=	Site Information Sheet
SSTLs	=	Site Specific Target Levels
SSV1	=	Soil Screening Value 1 (protection of water resources)
SSV2	=	Soil Screening Value 2 (commercial/industrial use)
SVS	=	Soil Vapour Survey
SWL	=	Static (ground) water level
TDS	=	Total Dissolved Solids
TWQR	=	Target Water Quality Range
ULP	=	Unleaded petrol
USTs	=	Underground Storage Tanks
VOCs	=	Volatile Organic Compounds

HYDROCENUS AND IMPACT ASSESSMENT

PROPOSED FUEL STATION AT PRESIDENT PARK

1 INTRODUCTION

Geo Pollution Technologies - Gauteng (Pty) Ltd (GPT) was appointed by AdiEnvironmental cc to conduct a hydrogeological impact assessment for the Proposed Fuel Station at President Park.

The assessment must determine the groundwater status in the area of interest. Further assess the potential impacts of the proposed development on the groundwater resource and propose mitigation measures on the potential impacts.

2 GEOGRAPHICAL SETTING

2.1 Site Location, Topography and Drainage

The site is located on the President Park (Emalahleni) Ext 6 which is located within Emalahleni in the Mpumalanga Province (Figure 1). The area forms part of quaternary catchment B11J of the Olifants Water Management Area.

The topography (shown in Figure 2) can normally be used as a good first approximation of the hydraulic gradient in the unconfined aquifer. This discussion will focus on the slope and direction of fall of the area under investigation, features that are important from a groundwater point of view.

The area is characterised by a generally flat topography and in the area of the site the slope is more or less in the order of 0.3 %.

Drainage is towards the tributary (unnamed stream) of the Olifants River, approximately 200 m northeast of the proposed site, that flows from south to north, which is regarded as a receptor. On a larger scale, drainage is towards the Olifants River that flows from south to north (flowing from the Doornpoort Dam) to the north of the site.

According to previous work done by Kyllinga Consulting[1], the NFEPA database indicate wetland units to the east and north of the site (shown in Figure 2), and is regarded as a receptor.

[1] Kyllinga Consulting (June 2020): Screening assessment for the President Park X6 site.

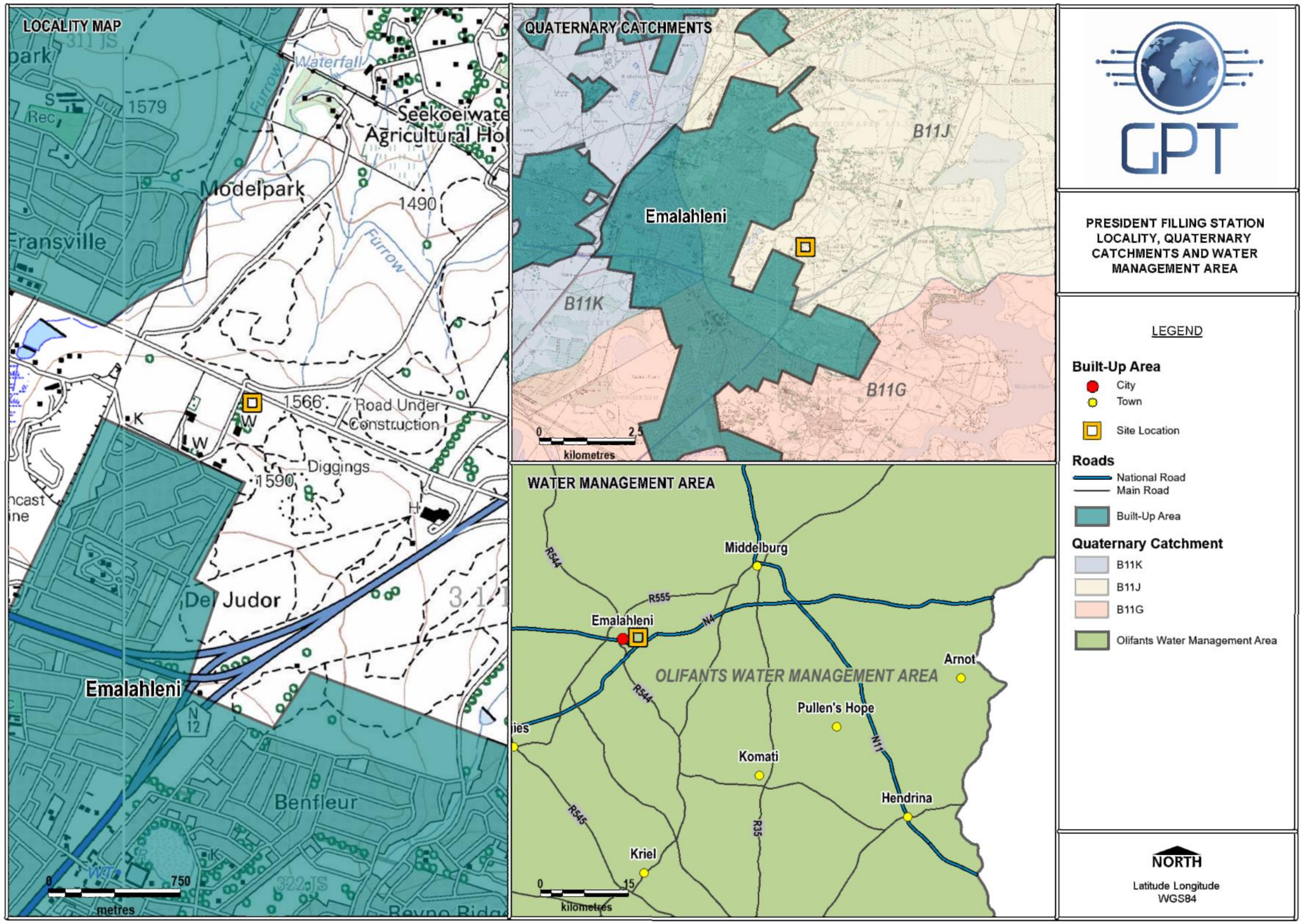

Figure 1: Site Location and Quaternary Catchment Boundaries.

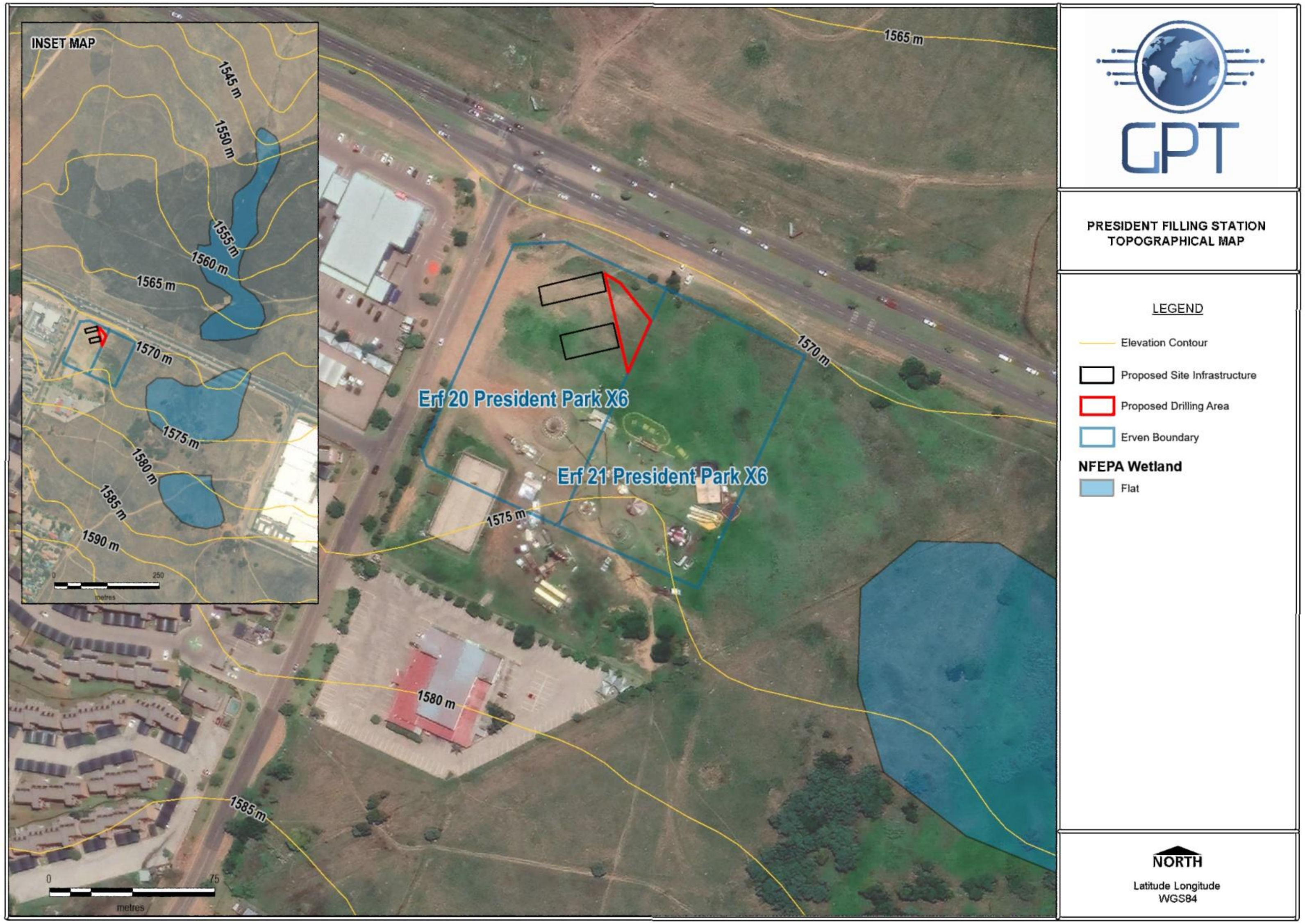

Figure 2: Site Topography.

2.2 Climate

Climatic data was obtained from the DWS weather station eMalahleni (rainfall data and evaporation data) at the Witbank Dam[2] (Table 1). The proposed site is located in the summer rainfall region of Southern Africa with precipitation usually occurring in the form of convectional thunderstorms. The average annual rainfall (measured over a period of 70 years) is approximately 873.6 mm, with the high rainfall months between November and April. Recharge is estimated at an average of 3.5% of annual rainfall, i.e. 25 mm/a.

Table 1: Climatic Data.

Month	Average monthly rainfall (mm)	Mean monthly evaporation
January	127.5	166.3
February	92.1	139.4
March	73.1	130.6
April	40.4	97.6
May	14.1	79.9
June	6.0	65.7
July	3.0	72.2
August	8.3	98.6
September	21.2	136.7
October	76.3	163.2
November	120.4	158.7
December	115.5	164.2
Annual	697.3	1476.7

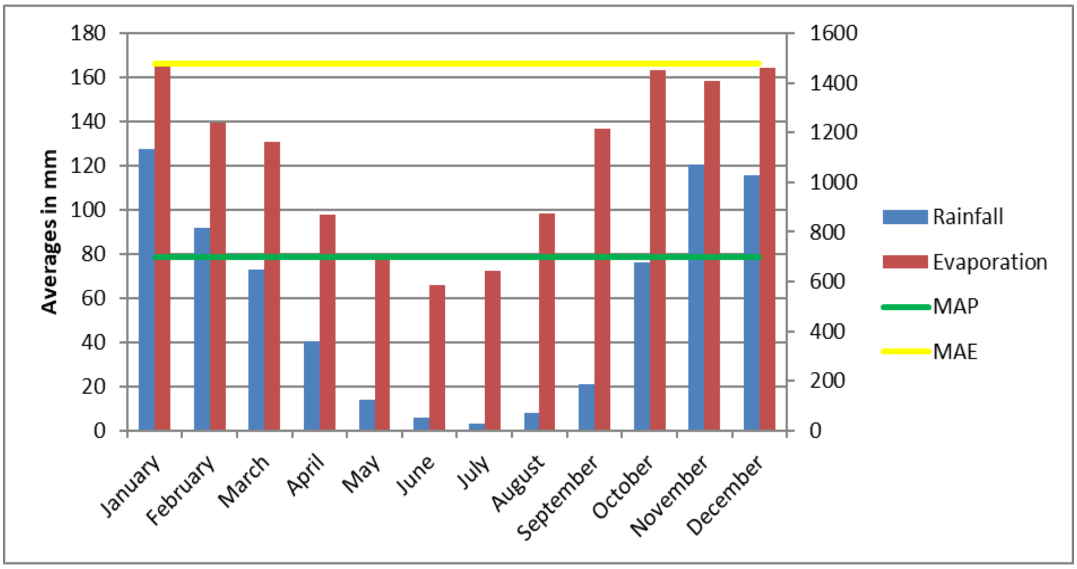

Figure 3: Climatic data representation.

2 Department of Water Affairs (DWA): www.dwa.gov.za

3 SCOPE OF WORK

The investigation consisted out of the following:

- Site Walk Over: The site and surrounding areas was visually assessed to determine the environmental sensitivity of the area. An audit checklist was used to note the land use, topographic features, natural and man-made drainage features and the position of underground services (if any). Signs of surface contamination as well as the condition of any equipment present on site was recorded.
- Based on the site walkover, the receptors of concern were determined. All potential receptors of any contamination that might emanate from the site and the different identified pollution sources on the site was noted. A potential receptor may be any person or place. Examples of receptors include proximate residential areas, schools, parks, and play grounds, as well as surface water bodies and private boreholes supplying water for human consumption. Workers on the site might also be receptors, depending on the identified pathway(s).
- Locate boreholes in the immediate vicinity of the site by conducting a hydrocensus survey. Groundwater samples was collected from nearby public/private boreholes, as well as from surface water bodies including storm water drains and outlets where considered necessary. Record GPS coordinates of these sample points. The National Groundwater Archive (NGA) was also consulted to identify any registered groundwater users within a 500 m radius of the site.
- If there is no existing borehole on site, drill and install one borehole to a maximum depth of 20 m to determine the depth to and status of the groundwater on site. The borehole will be equipped with 63 mm PVC casing and end caps, typically screened from 3 to 20 m, silica gravel pack, bentonite sanitary seal and manhole cover. The borehole will be developed after drilling to remove fines. Drilling will be terminated as soon as groundwater seepage occurs and to prevent possible (future) cross contamination to possible deeper lying secondary aquifers Groundwater samples will be collected from the new monitoring borehole approximately one week after drilling, if groundwater is present.
- Determine the groundwater flow direction.
- Perform a hydraulic conductivity test (slug/bail) on the new borehole to obtain an estimate of the groundwater flow velocity on site (under steady state conditions).
- Recovered water samples (max. 2) will be submitted to a SANAS accredited laboratory for the analysis of petroleum hydrocarbon compounds. A water sample from one borehole will also be submitted for inorganic analyses and physical parameters.
- Compare the targeted hydrocarbon concentrations detected in the water samples with TIER 1 Risk Based Corrective Action (RBCA) values to determine the inherent risks and health hazards for each identified contamination pathway, if any.
- Present the results of the investigation to the client in terms of a report.

3.1 Project Objectives

The primary objective of the study is to understand and document existing information on the hydrogeology in order to perform an assessment of the risk that the proposed development might pose to the groundwater environment. The objectives were defined as follows:

- Collect and interpret existing information of the hydrogeology of the area including:
    - Depth to groundwater,

  - Proximity of groundwater users and nature of use,
  - Proximity of surface water bodies,
  - Groundwater flow direction,
  - Groundwater quality,
  - Aquifer classification and vulnerability and
  - Potential sensitive receptors and other sources of contamination.
- Assess the impact of the proposed development on the groundwater and introduce mitigation measures on the related impacts.
- Make recommendations for the proposed development to protect groundwater.

4 METHODOLOGY

In order to achieve the objectives of this study the following actions were undertaken:

4.1 Desk Study

A complete desk study was conducted, entailing the gathering of information from topographical maps, geological maps, hydrogeological maps, previous reports, searching the National Groundwater Archive as well as consulting published maps.

4.2 Hydrocensus

The hydrocensus was done as a site familiarisation exercise and the collection of data from the study area and surrounding environments. It comprised a census of key boreholes, wells, springs and any other groundwater related information.

4.3 Borehole Drilling and Siting

Borehole drilling was required to obtain detailed knowledge of the following site-specific groundwater characteristics amongst others:

- The geological units
- The possible presence of preferential flow paths (fractured and/or weathered zones) along which contaminants may migrate
- The hydraulic properties of the aquifer systems by means of hydraulic tests (slug test)
- The current groundwater quality in the vicinity of the site
- The presence and extent of possible contaminant plumes emanating from the site
- Boreholes can also be used as part of monitoring networks or for abstraction purposes.

The percussion drilling was guided by the South African National Standard, SANS 10299-4:2003. Development, Maintenance and Management of Groundwater Resources. Part 4: Design construction and drilling of water boreholes.

4.4 Aquifer Tests

A bail-down test was conducted to achieve the following results:

- Groundwater resource evaluation, the aquifer characteristics, i.e. the ability of the aquifer to store and transmit groundwater

4.5 Groundwater sampling

Groundwater was sampled in accordance with the GPT's Standard Operating Procedure for groundwater sampling[3] by bailing.

4.5.1 Groundwater analysis

The following groundwater cation/anion parameters as listed in Table 2 were analysed by an accredited laboratory for interpretation.

Table 2: Groundwater Parameters Analysed.

Parameter	
Physical Properties	Total Alkalinity
	pH
	Electrical Conductivity (EC)
	TDS by Calculation
Inorganic: Anions	Nitrite (NO_2)
	Nitrate (NO_3)
	Chloride (Cl)
	Fluoride (F)
	Sulphate (SO_4)
	Phosphate (PO_4)
Inorganic: Cations	Ammonia (NH_3)
	Calcium (Ca)
	Magnesium (Mg)
	Potassium (K)
	Sodium (Na)
Inorganic: Other	Iron (Fe)
	Manganese (Mn)
	Silica (Si)
	Dissolved Oxygen (DO)

[3] Available on request from morne@gptglobal.com

4.6 Impact assessment criteria

The criteria for the description and assessment of groundwater impacts were drawn from the EIA Regulations, published by the Department of Environmental Affairs and Tourism (April 1998) in terms of the NEMA[4].

In order to determine the significance of an impact, the following criteria would be used: extent, duration, intensity and probability. The extent and probability criteria have five parameters, with a scaling of 1 to 5. Intensity also has five parameters, but with a weighted scaling.

The assessment of the intensity of the impact is a relative evaluation within the context of all the activities and other impacts within the framework of the project. The intensity rating is weighted as 2 since this is the critical issue in terms of the overall risk and impact assessment (thus the scaling of 2 to 10, with intervals of 2). The intensity is thus measured as the degree to which the project affects or changes the environment.

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes, each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. An explanation of the impact assessment criteria is defined below in Table 3.

Table 3: Explanation of the EIA criteria.

Criteria	Description
Nature	Includes a description of what causes the effect, what will be affected and how it will be affected.
Extent	The physical and spatial scale of the impact.
Duration	The lifetime of the impact is measured in relation to the lifetime of the proposed development.
Intensity	Examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself.
Probability	This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the lifecycle of the activity, and not at any given time.
Status	Description of the impact as positive, negative or neutral.
Significance	A synthesis of the characteristics described above and assessed as low, medium or high. A distinction will be made for the significance rating without the implementation of mitigation measures and with the implementation of mitigation measures.
Confidence	This is the level of knowledge/information that the environmental impact practitioner or a specialist had in his/her judgement.
Reversibility	Examining whether the impacted environment can be returned to its pre-impacted state once the cause of the impact has been removed.
Replaceability	Examining if an irreplaceable resource is impacted upon
Cumulative	Synthesis of different impacts in concert, considering the knock-on impacts thereof.

[4] Guideline document EIA regulations (April 1998): Implementation of sections 21, 22 and 26 of the environment conservation act.

4.6.1 Nature and Status

The nature of the impact is the consideration of what the impact will be and how it will be affected. This description is qualitative and gives an overview of what is specifically being considered. That is, the nature considers 'what is the cause, what is affected, and how is it affected. The status is thus given as being positive, negative or neutral, and is deemed to be either direct or indirect in impact.

4.6.2 Extent

The physical and spatial scale of the impact is classified in Table 3.

4.6.3 Duration

The lifetime of the impact is measured in relation to the lifetime of the project, as per Table 3.

4.6.4 Intensity

This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project, as per Table 3.

4.6.5 Probability

This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the lifecycle of the activity, and not at any given time. The probability classes are rated in Table 3.

4.6.6 Level of Significance

The level of significance is expressed as the sum of the area exposed to the risk (extent), the length of time that exposure may occur over in total (duration), the severity of the exposure (intensity) and the likelihood of the event occurring (probability). This leads to a range of significance values running from 'no impact' to 'extreme'.

The significance of the impacts has been determined as the consequence of the impact occurring (reflection of chance of occurring, what will be affected (extent), how long will it be affected, and how intense is the impact) as affected by the probability of it occurring, this translates to the following formula:

Significance value = (Extent + Duration + Intensity) x Probability

Each impact is considered in turn and assigned a rating calculated using the results of this formula and presented as a final rating classification according to Table 16. A distinction will be made for the significance rating of (a) without the implementation of mitigation measures, and, (b) with the implementation of mitigation measures.

4.6.7 Identifying Potential Impacts with Mitigation Measures

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale as contemplated below.

Low (L): The impact is mitigated to the point where it is of limited importance.

Medium (M): Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.

High (H): The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

5 PREVAILING GROUNDWATER CONDITIONS

5.1 Geology

5.1.1 Regional Geology

The investigated area falls within the 2528 Pretoria 1:250 000 geology series maps. An extract of these maps is shown in Figure 4.

The proposed development falls within the Selonsrivier Formation of the Rooiberg Group. The rocks of the Selonsrivier Formation mainly consist out of porphyritic amygdoidal red rhyolite, black rhyolite, agglomerate as well as sandstone and quartzite. These rocks dip slightly to the north east.

5.1.2 Local Geology

Within the study area, the geology mainly consists out of Selonsrivier Formation. The geology can be best concluded from the exploration drilling done by SGRS.

5.1.2.1 Percussion drilling

One (1) percussion borehole was drilled taking planned development and groundwater flow into account and where access was allowed. The borehole can be described as follows:

The lithology encountered is typical of Selonsrivier Formation of the Rooiberg Group (Appendix III).

- The borehole had brown to red soil overburden from 0 mbgl to 5 mbgl.
- From 5 mbgl to 20 mbgl, red, moderately weathered rhyolite was encountered.
- Seepage was encountered at 16 mbgl, and the formation was highly weathered until 20 mbgl.

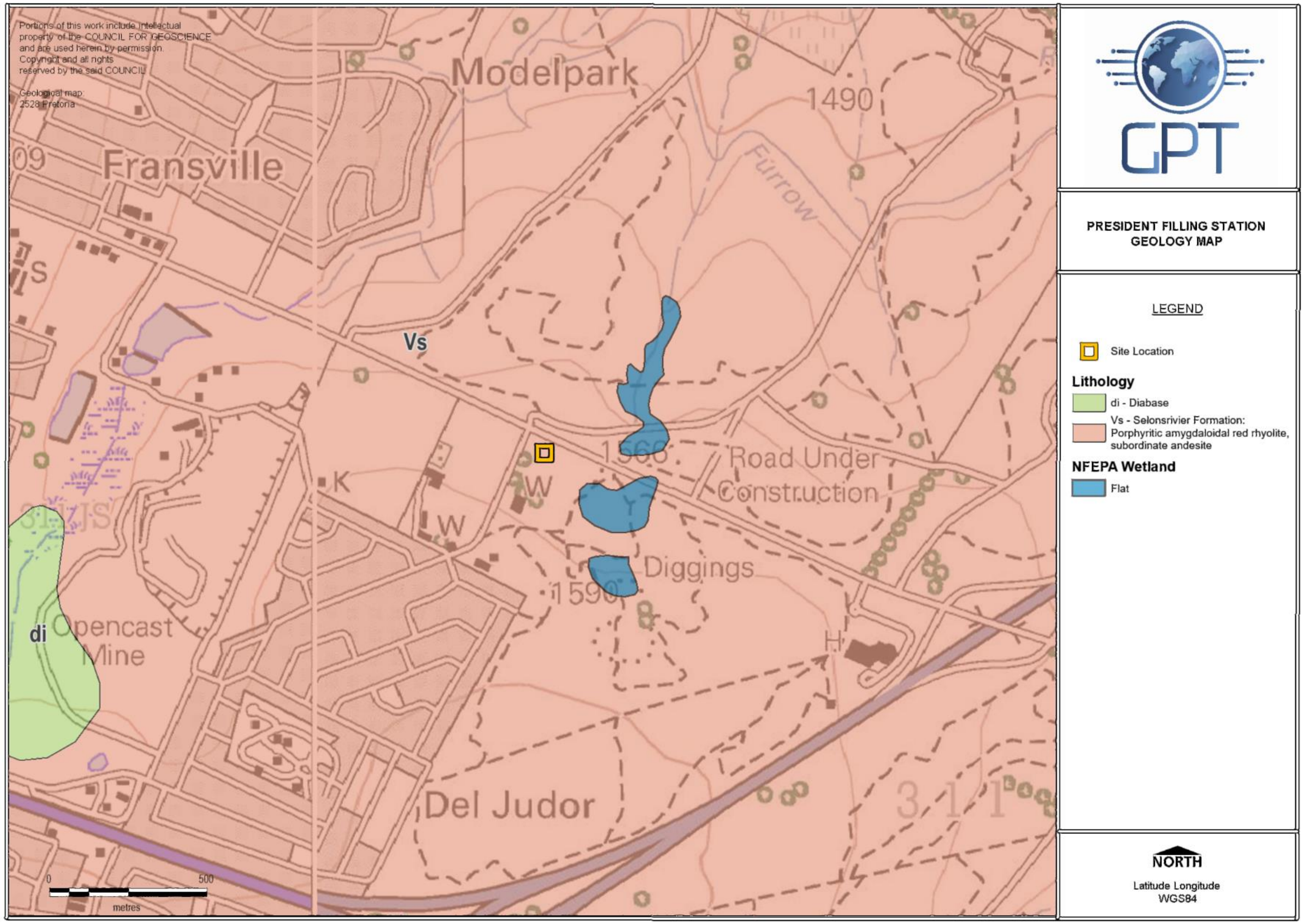

Figure 4: Regional Geology Map (1:250 000 geology series map)

5.2 Hydrogeology

According to the 1:500 000 General Hydrogeological Map[5] the Selonsrivier Formation (Rooiberg Group) rocks typically act as secondary aquifers (intergranular and fractured rock aquifers). However, the multi-layered weathering system present on these rocks could prove to have up to two aquifer systems present in the form of a shallow, saprolitic aquifer with a weathered, intergranular soft rock base associated with the contact of fresh bedrock and the weathering zone; and a fractured bedrock aquifer. These aquifer systems are discussed below. The aquifer can be classified as a minor aquifer with moderate vulnerability.

5.2.1 Unsaturated zone - Shallow, saprolitic aquifer

The main source of recharge into the shallow aquifer is rainfall that infiltrates the aquifer through the unsaturated (vadose) zone. Vertical movement of water is faster than lateral movement in this system as water moves predominantly under the influence of gravity. This aquifer may contain coarse, sand sediment when underlain by sandstone respectively. The hydraulic conductivity of the coarse, sand sediment can reach up to 20 m/day with porosities ranging between values of 0.25 to 0.5.

5.2.2 Saturated zone - Fractured, bedrock aquifer

Groundwater movement is predominantly associated with secondary structures in this aquifer (fractures, faults, dykes, etc.). The average water level depth in the area ranges between 5 and 10 mbgl. Borehole yields in the Selonsrivier fractured aquifers are generally low and can be expected to be between 0.1 and 0.5 l/s with regional flow resembling flow in the porous medium (i.e. obeying Darcy's law). These formations contain limited quantities of water resources due to the poor storage capacity of the igneous rock.

Both the porosity[6] and the hydraulic conductivity[7] of the Selonsrivier Formation fractured and intergranular aquifers are known to be low. The commonly expected values of porosity and permeability for igneous rock types are 0.05 (porosity) and 10^{-5} $m.d^{-1}$ (hydraulic conductivity) respectively (Kruseman & de Ridder, 1994). Movement of groundwater in this aquifer will be preferential in secondary structures such as joints, faults and fractures.

5.2.2.1 Rooiberg Group (Transvaal Supergroup)[5]

The porphyritic rhyolite and felsite associated with this unit represent acidic lava having a greater resistance to weathering than rock types which represent basic lava. The nature of these rocks and their weathering product is similar to that of granite, so that groundwater is usually encountered in the transition zone between weathered and more solid rock. Breccia and joint zones as well as lithological and dyke contact zones also contribute to a groundwater yield potential that is classed as poor on the basis that 86% of the available borehole yield records report a value of less than 2 l/sec. The groundwater rest level typically occurs between 10 m and 30 m below surface.

Generally excellent water quality of the groundwater as borne out by the average EC value of 34 mS/m and a mean pH value of 7.1. Elements that show a substantial coefficient of variation are

5 Barnard, H.C., (2000). An explanation of the 1:500 000 General Hydrogeological Map. Pretoria 2528. DWAF.

6 The ratio of the volume of void space to the total volume of the rock or earth material

7 Measure of the ease with which water will pass through the earth's material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (m/d).

sulphate and nitrate. The latter indicates that although a small measure of caution is required when considering this water for human consumption, it is generally suitable for all use.

5.3 Hydrocensus and Borehole Locations

The NGA database search did not identify any boreholes within a 1km radius from the proposed development area.

To the south and south-western direction of the proposed site (in an upstream direction), private properties (houses) along Nita Avenue, Melissa Street, Lynette Street and Cecile Street were visited, however, no additional boreholes were found as there was no access to these properties (owners of the properties were either not available or did not want to interact due to COVID-19 pandemic).

Four neighbouring properties (businesses) within a 500 m radius were visited during the hydrocensus. All information regarding properties visited and details of properties are available in Table 4. During the hydrocensus (Figure 5), except for the 1 newly drilled borehole, no additional groundwater level measurement could be measured. Only one additional borehole was found (Highveld View), a water sample was taken from the tank, however, no water level could be measured as the borehole was sealed. Based on the information collected during the hydrocensus, the borehole is used by Highveld View (private borehole) for irrigating the gardens, using as swimming pool water as well as drinking water.

5.4 Groundwater Quality

Water samples were collected from 1 borehole around the site, and from 1 newly drilled borehole. The water results are compared with the maximum recommended concentrations for domestic use as defined by the SANS 241-1: 2015 target water quality limits. The SANS 241-1: 2015 standard is applicable to all water services institutions and sets numerical limits for specific determinants to provide the minimum assurance necessary that the drinking water is deemed to present an acceptable health risk for lifetime consumption. Colours of individual cells refer to the drinking water classification of the specific groundwater sample.

The results for groundwater are presented in Table 5 and discussed in the sections below:

5.4.1 Groundwater quality vs SANS 241-1:2015 standards for domestic use

- Calcium concentrations is within tolerable limits in BH1.
- Manganese concentrations is within tolerable limits at MW1.
- None of the samples exceed the TWQR limits, therefore both samples comply with the SANS 241-1:2015 Standards for Domestic Use.

5.4.2 Groundwater quality vs Tier 1 Risk Based Screening Levels

The groundwater sample was also analysed for hydrocarbon compounds, the results of the analysis are listed in Table 6. The concentrations were compared to Tier 1 Risk Based Screening Levels GW Ingestion - Commercial in order to determine the potential health risks posed to human receptors by contamination (Table 7). The following observations were made: Both sample analysis was below detection limit and no potential health risks are associated with the water at MW1 and BH1.

5.4.3 Spatial analysis of groundwater quality

The pie diagrams (Figure 6) show both the individual ions present in a water sample and the total ion concentrations in meq/l or mg/l. The scale for the radius of the circle represents the total ion concentrations, while the subdivisions represent the individual ions. It is very useful in making quick comparisons between waters from different sources and presents the data in a convenient manner for visual inspection. From the tables and figures the following can be deduced:

- BH1 upstream of the proposed operation have higher proportions of SO_4 and Ca.
- MW1 downstream of the proposed area have higher proportions of K and HCO_3.

Table 4: Hydrocensus information.

Property	Latitude	Longitude	Borehole	Contact Person (if available)	Contact Details (if available)	Comments
Groundwater						
Casa Portuguesa	-25.8839	29.25648	No	Mr. Paul	083-259-3176	No one available by time of site visit. A telephonic conversation with the owner confirmed that they do use municipal water and have no borehole.
Nissan	-25.8819	29.25617	No	-	-	According to employee, no borehole. Uses municipal water.
Highveld View	-25.8841	29.25547	Yes	Ms. Justice	-	Borehole was sealed, therefore, no water level could be measured, however sample taken.
Witbank Baptist Church	-25.8855	29.25468	No	Mr. Karl	076-110-9722	No one available by time of site visit. A telephonic conversation with Mr. Karl confirmed that they do use only municipal water.
Surface Water						
Tributary NE of site	-25.8806	29.26051	N/A	N/A	N/A	Stream Dry.

5.4.4 Water Type

The Piper diagram (Figure 8) displays the combination of the cation and anions on a triangle that lies on a common baseline. A diamond shape between them is used to replot the analyses as different symbols whose areas are proportional to their TDS. These positions are used to make a tentative conclusion on the origin of the water represented by the analysis. From the results it is observed that MW1 have deeper fresh groundwater. The presence of HCO_3 suggest evidence of freshly recharged water. BH1 falls within slightly polluted water type, with the presence of SO_4.

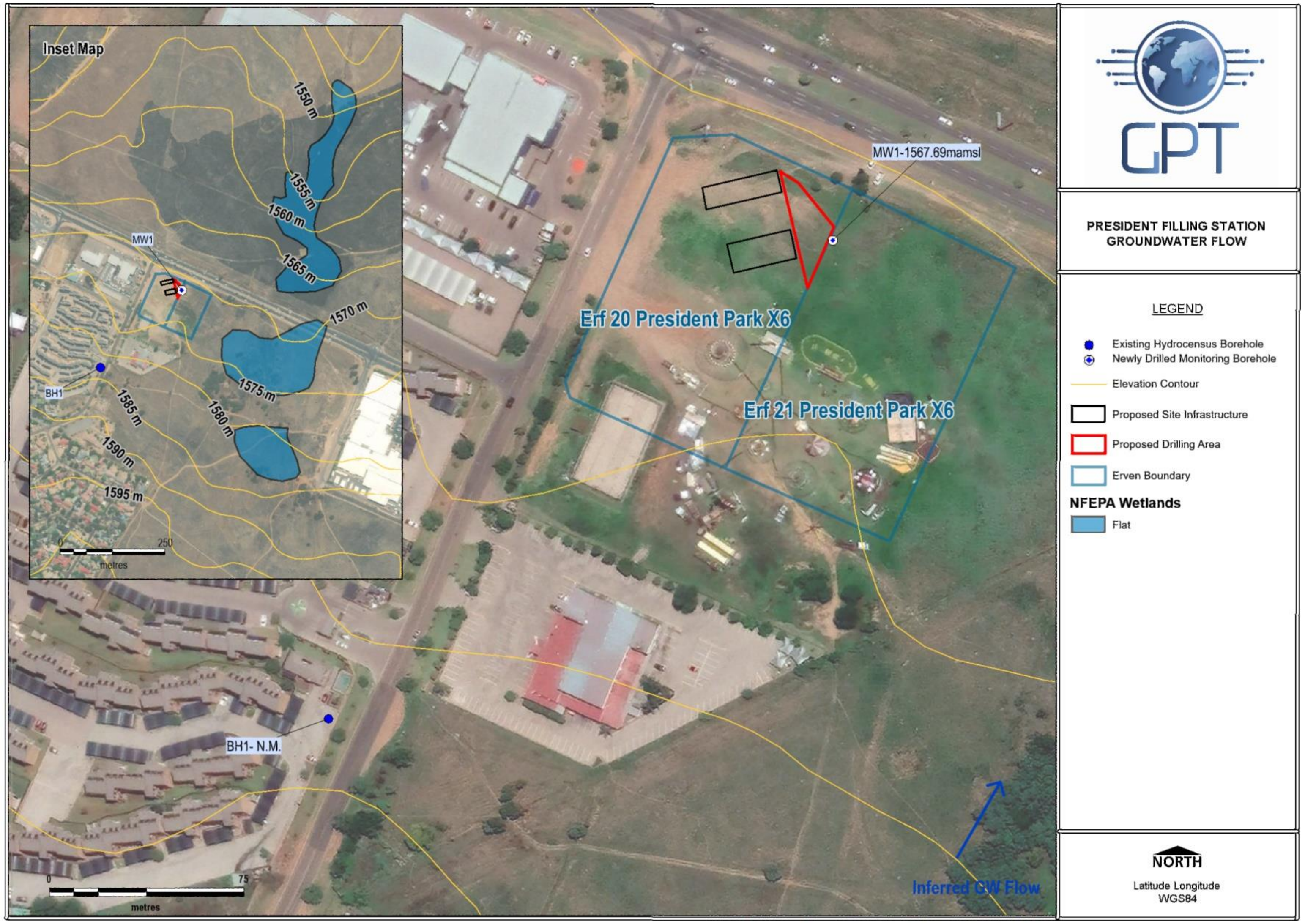

Figure 5: Map indicating hydrocensus borehole BH1, newly drilled borehole MW1 and inferred groundwater flow direction.

Table 5: Water qualities compared to SANS 241-1:2015 guidelines for domestic use.

Water Quality Constituents		MW1	BH1	TWQR	Tolerable	Exceeding TWQR
Total Alkalinity	M Alk. [mg/l CaCO3]	54.00	61.20	*Not available*		
Aluminium	Al [mg/l]	0.00	0.00	0 - 0.15	0.15 - 0.5	> 0.5
Calcium	Ca [mg/l]	4.86	37.00	0 - 32	32 - 80	> 80
Chloride	Cl [mg/l]	3.82	21.00	0 - 100	100 - 600	> 600
Dissolved Oxygen	DO [mg/l]	5.92	6.08	*Not available*		
Electrical Conductivity	EC [mS/m]	15.00	51.20	*Not available*		
Fluoride	F [mg/l]	0.00	0.18	0 - 1.0	1.0 - 1.5	> 1.5
Iron	Total Fe [mg/l]	0.00	0.00	0 - 0.1	0.1 - 1.0	> 1.0
Magnesium	Mg [mg/l]	2.06	24.40	0 - 30	30 - 70	> 70
Manganese	Mn [mg/l]	0.06	0.00	0 - 0.05	0.05 - 1.0	> 1.0
Nitrate	NO_3 as N [mg/l]	1.59	0.49	0 - 6		> 6
pH	pH units	7.05	7.19	6.0 - 9.0		<6, >9
Potassium	K [mg/l]	9.90	6.24	0 - 50	50 - 100	> 100
Sodium	Na [mg/l]	13.00	21.30	0 - 100	100 - 200	> 200
Sulphate	SO_4 [mg/l]	1.91	162.00	0 - 200	200 - 400	> 400
Total Dissolved Solids	TDS [mg/l]	76.11	311.17	0 - 450	450 - 1 000	> 1000
Cation/Anion Balance %		-2.39	-2.56	*Error should not exceed 5%*		
Notes: A value of zero indicates that the analysis was below the detection limit						
TWQR- Target water quality range						
Tolerable - Suitable for short-term intake, in some instance's health problems can occur during extensive long-term intake in sensitive individuals such as infants						
Exceeding TWQR- Exceedance of target water quality range may lead to adverse effects						

Table 6: Water analysis results (mg/l) - organic compounds.

	Sample no.	MW1	BH1
	Sample depth (mbgl)	10mbgl	Tap Sample
Gasoline Range Organics	Benzene	BDL	BDL
	Toluene	BDL	BDL
	Ethylbenzene	BDL	BDL
	Xylenes	BDL	BDL
	MTBE	BDL	BDL
	TAME	BDL	BDL
	Naphthalene	BDL	BDL
	1,2,4 Trimethyl benzene	BDL	BDL
	1,3,5 Trimethyl benzene	BDL	BDL
Poly Aromatic Compounds	Acenaphthene	BDL	BDL
	Acenaphthylene	BDL	BDL
	Fluorene	BDL	BDL
	Phenanthrene	BDL	BDL
	Anthracene	BDL	BDL
	Fluoranthene	BDL	BDL
	Pyrene	BDL	BDL
Diesel Range Organics	TPH Aliphatic C_8-C_{10}	NA	NA
	TPH Aliphatic C_{10}-C_{12}	BDL	BDL
	TPH Aliphatic C_{12}-C_{16}	BDL	BDL
	TPH Aliphatic C_{16}-C_{20}	BDL	BDL
	TPH Aliphatic C_{10}-C_{14}	BDL	BDL
	*TPH Aliphatic C_{15}-C_{36}	BDL	BDL
	Total VPHs Identified	BDL	BDL
	Estimated VPHs Unidentified	BDL	BDL
	Estimated TOTAL VPHs	BDL	BDL

Table 7: Water screening results (RBSL).

Relevant GW Exposure Pathway	MW1	BH1
Tier 1 RBSL GW Ingestion - Commercial	*No compound exceeded its screening level*	*No compound exceeded its screening level*
Tier 1 RBSL Indoor Air - Commercial	*No compound exceeded its screening level*	*No compound exceeded its screening level*
Tier 1 RBSL Outdoor Air - Commercial	*No compound exceeded its screening level*	*No compound exceeded its screening level*

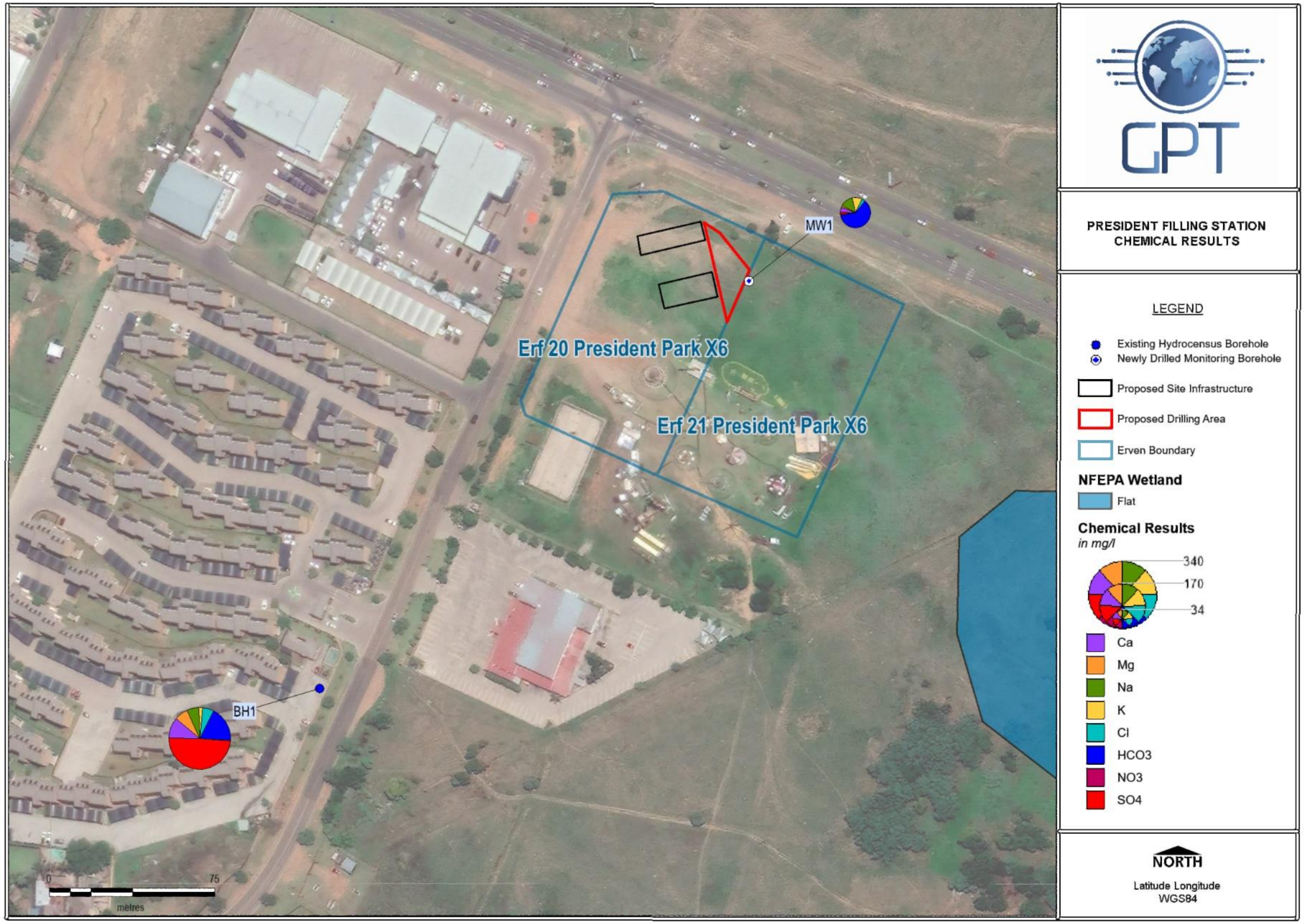

Figure 6: Pie diagrams for groundwater samples.

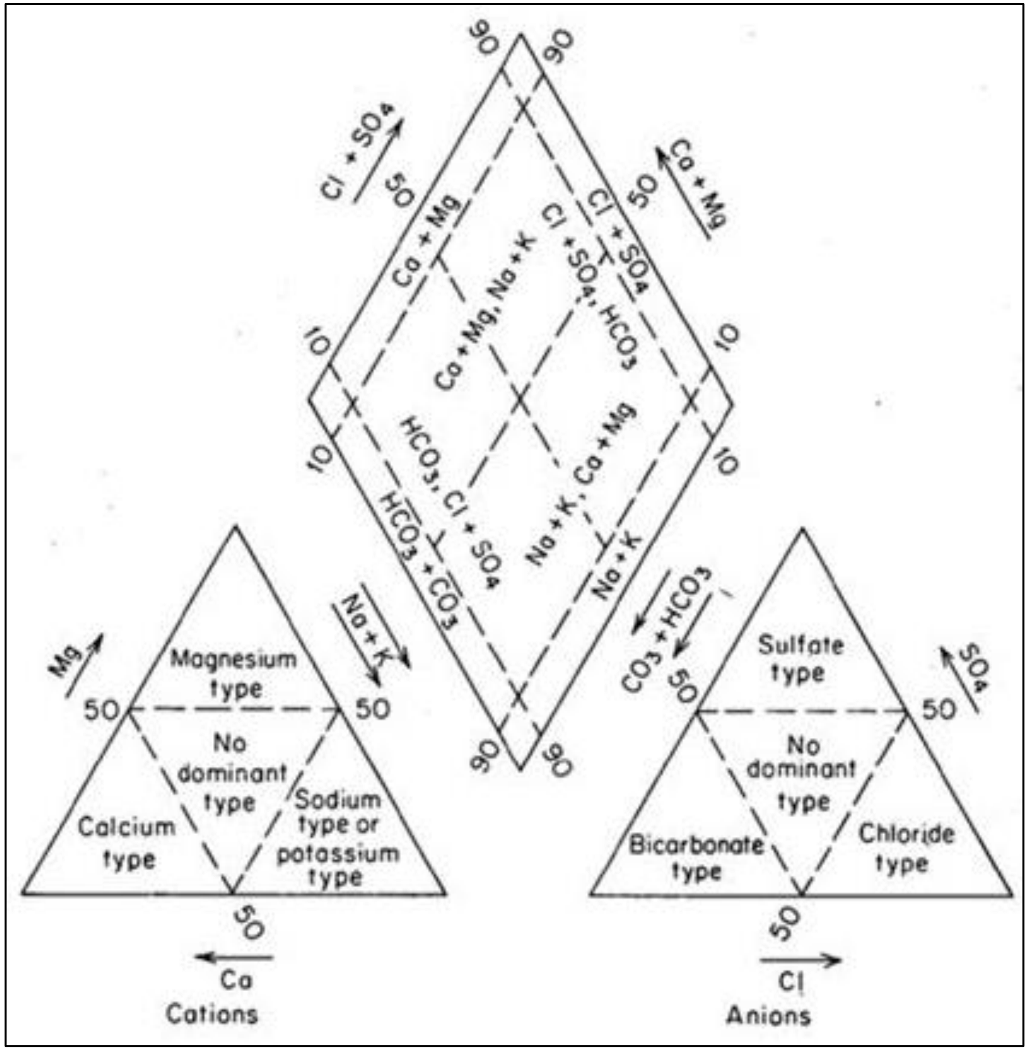

Figure 7: Explanation of the hydrochemical facies in the Piper Diagram.

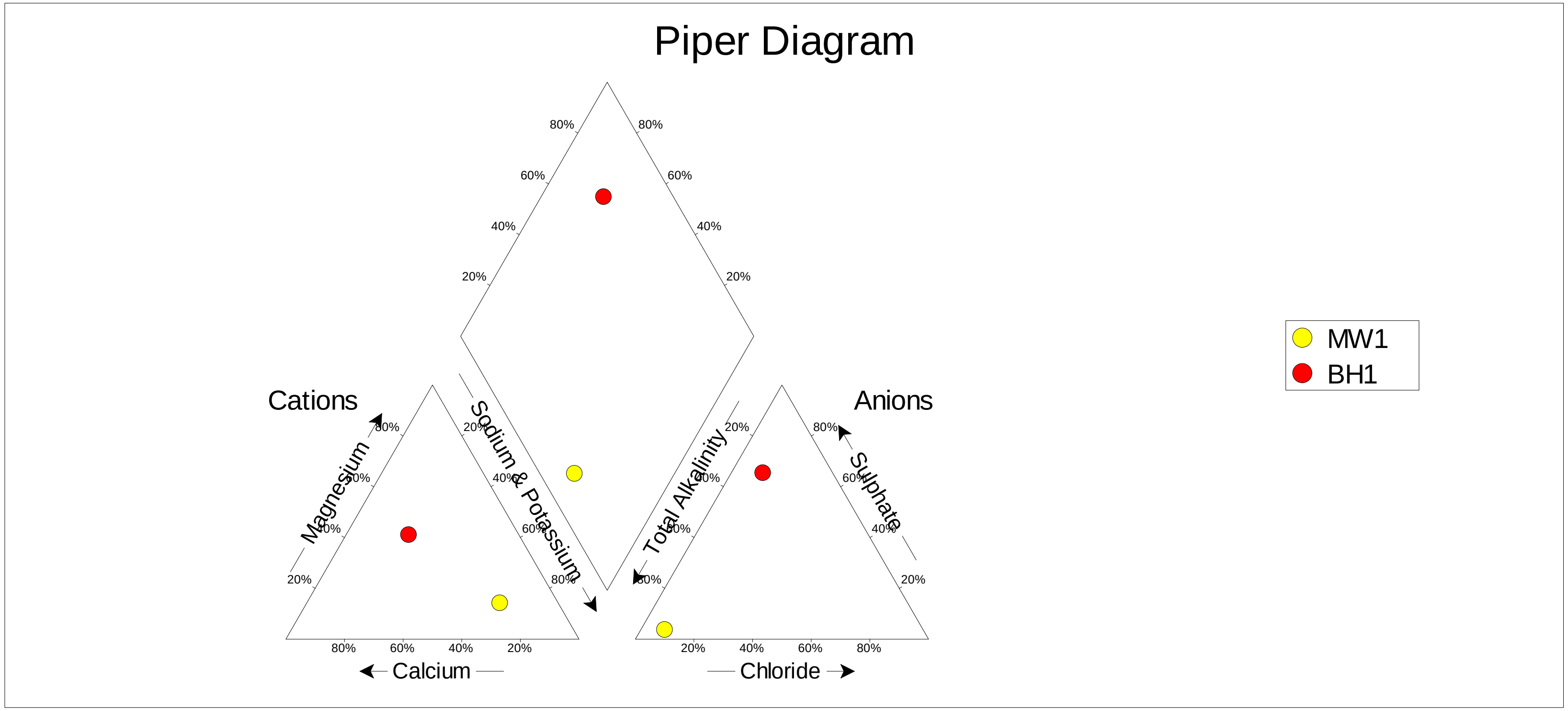

Figure 8: Piper Diagram.

5.5 Hydraulic conductivity and estimated groundwater flow velocity

A bail-down test was conducted on monitoring borehole MW1 in order to determine the hydraulic conductivity of the underlying aquifer. During a bail-down test, a volume of water is removed from the borehole with a change of the water level as a result. After the initial change, the water level gradually returns to its static position. The rate of this process is a function of the size of the pulse and the geohydrological parameters, i.e. the hydraulic conductivity (K) of the aquifer. Therefore, if it is possible to establish a relation between the piezometric head in the aquifer and the variation of the disturbed water level in the borehole, it is possible to obtain estimates of the hydraulic conductivity (K) of the aquifer in the vicinity of the borehole. The bail-down test data was interpreted by using the FC-method software (Appendix IV) and the following K-value was determined:

MW1 = 0.01 m/d

Once "K" is known, an approximate groundwater flow velocity ("v" in metres per day) can be calculated. The hydraulic gradient (i) is taken as 0.03 in a northern direction. The porosity (n) is taken as 0.05 (5%).

$$v = Ki/n$$

$$v = 6 \times 10^{-3} \text{ m/d}$$

Based on the flow velocity calculated above, groundwater on-site is expected to travel approximately 2.2 m per year in a northern direction under steady state conditions (if no preferential flow paths exist).

6 CONCEPTUAL SITE MODEL (CSM)

In principle, the conceptual site model (CSM) is one of the primary planning tools that can be used to support the decision-making process and the management of contaminated land and groundwater on a large scale. The CSM organises available information about a site in a clear and transparent structure and facilitates the identification of data and information gaps. Once the CSM is established, additional required data can be gathered and integrated in the CSM, followed by a revision of the CSM and a refinement of decision goals over time. Thus, the CSM matures and enables an improved understanding of the environmental status, receptor profiles, and source terms, and subsequently the re-adjustment of decision criteria.

- *Surrounding Land Use*: The dominant land use within 500 m of the property is residential.
- *Geology*: The site is underlain by rhyolite of the Selonsrivier Formation (Rooiberg Group).
- *Aquifer Description*: The site is underlain by a shallow perched aquifer type. The deeper aquifer is a fractured rhyolitic aquifer type. The borehole yields in the Selonsrivier Formation range between 0.1 and 0.5 l/s. The newly drilled borehole only has seepage water.
- *Topography*: The site is located at an altitude of approximately 1 572 mamsl with a gradient of 0.03 in a northern direction.
- *Static Water Level*: During the drilling phase, seepage was encountered at 16 m, and the static groundwater level measured in the newly drilled borehole is 5.31 mbgl.
- *Groundwater Quality*: Calcium concentrations is within tolerable limits in BH1. Manganese concentrations is within tolerable limits at MW1. None of the samples exceed the TWQR limits, therefore both samples comply with the SANS 241-1:2015 Standards for Domestic Use.

- *Contamination Pathway Summary*: According to the results of the two boreholes, it is clear that concentrations in BH1 (upstream of site) are higher than in the newly drilled borehole MW1.
- *Receptors*: The tributary (unnamed stream) of the Olifants River, approximately 200m northeast of the study area, as well as the wetlands to the east and north of the site.

7 HYDROGEOLOGICAL IMPACT ASSESSMENT

Based on the impact assessment criteria as detailed in the preceding paragraph an impact rating is given in Table 8 to Table 17. The tables also summarise all the groundwater related EMP's and should be implemented during the planned activities.

When considering the potential impacts of the proposed development in terms of groundwater, there are two issues at stake. The first is the impact on the groundwater during the construction phase of the proposed development and the second the impact on the groundwater during the operational phase of the proposed development. Each of the phases and its associated potential impacts will be assessed as per the methodology presented in Section 4.6.

7.1 Construction Phase of Proposed Development

7.1.1 Fuel and Oil Spillage during Construction

With the use of heavy construction equipment comes the use of contaminants like fuel and oil. There is a possibility that some of this product could enter the environment if an incident should occur. Spills on surface can either run off the sealed areas into surface water drainage channel and surface water bodies. The aquifer will be very susceptible to any fuel or oil spill during construction.

7.1.2 Potential Dewatering of Groundwater During Tank Installation

During the drilling phase of MW1, seepage was encountered at approximately 16 mbgl, and the static water level is 5.31 mbgl. It is unlikely that dewatering will be required based on the depth where seepage was encountered and based on the static water level of the newly drilled borehole on site.

7.1.3 Removal of soil, subsoil and rock

The construction phase would involve the installation of the underground tanks i.e. removal of vegetation and excavation of the pit for tanks (i.e. removal of soil, subsoil and rhyolitic rock). Depending on the tank size, installation takes place between 3m and 6m. Groundwater would therefore not be impacted as a result of the excavation activities as the water table is situated at 16m where seepage was encountered during the drilling phase. The buffer between the groundwater table and the underground tanks (installed on a worst-case scenario at 6m) will be 10m.

Table 8: Impact assessment during construction - Extent.

Criteria	Description	Scoring	Fuel and oil spillage during construction	Removal of vegetation, soil, subsoil and rock
Without Mitigation (WOM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	2	1
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		
With Mitigation (WM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	1	1
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		

Table 9: Impact assessment during construction - Duration.

Criteria	Description	Scoring	Fuel and oil spillage during construction	Removal of vegetation, soil, subsoil and rock
Without Mitigation (WOM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	1	1
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		
With Mitigation (WM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	1	1
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		

Table 10: Impact assessment during construction - Intensity.

Criteria	Description	Scoring	Fuel and oil spillage during construction	Removal of vegetation, soil, subsoil and rock
Without Mitigation (WOM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	6	2
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		
With Mitigation (WM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	2	2
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		

Table 11: Impact assessment during construction - Probability.

Criteria	Description	Scoring	Fuel and oil spillage during construction	Removal of vegetation, soil, subsoil and rock
	Without Mitigation (WOM)			
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	4	3
Possible	The possibility of the impact occurring is very low, either due to the circumstances, design or experience (25 - 49%).	2		
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made (50 - 69%).	3		
Highly likely	It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 - 89%).	4		
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 - 100%).	5		
	With Mitigation (WM)			
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	3	2
Possible	The possibility of the impact occurring is very low, either due to the circumstances, design or experience (25 - 49%).	2		
Likely	There is a possibility that the impact will occur to the extent that provisions must therefore be made (50 - 69%).	3		
Highly likely	It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 - 89%).	4		
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 - 100%).	5		

Table 12: Impact assessment during construction - Significance.

Criteria	Description	Scoring	Fuel and oil spillage during construction	Removal of vegetation, soil, subsoil and rock
Without Mitigation (WOM)				
No Impact	There is no impact.	0-9	36	12
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 - 49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		
With Mitigation (WM)				
No Impact	There is no impact.	0-9	12	8
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 -49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		

7.2 Operational Phase of Proposed Development

Despite the rigorous operating procedures and mechanical equipment integrity of equipment some product may escape from containment to groundwater during site operations. Therefore, effective containment and controls must be put in place.

7.2.1 Hazardous Liquid (contaminates) Surface Spills

The most frequent spills are refuelling incidents, spills caused by leaking truck fuel tanks, filling of portable containers, filling of underground storage tanks either directly or through filler points. Hazardous liquids spilled on surface can run off the sealed areas into surface water drainage channels and surface water bodies. Surface spills can cause hazardous liquids to mobilize directly into the storm waters. It is highly unlikely that surface spills can enter the major shallow intergranular aquifer directly as seepage was found to be at 16 m. The areas susceptible to surface spills should be impermeable. The surface runoff must be controlled to a separator.

7.2.2 Hazardous Liquid (Contaminants) Subsurface Leaks

Hazardous liquids can also be spilled under dispenser valves and flexible couplings, pipelines, tanks and off set fill pipes, faulty oil or water separator operations. Since the pipelines and underground storage tanks will be installed below the soil horizon (0-5 m), it may be assumed that the pollutants will travel directly into the intergranular aquifer, hereafter into the deeper fractured aquifer.

7.2.3 Migration of Contaminants

The vertical migration distance of the contaminants will be very short for the intergranular aquifer. The horizontal migration for the aquifer would be very high if the contaminants enter the aquifer. The hazardous liquids can further than either stagnate where it will form a secondary source of contamination or mobilize further into the fractured aquifer. Mobilization of hazardous liquids in the fractured aquifer can occur along the weathered fracture bedrock, bedding planes and through vertical fractures. Based on the hydrocensus, no nearby groundwater users were identified with the exception of BH1 (Highveld View upstream of the proposed site). If development does occur in the future to the north of the site, then these nearby groundwater users may be impacted in the instance of a leak, as the plume movement will be towards the north to north eastern direction. Leak proof dip trays or membrane arrangement beneath the dispenser must be fitted. Pump sumps should be impervious to fuel and adequately protected against erosion and fitted with leak detectors. Fuel storage tanks installed below the ground should be of the corrosion resistant double skin or composite type and incorporate leak detection monitoring. The manholes should have secondary containment.

Table 13: Impact assessment during operation - Extent.

Criteria	Description	Scoring	Hazardous Liquid (contaminants) Surface Spills	Hazardous Liquid (contaminates) Subsurface Leaks
Without Mitigation (WOM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	2	3
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		
Without Mitigation (WM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	1	2
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		

Table 14: Impact assessment during operation - Duration.

Criteria	Description	Scoring	Hazardous Liquid (contaminants) Surface Spills	Hazardous Liquid (contaminants) Subsurface Leaks
Without Mitigation (WOM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	3	4
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		
Without Mitigation (WM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	2	3
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		

Table 15: Impact assessment during operation - Intensity.

Criteria	Description	Scoring	Hazardous Liquid (contaminants) Surface Spills	Hazardous Liquid (contaminates) Subsurface Leaks
Without Mitigation (WOM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	6	6
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		
With Mitigation (WM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	2	4
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		

Table 16: Impact assessment during operation - Probability.

Description	Scoring	Hazardous Liquid (contaminants) Surface Spills	Hazardous Liquid (contaminants) Subsurface Leaks
Without Mitigation (WOM)			
The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	4	4
The possibility of the impact occurring is very low, either due to the circumstances, design or experience (25 – 49%).	2		
There is a possibility that the impact will occur to the extent that provisions must therefore be made (50 – 69%).	3		
It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 – 89%).	4		
The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 – 100%).	5		
With Mitigation (WM)			
The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	3	3
The possibility of the impact occurring is very low, either due to the circumstances, design or experience (25 – 49%).	2		
There is a possibility that the impact will occur to the extent that provisions must therefore be made (50 – 69%).	3		
It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 – 89%).	4		
The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 – 100%).	5		

Table 17: Impact assessment during operation - Significance.

Criteria	Description	Scoring	Hazardous Liquid (contaminants) Surface Spills	Hazardous Liquid (contaminats) Subsurface Leaks
Without Mitigation (WOM)				
No Impact	There is no impact.	0-9	44	52
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 - 49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		
With Mitigation (WM)				
No Impact	There is no impact.	0-9	15	27
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 -49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		

8 GROUNDWATER MONITORING SYSTEM

8.1 Groundwater Monitoring Network

A groundwater monitoring system has to adhere to the criteria mentioned below. As a result, the system should be developed accordingly.

8.1.1 Source, plume, impact and background monitoring

A groundwater monitoring network should contain monitoring positions which can assess the groundwater status at certain areas. The boreholes can be grouped classification according to the following purposes:

- **Source monitoring:** Monitoring boreholes are placed close to or in the source of contamination to evaluate the impact thereof on the groundwater chemistry.
- **Plume monitoring:** Monitoring boreholes are placed in the primary groundwater plume's migration path to evaluate the migration rates and chemical changes along the pathway.
- **Impact monitoring:** Monitoring of possible impacts of contaminated groundwater on sensitive ecosystems or other receptors. These monitoring points are also installed as early warning systems for contamination break-through at areas of concern.
- **Background monitoring:** Background groundwater quality is essential to evaluate the impact of a specific action/pollution source on the groundwater chemistry.

8.1.2 System response monitoring network

Groundwater levels: The response of water levels to abstraction is monitored. Static water levels are also used to determine the flow direction and hydraulic gradient within an aquifer. Where possible all of the above-mentioned borehole's water levels need to be recorded during each monitoring event.

8.1.3 Monitoring parameters

The identification of the monitoring parameters is crucial and depends on the chemistry of possible pollution sources. They comprise a set of physical and/or chemical parameters (e.g. groundwater levels and predetermined organic and inorganic chemical constituents). Once a pollution indicator has been identified it can be used as a substitute to full analysis and therefore save costs. The use of pollution indicators should be validated on a regular basis in the different sampling positions. The parameters should be revised after each sampling event; some metals may be added to the analyses during the operational phase, especially if the pH drops.

8.1.4 Abbreviated analysis (pollution indicators)

Physical Parameters:

- Groundwater levels

Chemical Parameters:

- Field measurements:
  - pH, EC
- Laboratory analyses:

  - Major anions and cations (Ca, Na, Cl, SO4)
  - Other parameters (EC)

8.1.5 Full analysis

Physical Parameters:

- Groundwater levels

Chemical Parameters:

- Field measurements:
  - pH, EC
- Laboratory analyses:
  - Anions and cations (Ca, Mg, Na, K, NO3, Cl, SO4, F, Fe, Mn, Al, & Alkalinity)
  - Other parameters (pH, EC, TDS)
  - Petroleum hydrocarbon contaminants (where applicable, near workshops and petroleum handling facilities)
  - Sewage related contaminants (E.Coli, faecal coliforms) in borehole in proximity to septic tanks or sewage plants.

Organic Parameters:

- Analyses of Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) at a SANAS accredited Organics laboratory.

8.1.6 Monitoring frequency

In the operational phase and closure phase, bi-annual monitoring of groundwater quality and groundwater levels is recommended. Quality monitoring should take place before, after and during the wet season, i.e. during September and March. It is important to note that a groundwater-monitoring network should also be dynamic. This means that the network should be extended over time to accommodate the migration of potential contaminants through the aquifer as well as the expansion of infrastructure and/or addition of possible pollution sources.

8.2 Monitoring Boreholes

DWAF (1998) states that "A monitoring hole must be such that the section of the groundwater most likely to be polluted first, is suitably penetrated to ensure the most realistic monitoring result."[8]

Currently a monitoring network does not exist for the proposed development. The recommended monitoring borehole is listed in Table 18 and the location of the monitoring borehole is shown in Figure 9. The borehole can be utilised for water level monitoring during operations, as well as groundwater quality monitoring of the site.

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[8] Department of Water Affairs and Forestry (DWAF). (1998). Minimum Requirements for the Water Monitoring at Waste Management Facilities. CTP Book Printers. Cape Town.

However, a monitoring network should be dynamic. This means that the network should be extended over time to accommodate the migration of contaminants through the aquifer as well as the expansion of infrastructure and/or addition of possible pollution sources. An audit on the monitoring network should be conducted annually.

Table 18: Proposed monitoring positions.

ID	Latitude (South)	Longitude (East)	Owner	Borehole Depth (mbgl)	Reasoning	Frequency	Existing/New
Groundwater							
MW1	-25.882600	29.257500	President Park	20	Source Monitoring	Quarterly	Newly Drilled

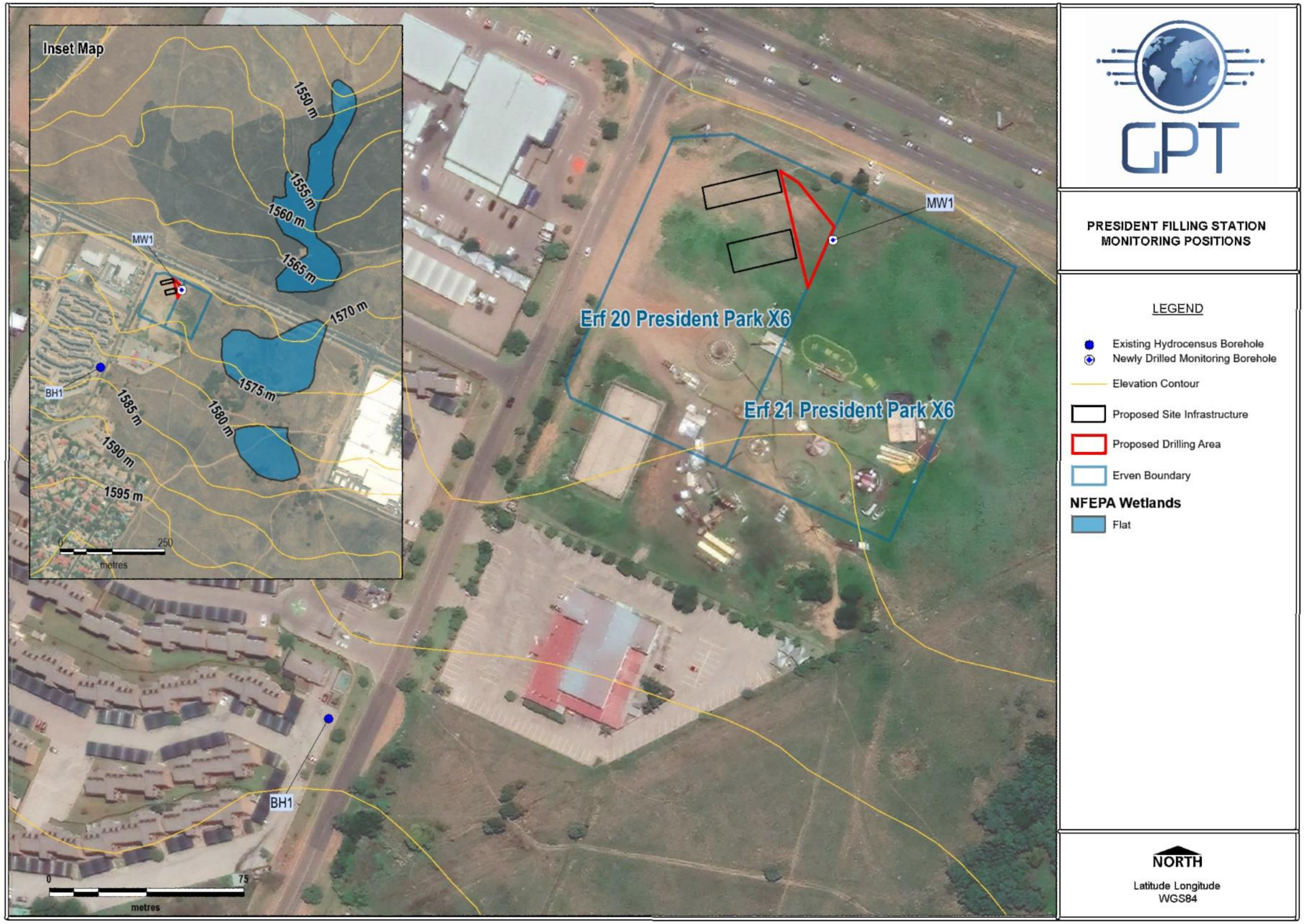


Figure 9: Proposed monitoring position of the newly drilled borehole MW1.

9 MITIGATION MEASURES RECOMMENDATIONS

The impact measures during construction phase were calculated to be medium without mitigation. During the operational phase the impacts were calculated to be medium to high without mitigation. Mitigation measures therefore need to be implemented to lower the significance of the impact of fuel and oil spillage during the construction phase and for hazardous liquid (contaminants) for surface and subsurface spills during operational phase. The proposed development at President Park can continue from a hydrogeological perspective, however protection to the aquifer must be prioritized by following the mitigation, recommendations, management and monitoring procedures below:

9.1 Construction Phase

- Drip trays should be used when servicing machinery; that all contaminated material be removed off-site and disposed of in a responsible manner.
- No fuel storage should take place during construction onsite.
- During the drilling phase of MW1, seepage was encountered at approximately 16 mbgl, and the static water level is 5.31 mbgl. It is unlikely that dewatering will be required based on the depth where seepage was encountered and based on the static water level of the newly drilled borehole on site.

9.2 Operational Phase

- Areas susceptible to contamination or tanker off-loading points, should be impermeable to hydrocarbons. Run off should be controlled by appropriate drainage to a separator connected to a sewer.
- All dispensers should be fitted with a leak proof drip tray or membrane arrangement beneath the dispenser. To avoid subsurface contamination, under pump sumps should be impervious to fuels, adequately protected against corrosion, and sealed at all pipe entries, fitted with appropriate leak detector devices, designed to allow any removal of fuel.
- It is essential that any pipework has protection against corrosion. Joints for pipework may be mechanical. The pipework should always be connected to tanks or dispensers using flexible connections. The use of enclosed systems within conduits that drain to inspection manholes or double walled piping underground, should be considered, since such mitigation measurements would further reduce the risk of spills to ground.
- Fuel storage tanks installed below the ground should be of corrosion resistant double skin or composite type and incorporate leak detection monitoring. The manholes should have secondary containment.
- Observation wells should be installed vertically without any curvature to the pipe adjacent to fuel tanks for monitoring purposes.
- Fillers should be sited that surface water and soil are prevented from entering the filler box. The filler box should be leakproof, able to contain the contents of a bulk delivery vehicle discharge hose and have secondary containment.
- Care shall be taken to ensure that the basic indication that an overfill has occurred or is imminent, is not the spilling of the product out of the dip pipe, but a slowing down or stoppage of the delivery flow. To achieve this, a back pressure must develop in the storage tank.

10 Management and Monitoring Requirements

- All new underground petroleum storage systems will require automatic tank gauging.
- USTs must be dipped daily and reconciled against volume to check for losses due to leakage.
- All existing underground petroleum storage systems will require a leak monitoring system for tanks and piping where practicable. Where it is not practicable to implement such a system, a suitable alternative process to check for any loss from the system on a regular basis must be implemented.
- Leak detection installed including observation wells situated around the tank farm to facilitate early warning that a leak has arisen.
- SANS codes must be applied during the construction of the development.
- Installation must comply with local authority bylaws.
- Mitigation Measures included in the report to be included in the Draft Environmental Management Programme.
- Surface spillages that occur must be directed to separator before discharge into municipal sewer.
- Regular inspections on oil interceptors to ensure proper functioning. Should any information come to light that a possible leak or spill has occurred, the extent of the contamination in the subsurface needs to be determined through a site assessment, a hydrocensus that includes sampling should be completed and the relevant authorities need to be notified.
- Assessment during the dewatering design phase will assist in the determination of the most appropriate operational methodology, tanked or sump and pump, and the corresponding monitoring method. This will assist incompliance with legislative requirements and addressing potential impacts on the completed structure after construction.
- To ensure that any potential environmental harm is managed correctly and to enable the proponent to demonstrate compliance, regular monitoring of water quality parameters must continue in a manner advised by the local council by laws. The monitoring regime will depend on the wastewater quality, water treatment methods (oil/water separators) and point of discharge (stormwater or sewers).

11 CONCLUSION

Geo Pollution Technologies - Gauteng (Pty) Ltd (GPT) was appointed by AdiEnvironmental cc to conduct a hydrogeological impact assessment for the Proposed Fuel Station at President Park. The assessment must determine the groundwater status in the area of interest. Further assess the potential impacts of the proposed development on the groundwater resource and propose mitigation measures on the potential impacts.

<u>**Site Location, Topography and Drainage:**</u> The site is located on the President Park (Emalahleni) Ext 6 which is located within Emalahleni in the Mpumalanga Province. The area forms part of quaternary catchment B11J of the Olifants Water Management Area. The area is characterised by a generally flat topography and in the area of the site the slope is more or less in the order of 0.3 %. Drainage is towards the tributary (unnamed stream) of the Olifants River, approximately 200 m northeast of the proposed site, that flows from south to north. On a larger scale, drainage is towards the Olifants River that flows from south to north (flowing from the Doornpoort Dam) to the north of the site.

<u>**Geology:**</u> The investigated area falls within the 2528 Pretoria 1:250 000 geology series maps. The proposed development falls within the Selonsrivier Formation of the Rooiberg Group. The rocks of

the Selonsrivier Formation mainly consist out of porphyritic amygdoidal red rhyolite, black rhyolite, agglomerate as well as sandstone and quartzite. These rocks dip slightly to the north east.

Hydrogeology: The porphyritic rhyolite and felsite associated with this unit represent acidic lava having a greater resistance to weathering than rock types which represent basic lava. The nature of these rocks and their weathering product is similar to that of granite, so that groundwater is usually encountered in the transition zone between weathered and more solid rock. Breccia and joint zones as well as lithological and dyke contact zones also contribute to a groundwater yield potential that is classed as poor on the basis that 86% of the available borehole yield records report a value of less than 2 l/sec. The groundwater rest level typically occurs between 10 m and 30 m below surface. Generally excellent water quality of the groundwater as borne out by the average EC value of 34 mS/m and a mean pH value of 7.1. Elements that show a substantial coefficient of variation are sulphate and nitrate. The latter indicates that although a small measure of caution is required when considering this water for human consumption, it is generally suitable for all use.

Groundwater Levels: Five neighbouring properties within a 500 m radius were visited during the hydrocensus. During the hydrocensus, except for the 1 newly drilled borehole (Borehole MW1), no additional groundwater level measurement could be measured. Only one additional borehole was found (Highveld View), however, no access was available to measure groundwater level. Based on the information collected during the hydrocensus, the borehole is used by Highveld View (private borehole) for irrigating the gardens, using as swimming pool water as well as drinking water. During the drilling phase, seepage was encountered at 16 mbgl, and the static water level was measured at 5.31 mbgl.

Groundwater quality: Both samples comply with the SANS 241-1:2015 Standards for Domestic Use. The concentrations of all organic constituents were below detection in both boreholes and no potential health risks are associated.

Hydraulic Conductivity: Based on the flow velocity calculated for MW1, groundwater on-site is expected to travel approximately 2.2 m per year in a northern direction under steady state conditions (if no preferential flow paths exist).

Conceptual Site Model: Groundwater contamination susceptibility is evident in the proposed development area. Groundwater contamination migration can occur directly from surface contamination or mobilize into the subsurface, along weathered fractured bedrock, bedding plane fractures and joints. However, based on the hydrocensus and the aquifer classification map of South Africa, the aquifer underlying the site is a minor aquifer system (moderately-yielding aquifer system of variable water quality). The impact assessment identified that both the construction and operational phases, without mitigation can have an impact of medium significance (construction) and medium to high significance (operational) on the groundwater in the area. The proposed operation can continue from a hydrogeological perspective, however protection to the aquifer must be prioritized by following the prescribed mitigation, recommendations, management and monitoring procedures.

12 Disclaimer

This report prescribes to a predetermined scope of investigation as set out in the contract between Geo Pollution Technologies and AdiEnvironmental cc. The information contained in this report pertains exclusively to the areas investigated/ sampled and cannot be used to infer environmental conditions beyond the areas investigated as set out in the Scope of Work. This report does not constitute legal advice. Most historical and operational information is gathered during interviews with site operators and responsible personnel. None of this information has been verified by other means and should not be regarded as absolute fact.

13 References

- 1:250 000 scale published Geological Maps of The Republic of South Africa.
- 1:500 000 scale Hydrogeological Map Series of the Republic of South Africa, DWAF
- Barnard, H.C., (2000). An explanation of the 1:500 000 General Hydrogeological Map. Pretoria 2528. DWAF.
- Department of Water Affairs (DWA): www.dwa.gov.za
- Guideline document EIA regulations (April 1998): Implementation of sections 21, 22 and 26 of the environment conservations acts.
- Department of Water Affairs and Forestry (DWAF). (1998). Minimum Requirements for the Water Monitoring at Waste Management Facilities. CTP Book Printers. Cape Town.

APPENDIX I: HYDROCENSUS INFORMATION

GEO POLLUTION TECHNOLOGIES
SAFETY, HEALTH, ENVIRONMENT AND QUALITY

Title:	Hydrocensus of Ground water	Doc No., Rev No.:	5.3.3.14, Rev 02
Department:	Inorganics	Page No.:	Page 1 of 1
Project Name:	ALELA-20-5215	Project Number:	ALELA-20-5215
Census date:	22/05/2020	Field Technician:	Stephen Lekalakala

Site Information

Owner:	Justice (Highveld View)		
Address:		Tel:	
		Fax:	
		Cell:	

Borehole / Monitoring Well Info

Borehole number:	**BH1**					In use:	Yes		X	No			
Y-coordinate: (South)	**-25.88426**					When last pumped:				Currently	X	N/A	
X-coordinate: (East)	**29.25556**					Pump type:	Sub	X	Wind		Mono		Hand
Z-coordinate:	**1584**			mamsl			Sun		None		Other		
Diameter:	165mm	X	225mm		mm	Depth to water table (SWL):				mbgl	No access		X
Collar height:	Level		0		mm	Sample: Yes	X	No		Water level	Pumped		Rest
						Float/pumped sample:			Float	X	Pump		Tank

Water Application

Garden/Landscape:	Garden	X	Veg.		Mix		Cotton		Fruits		Grains		Feed		Other	
Area of garden/crop:		ha		ha		ha		ha		ha		ha		ha		ha
Livestock watering:	Horses		Poultry		Pigs		Sheep / Goats		Cattle		Game		Exotic		Other	
No of:																

Aqua Farming:	Yes		No	Volume and no. of tanks:	**10 Tabks (10 000L)**
Domestic:	No. of households	**Unknown**		No. of people	**Unknown**
Other uses:	**Refill the pool, watering garden as well as drinking water**				
Possible future use:	**N/A**				

Additional Borehole Information

Date drilled:			UnKn	X	Depth of water strikes:					UnKn	X
Depth drilled:			UnKn	X	Pump size:				kW	UnKn	X
Casing type:	Steel	X	UnKn		Yield:		Gal		l/h	UnKn	X
	Plastic		UnKn		Pump to reservoir:	Yes		No		Vol.	
Depth of casing:		m	UnKn	X	How often pumped:	As needed				Daily	X
Length of perforated casing:		m	UnKn	X		Auto level control					

Notes	Photo
Borehole drilled long ago	
Sample taken from pipe before entering the tanks	
UnKn=UnKnown	

APPENDIX II: LABORATORY CERTIFICATE OF ANALYSIS

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

Geo Pollution Technologies (Pty) Ltd
Attention: Collen Nkosi
P.O. Box 38384
GARSFONTEIN EAST
0060

Job No:	**E44503 - W20_1558**
Report Reference:	**ER_GEO_2020-05-25_00784_001**
Enquiries:	**Rita Botha**
Date:	**2020/05/25**
	RitaB@yanka.co.za
Job Reference:	**W20/1558 - Advice Note 2005W238**
Job Description:	**2 x Routine Analysis**
Project:	**PRESIDENTS PARK SAMPLES**

TEST RESULTS FOR GPT Presidents Park - 22 May 2020

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

ANALYSED WITHIN 22 May 2020 - 2020/05/25

RITA BOTHA (Technical Signatory)
ENVIRONMENTAL SERVICES

SANAS Certificate obtainable from the address below
https://www.sanas.co.za/Certificate%20Published/T0647-10-2015.pdf

*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.

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

ANALYSTS

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

YANKA LABORATORIES
CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpPresp 1	SpPresp 2
SAMPLE DESCRIPTION			MW - 1	BH - 1
SAMPLE NUMBER			E44503-001	E44503-002
SAMPLED		Test Method **	2020/05/22 10:50	2020/05/22 12:30
Remarks			Brownish	Clear
Total Alkalinity (pH>4.5)	mg $CaCO_3$/L	YE010Alk	54.0	61.2
Bicarbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	54.0	61.2
Carbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	0.00	0.00
M Alkalinity (8.3>pH>4.5)	mg $CaCO_3$/L	YE010Alk	54.0	61.2
P Alkalinity (pH>8.3)	mg $CaCO_3$/L	YE010Alk	0.00	0.00
Conductivity (Laboratory)	mS/m	YE020CON	15.0	51.2
pH (Laboratory)		YE030pH	7.05	7.19
Total Hardness	mg $CaCO_3$/L	YE061H	20.6	193
Calcium Hardness	mg $CaCO_3$/L	YE061H	12.1	92.4
Magnesium Hardness	mg $CaCO_3$/L	YE061H	8.48	100
Total Dissolved Solids (TDS)	mg/L	Calculation	76.1	311
Temperature	°C	Thermometer	21.0	21.0
Oxygen Dissolved (DO)	mg O_2/L	YE051OD	5.92	6.08
Ammonia and Ammonium	mg N/L	YE070AK	0.53	<0.45
Calcium	mg Ca/L	YE060ICP	4.86	37.0
Chloride	mg Cl/L	YE070AK	3.82	21.0
Magnesium	mg Mg/L	YE060ICP	2.06	24.4
Nitrate and Nitrite (TON)	mg N/L	YE070AK	1.64	0.49
Nitrite	mg N/L	YE070AK	0.05	<0.01
Ortho Phosphate	mg P/L	YE070AK	<0.03	<0.03
Potassium	mg K/L	YE060ICP	9.90	6.24
Sodium	mg Na/L	YE060ICP	13.0	21.3
Silicon	mg Si/L	YE060ICP	17.1	2.48
Sulphate	mg SO_4/L	YE070AK	1.91	162
Aluminium	mg Al/L	YE060ICP	<0.01	<0.01
Fluoride	mg F/L	YE070AK	<0.09	0.18
Iron	mg Fe/L	YE060ICP	<0.01	<0.01
Manganese	mg Mn/L	YE060ICP	0.06	<0.01
Langelier Index (indicative, not SANS)		Calculation	-1.98	-0.97
pHs (indicative, not SANS)		Calculation	9.03	8.16
Sodium Absorption Ratio (indicative)		Calculation	1.24	0.66
TDS to EC Ratio (indicative, not SANS)		Calculation	5.07	6.08
Corrosion Ratio (indicative, not SANS)		Calculation	0.22	2.35
Ryznar Index (indicative, not SANS)		Calculation	11.02	9.13
Anion Sum			1.35	5.24
Cation Sum			1.28	4.98
Difference			-0.06	-0.26
% Difference			-2.39%	-2.56%

Methods adapted to accommodate local laboratory conditions. SM refers to the Standard Methods for the Examination of Wat

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 standard**

UIS ORGANIC LABORATORY

sanas Testing Laboratory T0419

TEST REPORT 28282A

Test Description: Screening for Volatile Petroleum Hydrocarbons
Test Method: UISOL-T-012

Client and Project Information

Client:	Geo Pollution Technologies				
Address:	Box 38384, Garsfontein East, 0060	**Attention:**	Dr Ahee Coetsee	**Project number:**	ALELA-20-5215
	Gauteng	**Tel:**	(012) 804 8120	**Project name:**	President FS Risk Assessment
	0060	**Email:**	ahee@gptglobal.com		

Sample Information

Sample ID:	**BH1**	**Matrix:**	Water	**Date Received:**	2020/05/22
Dilution:	No Dilution	**Storage:**	Fridge at 0-6°C	**Date Analysed:**	2020/05/22
Container:	Glass			**Date Issued:**	2020/05/25

Gasoline Range Organics (GRO's)

PARAMETER	RESULT
MTBE	<5 µg/liter
TAME	<5 µg/liter
Benzene	<1 µg/liter
Toluene	<10 µg/liter
Ethylbenzene	<2 µg/liter
m+p-Xylene	<4 µg/liter
o-Xylene	<2 µg/liter
1,3,5-Trimethylbenzene	<2 µg/liter
1,2,4-Trimethylbenzene	<2 µg/liter
Naphthalene	<2 µg/liter

Polycyclic Aromatic Hydrocarbons (PAH's)

PARAMETER	RESULT
Acenaphthene *	<1 µg/liter
Acenaphthylene *	<1 µg/liter
Flourene *	<1 µg/liter
Phenanthrene *	<1 µg/liter
Anthracene *	<1 µg/liter
Fluoranthene *	<1 µg/liter
Pyrene *	<1 µg/liter

Diesel Range Organics (DRO's)

PARAMETER	RESULT
C10 *	<1 µg/liter
C11 *	<1 µg/liter
C12 *	<1 µg/liter
C13 *	<1 µg/liter
C14 *	<1 µg/liter
C15 *	<1 µg/liter
C16 *	<1 µg/liter
C17 *	<1 µg/liter
C18 *	<1 µg/liter
C19 *	<1 µg/liter
C20 *	<1 µg/liter

Diagnostic Ratios

PARAMETER	RESULT
1,3,5TMB : 1,2,4TMB *	#Num!
(B+T)/(E+X) *	#Num!
Total VPHs Identified *	<10 µg/liter
Estimated VPHs Unidentified *	<10 µg/liter
Estimated TOTAL VPHs *	<10 µg/liter

Reinardt Cromhout
Authorised Signatory

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

TEST REPORT 28282A

Test Description: Screening for Volatile Petroleum Hydrocarbons
Test Method: UISOL-T-012

Client and Project Information

Client:	Geo Pollution Technologies				
Address:	Box 38384, Garsfontein East, 0060	**Attention:**	Dr Ahee Coetsee	**Project number:**	ALELA-20-5215
	Gauteng	**Tel:**	(012) 804 8120	**Project name:**	President FS Risk Assessment
	0060	**Email:**	ahee@gptglobal.com		

Sample Information

Sample ID:	**MW1**	**Matrix:**	Water	**Date Received:**	2020/05/22
Dilution:	No Dilution	**Storage:**	Fridge at 0-6°C	**Date Analysed:**	2020/05/22
Container:	Glass			**Date Issued:**	2020/05/25

Gasoline Range Organics (GRO's)

PARAMETER	RESULT
MTBE	<5 µg/liter
TAME	<5 µg/liter
Benzene	<1 µg/liter
Toluene	<10 µg/liter
Ethylbenzene	<2 µg/liter
m+p-Xylene	<4 µg/liter
o-Xylene	<2 µg/liter
1,3,5-Trimethylbenzene	<2 µg/liter
1,2,4-Trimethylbenzene	<2 µg/liter
Naphthalene	<2 µg/liter

Polycyclic Aromatic Hydrocarbons (PAH's)

PARAMETER	RESULT
Acenaphthene *	<1 µg/liter
Acenaphthylene *	<1 µg/liter
Flourene *	<1 µg/liter
Phenanthrene *	<1 µg/liter
Anthracene *	<1 µg/liter
Fluoranthene *	<1 µg/liter
Pyrene *	<1 µg/liter

Diesel Range Organics (DRO's)

PARAMETER	RESULT
C10 *	<1 µg/liter
C11 *	<1 µg/liter
C12 *	<1 µg/liter
C13 *	<1 µg/liter
C14 *	<1 µg/liter
C15 *	<1 µg/liter
C16 *	<1 µg/liter
C17 *	<1 µg/liter
C18 *	<1 µg/liter
C19 *	<1 µg/liter
C20 *	<1 µg/liter

Diagnostic Ratios

PARAMETER	RESULT
1,3,5TMB : 1,2,4TMB *	#Num!
(B+T)/(E+X) *	#Num!
Total VPHs Identified *	<10 µg/liter
Estimated VPHs Unidentified *	<10 µg/liter
Estimated TOTAL VPHs *	<10 µg/liter

Disclaimers

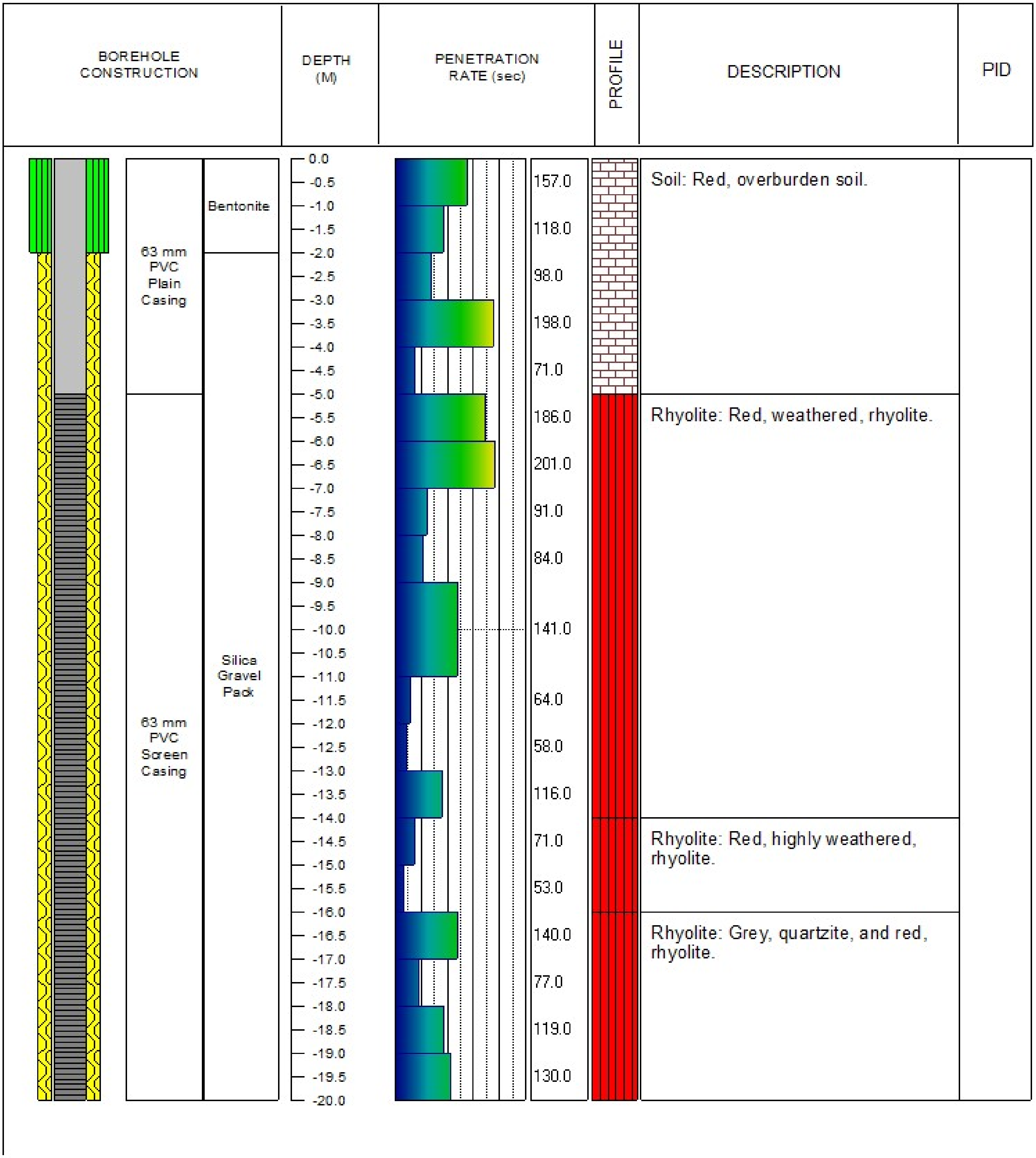
1) The results only relate to the test items provided, in the condition as received.
2) This report may not be reproduced, except in full, without the prior written approval of the laboratory.
3) Parameters marked " * " are not included in the SANAS Schedule of Accreditation for this laboratory.
4) A = Concentration outside calibration range, O = Outsourced analysis, UTD = Unable to Determine.
5) Uncertainty of measurement for all methods included in the SANAS Schedule of Accreditation is available on request.

Reinardt Cromhout
Authorised Signatory

APPENDIX III: BOREHOLE LOGS

Geo Pollution Technologies Gauteng (Pty) Ltd

PROJECT NO: ALELA-20-5215
PROJECT NAME: Presidents Park FS
BOREHOLE NO: BH1
LOGGED BY: A v Heerden
CLIENT: Adi Enviromental
DATE DRILLED: 2020-05-15
DRILL EQUIP: Percussion
DRILLING METHOD: Air Percussion
CONTRACTOR: SGRS
SWL:
CHECKED BY:



REMARKS: Groundwater seepage observed: 16.0 - 20.0 mbgl.

APPENDIX IV: FC INTERPRETED BAIL DOWN TEST DATA

H0 (m)=	2.3	r_w(m) =	0.03	d(m) =	15	d/rw =	500	C =
		b (m) =	14.69		K (m/d)=	0.01		

t(s)	h(m)
0	2.4
30	2.34
60	2.29
90	2.24
120	2.19
150	2.13
180	2.09
300	1.9
600	1.54
900	1.2
1200	0.95
1800	0.62
2700	0.34