GROUNDWATER SENSITIVITY ANALYSIS FOR THE PROPOSED BREIBACH MIXED USE DEVELOPMENT

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REFERENCES

GROUNDWATER SENSITIVITY ANALYSIS FOR THE PROPOSED BREIBACH MIXED USE DEVELOPMENT.

1.0 INTRODUCTION

This hydrogeological report describes and assesses the sensitivity of the aquifer(s) to possible pollution and degradation should there be any failures within the development both during and post construction. The proposed site for the development and the town planning design has been supplied by DBP Consulting (Appendix 1); Portions of the plan are shown within the report.

This report also forms specialist input to the Integrated Water Use Licensing Application (IWULA) for the development, as required by DWS (under National Water Act, Section 21 Water Uses). More specifically, this report addresses the essential risks to surface and groundwater as they are an integral portion of the hydrological cycle, and suggests the way forward. In essence, an 'impact significance assessment´. The intension was to subdivide and rezone the erven into 15 portions including land uses such as open space; offices, retail and housing (refer to appendix 1). The slte is off of Welkom Street and lies parallel to the N2.

Phase 1.

The proposed development comprises a filling station forecourt, carwash, restaurant, Supermarket, offices, residential and retail.

Overall the petrol station development will comprise the following:

1. The installation of less than 80 000l of underground storage capacity.
2. Associated fuel handling infrastructure including an oil-water separator system; fuel lines and filler lines; pump dispensers; and tank filler points situated on a spill containment slab which discharges to the separator system.
3. A forecourt canopy and dispensing area sloping to a central catch-pit which discharges to the separator system.
4. A convenience store and fast food restaurant with seating area.
5. Car, bus and caravan parking areas.
6. Associated roads on site, including ingress and egress.
7. Grassed and landscaped area.

The total development building area associated with the proposed petrol station development will be approximately 930m2 in extent. This excludes the associated infrastructure in phase 1.

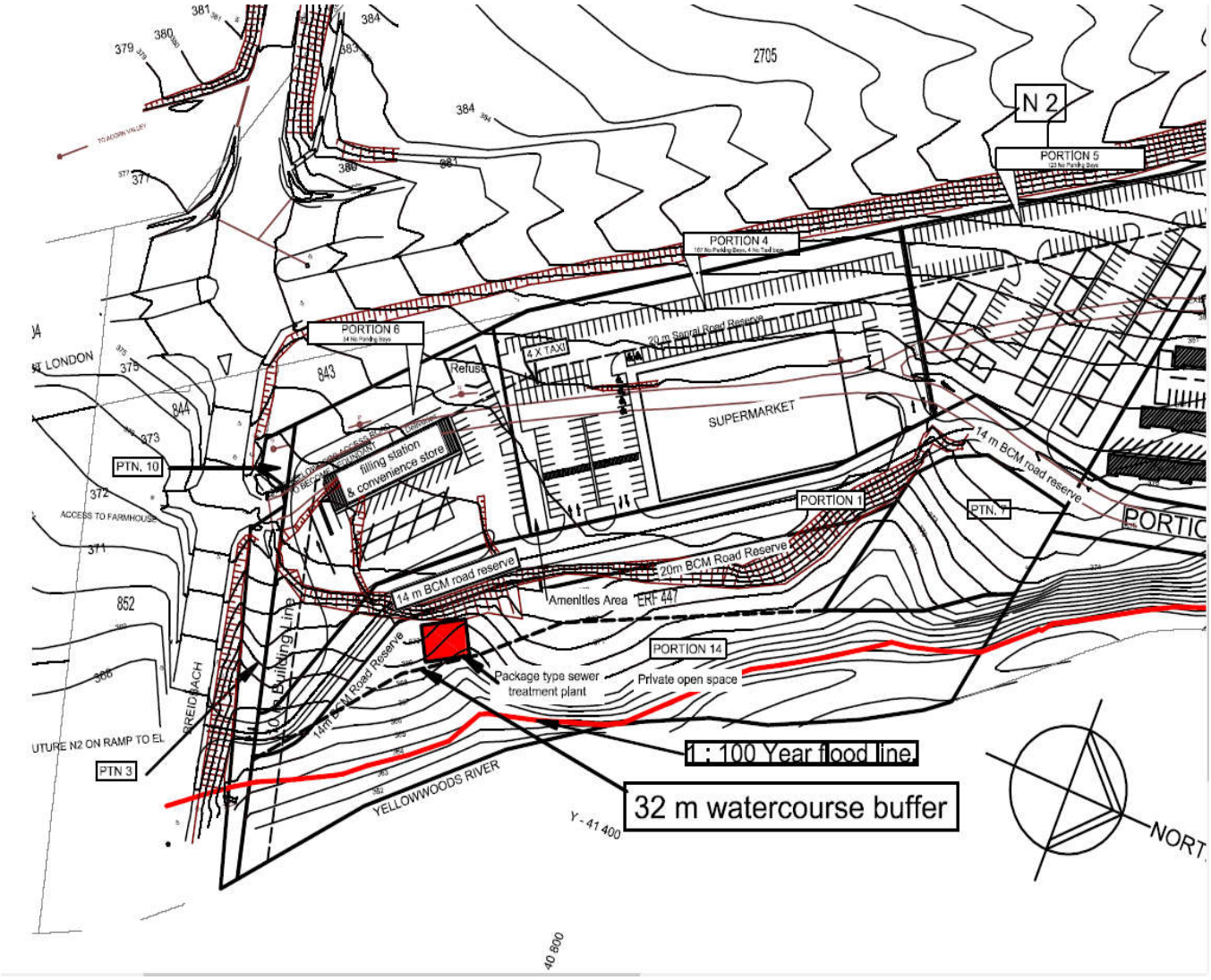


Diagram 1. The phase 1 development site plan as supplied by DBP Consulting.

BUS 1	Business Zone 1	n/a	PHASE 1 Mixed use – Supermarket, retail, office, line shops and bottle store	4	1,064	2500 S/mar 150 B/store 250 Restaurant 100 Toilets = 3000m²	6 Bays / 100 m² = 180 Bays	28.1%	Unrestricted 0.28	1
BUS 1	Business Zone 1	n/a	Mixed Use. Business. Office. Retail. Residential including MDR and HDR	5	0.752	80 DU / HA= 60 Residential apartments	2 Bays / DU = 120 123 Provided	16.8 %	3	3
BUS 1	Business Zone 1	Car Wash	Business+ Special Consent for Service Station,restaurant & convenience store	6	0.4355	100 m² Convenience 300 m² restaurant 200 m² drive through restaurant 330 m² Forecourt	4 Bays + 6/ 100 m² = 34 Bays	100 21.3 %	Less than 2 0.21	1

Table 1. Site development plan for phase 1.

Phase 2.

This includes 1178 housing units and related infrastructure including open areas.

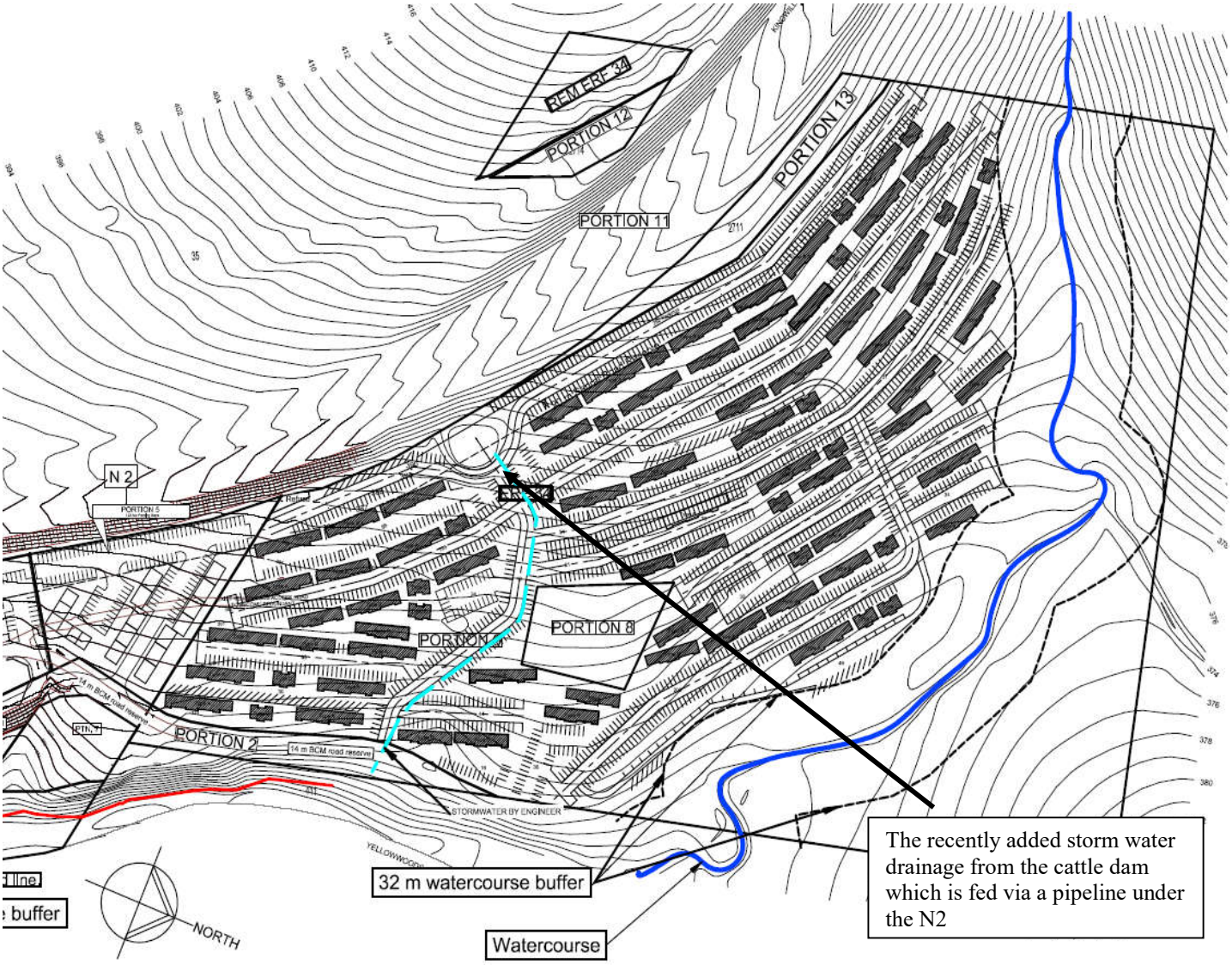


Diagram 2 of the phase 2 development site as supplied by DBP Consulting.

ZONING		DEPARTURE	LAND USE	PORTION	SIZE (ha)	GLA (m²)	PARKING	COVERAGE	FAR	HEIGHT
BUS 1	Business Zone 1	n/a	Mixed Use, Business,Office Retail,Residential including MDR and HDR	7	0,2749	n/a	6 Bays / 100 m²	100	Less than 3	5
RES3C	Residential zone III	Barn, Storage Warehouse	Small Holding	8	0.3300	n/a	1	50	Less than 3	2
RES5	Residential Zone 5	n/a	Residential MDR and HDR	9	14,816	80 DU / ha = 1185 units	1.5 Bays /du =1778 bays	9,1 %	0,9	3
TPT2	Transport Zone 2	n/a	Public road (SANRAL)	10	0.0162	n/a	–	–	–	–
TPT2	Transport Zone 2	n/a	Public road (N2 SANRAL)	11	2.3102	n/a	–	–	–	–
TPT2	Transport Zone 2	n/a	Public road (ERF 2714)	12	0.1518	n/a	–	–	–	–
TPT2	Transport Zone 2	n/a	Public road (ERF 2711)	13	0,3672	n/a	–	–	–	–
POS2	Open space 2	n/a	Private open space	14	0,8642	n/a	–	–	–	–
AGRI.	Agricultural	n.a.	Small Holding	Rem. erf 34	0,3336	n/a	1	50	n/a	2
TOTAL					22,9064 ha					

Table 2. Site development plan for phase 2

Although the phase 1 and 2 are separated above, the development can proceed as one entity. The overall plan is in appendix 1. Due to the nature of the filling station and related infrastructure, we have from a ground and surface water aspect considered the inherent risks of pollution that petrol stations have compared to housing.

2.0 TERMS OF REFERENCE

Water Resource Development was appointed by Breidbach Properties CC to prepare and submit a specialist report of ERVEN 34 & 477. The brief was to conduct a hydrogeological specialist study for an IWULA and the CSIR's 'Guideline for Involving Hydrogeologists in the EIA Process' (2005) was followed as well as 'Environmental Planning Guidelines´ (Project Components) DWAF, 2005.

The proposed petrol station and associated infrastructure has further DWS guidelines, namely:

- DWS proposed requirements for geohydrological component of site investigation and reporting for underground storage facilities;
- DWS minimum requirements for water monitoring at waste management facilities, Second Edition, dated 1998;
- South African National Standard, SANS 10089-3:2010, Part 3. The installation, modification and decommissioning of underground storage tanks, pumps, dispenses and pipe work at service stations and consumer installations.

3.0 SCOPE OF WORK

Water Resource Dev. was tasked with providing information on the study area under investigation and to report on the following:

- Geology and potential aquifers.
- A list and position of existing boreholes, reservoirs, springs and wetlands.
- Existing surface and groundwater use.
- Groundwater quality if available (TDS/EC, pH, S04, and $N0_3$).
- Assessment of immediate and subsurface permeability.
- Flow regime changes, if any.
- Assessment of pollution risk.
- Recommendations with respect to groundwater monitoring.
- Classification of groundwater (after Parsons and GRDM).
- Impact significance of various alternative options.
- Cumulative effects of groundwater pollution.
- The "no go' option.

The following methodology was followed:

Desk Study that included a review of information from the National Groundwater Data Base (NGDB), as well as the Groundwater Resource Information Project (GRIP). A review of existing hydrogeological literature, and more importantly recent assessments on the Environmental Report for The N2 Upgrade for SANRAL by EOH..

Geological and associated structural interpretations were completed. From this an assessment of pollution to the groundwater aquifers was completed.

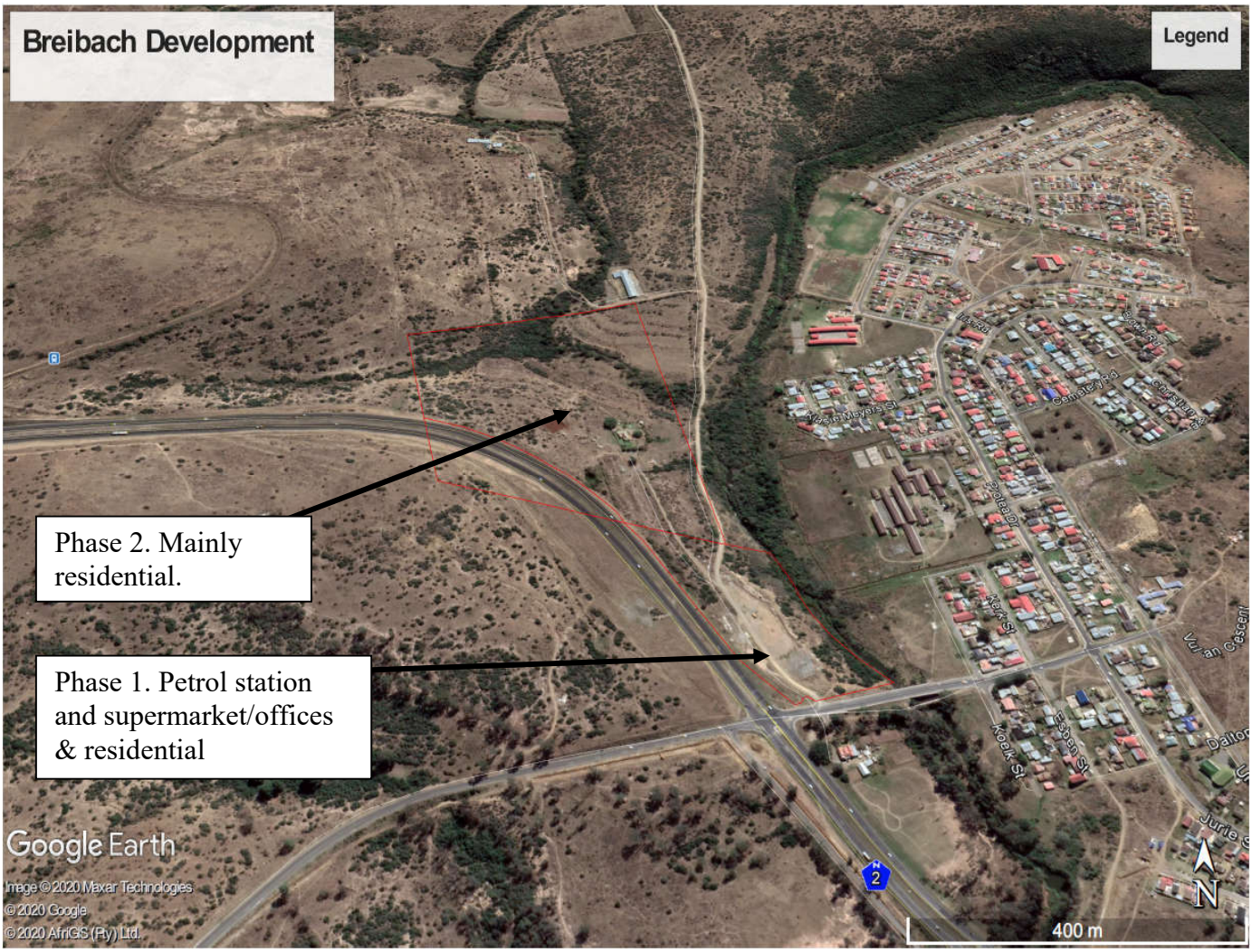
Site investigation that confirmed basic hydrocensus information, but more importantly the actual geological formations, alluvial thicknesses, saturation of the soil and soil type. The present pathways of potential pollutants to the surface and groundwater components and farming practices were noted. The actual site of the proposed development and the topographical influences such as perched water tables and flood plains were included.

A Report that included further literature reviews was then compiled taking into consideration the IWULA requirements and the National Water Act of 1998.

4.0 SITE LOCALITY AND DESCRIPTION

4.1 Location.

The site is off of Welkom Street and lies parallel to the N2. The Breibach Secondary School lies within 500m of the entrance to the proposed development. The existing land use on the area to be developed is vacant. The area comprises of various land uses such as a small holding, a school and a predominantly medium density residential area.



A satellite Image of the proposed Breibach Mixed Use Development (red outline).

4.2 Climate

The study area is King William's Town in the Eastern Cape Province of South Africa. The climatic conditions are therefore assumed uniform throughout King William's Town. The area primarily receives summer rainfall (Figure 1a). This usually amounts to approximately 502mm of rain per year (SA Explorer; 2015). The area receives the majority of its rainfall during the month of March (±74mm), whereas the average rainfall amounts to 8mm in the month of July. The average midday temperature ranges from 19.7°C in winter to 26.7°C during the summer months (Figure 1b). The area is coldest during the month of July when the average night-time temperature is 6.5°C (Figure 1c).

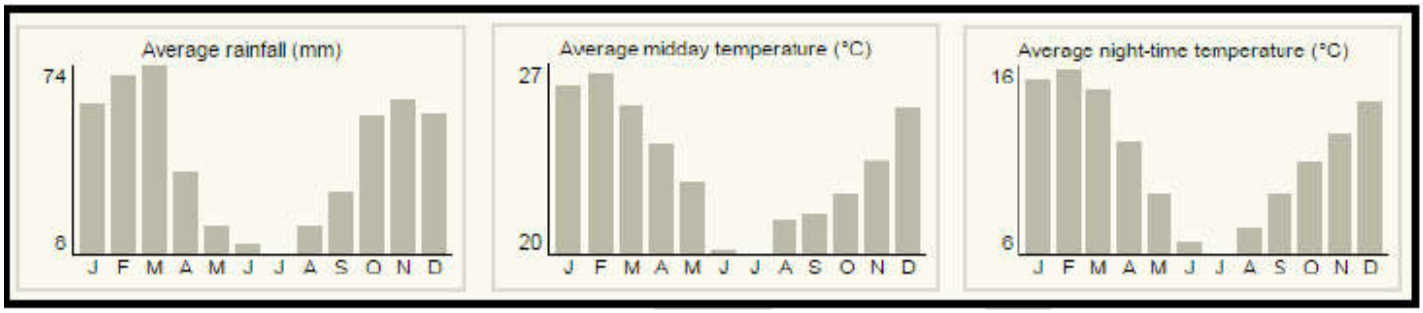


Figure 1: (a) Graph of the average monthly rainfall; (b) Graph of the average monthly midday temperature; and (c) Graph of the average monthly night-time temperature (SA Explorer; 2015).

4.3 Physiography and drainage

The topography of the King William's Town region ranges from 360m above sea-level to 560m above sea-level, as indicated in Figure 2 (EOH, EIA SANRAL report). The lower-lying areas are indicated by a darker shade of brown, which includes the Buffalo River system. The higher-lying areas are a lighter shade brown.

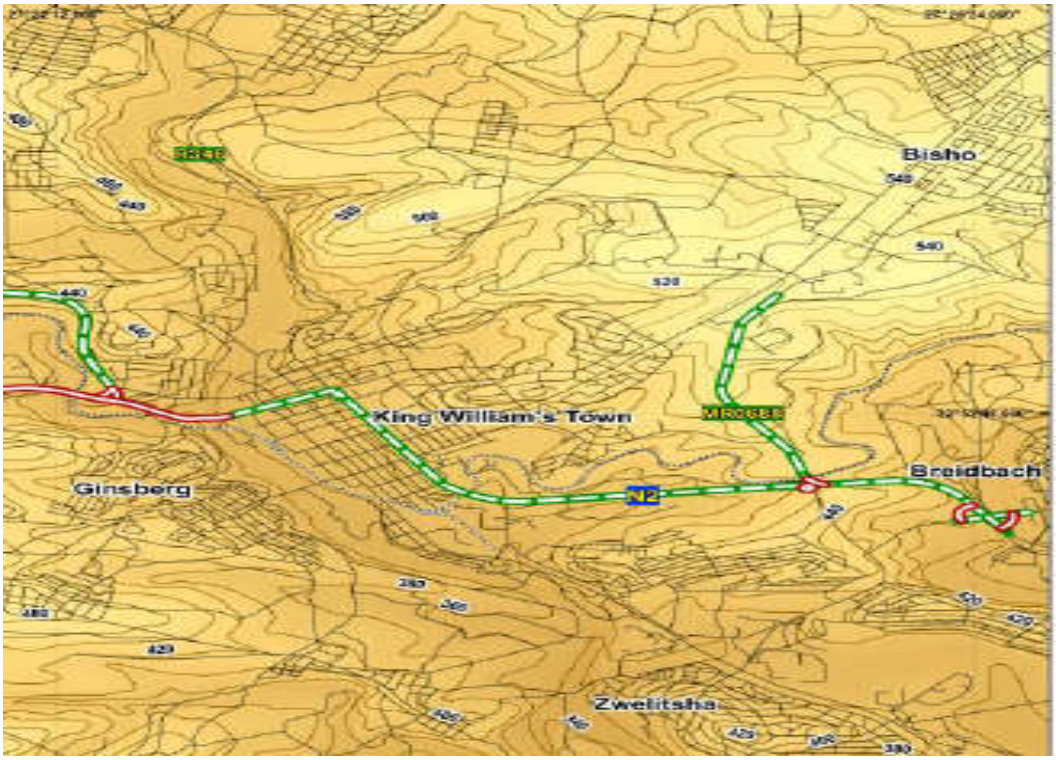


Figure 2. Topography Map of the study area.

The area had no excessively steep slopes, however storm water management will play a large role in ensuring the integrity of the area is maintained and that no long-term erosional issues arise in the future.

4.4 Soils and vegetation

The geology is responsible for the soil types and together they influence the runoff co-efficient for the rivers, dams and the recharge of groundwater aquifers. Within the study area we have the following:

- Shallow (0.2m) to deep (3.5m) alluvial flood plain (limited area).
- Shallow sandy soils that occur on sandstone (Balfour). They have a bleached layer above the partially weathered underlying rock. They are extremely erodible (index of 1).

Soil forms generally have limited ranges of physical and **hydrological properties. Together with effective depth and clay content, these properties affect the way the soils take up rainwater and the amount of run off or recharge of aquifers that occurs.** The **clay content** of the soil profile up to 600mm is between 6 and 12%. The vegetation is discussed in detail in the EIA report.

5.0 LOCAL GEOLOGY

The King William's Town region primarily consists of steep slopes of river valleys in highly dissected hills and moderately undulating plains. The area consists of sandstones, shale and mudstones derived from the Beaufort Group of the Karoo Supergroup intruded by dolerite sills and dykes.

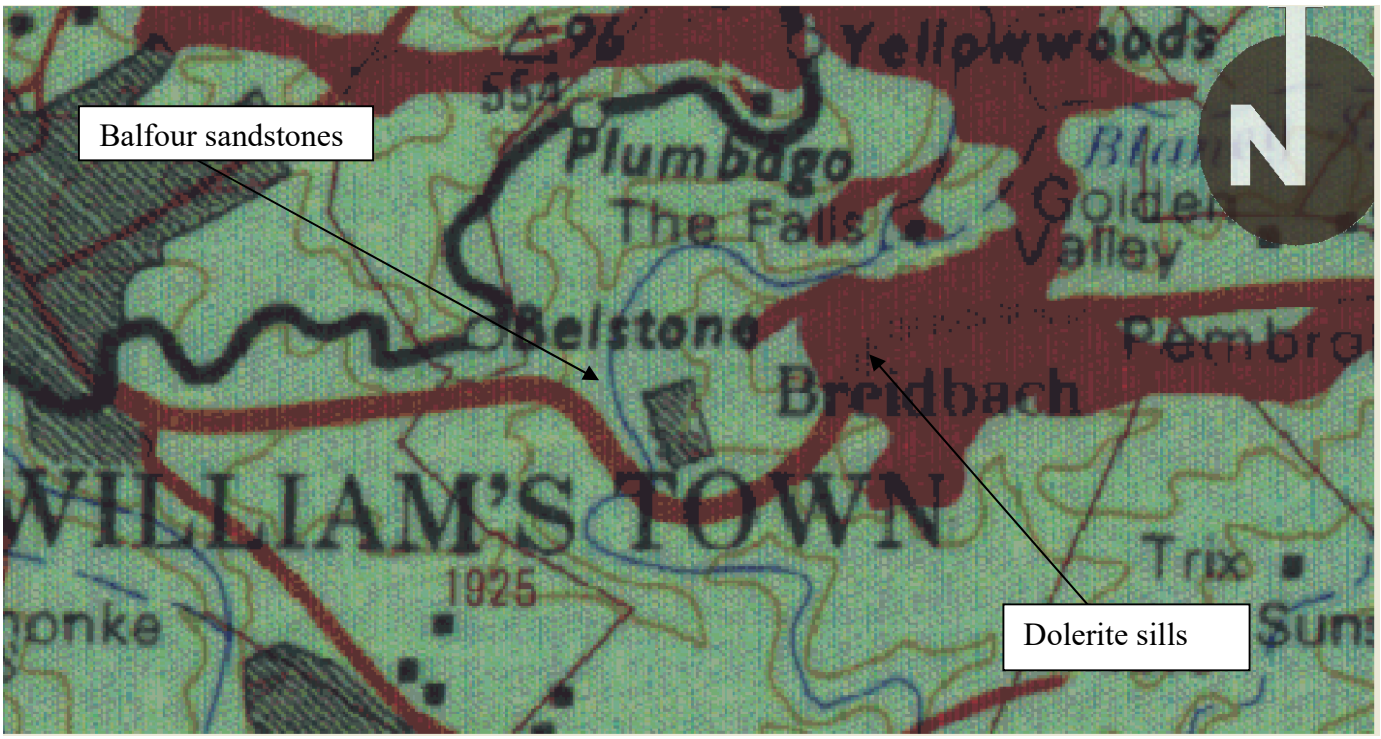


Figure 3. Geological Map of the Study Area.

5.1 Lithology

Regional geology is described below in chronological order, commencing from the older rocks through to younger.

rock units. The Beaufort Group (BG) is the geologically dominant unit in the district. This Group (BG) forms part of the Karoo Supergroup. Dolerite intrusions form massive sheets, dykes and ring-shaped intrusions in this Group (BG). The Group (BG) is divided into two subgroups namely the Tarkastad and Adelaide Subgroups. These Subgroups has been divided into formations. The following formation is present in the study area,

- Balfour Formation.

Mudstone predominates the Balfour Formation but the formation becomes more sandstone rich in depth (sandstone is evident in the study area). The formation is approximately 2000 m deep. The mudstone is essentially a gray, fine-grained, argillaceous rock type, which is particularly susceptible to erosion when exposed to atmosphere. As a result, the mudstone usually underlies the low-lying topographic areas. **This formation is also the main source of the deep silt layers found in the valley and also the high silt content of river water.**

A general dip of 2 to 4 degrees to the North East is characteristic of the strata within the study area.

5.2 Geological Structures

Folding: Variations in dip steepness and direction occur locally next to some intrusions.

Fracturing: Localized fracturing associated with dolerite intrusions occur in both the host rock and the dolerite itself. Lithological boundaries often represent opportunity when there is local flexure and rock competence contrasts.

Weathering: The weathered zone rarely exceeds 10 m in depth.

Stress regime: NW-SE trending structures are likely to be in tension (open) and those at right angles to this in compression (closed). The NW-SE trending (vertical) fractures are most likely to be open at depth given the NW-SE maximum horizontal stress.

6.0 HYDROGEOLOGICAL DESCRIPTION

Groundwater occurs mainly in the rock matrix. Principal Transmissivity is derived from large but infrequent fractures. These fractures have a relatively low storage capacity. Secondary transmissivity occur by numerous micro fissures with higher storativity but lower transmissivity. Hence the name dual porosity aquifers. Deeper fractures often have a higher transmissivity but lower storativity than shallow fractures. The type of aquifers within the study area will to a large degree determine their vulnerability to either source or wide spread pollution occurrences. The massive sandstone formation of the study area has no prominent fracture or bedding planes. ***The existence or absence of fracture structures and prevailing groundwater recharge conditions thus play a decisive role in the occurrence and characteristics of groundwater.***

6.1 Aquifers

Two general types of aquifer are found in the area:

- Deep to shallow primary (porous) aquifers in the alluvial areas (Quaternary Alluvium).
- The deeper secondary (fractured) aquifer in the Burgersdorp Formation.

The main aquifer with a permanent water table is found in the fractured sandstone or mudstones of the Burgersdorp

Formation. Borehole yields in this arenaceous to argilaceous formation in excess of 2 l/s are not uncommon (Meyer 1998). The small overlying alluvial deposit adjacent to the stream (primary/porous aquifer) could sustain a type of perched water table after periods of prolonged precipitation. These perched aquifers seem to develop due to hydraulic conductivity differences at the base of the alluvial sands, where they are underlain by the comparably less permeable sandstones (study area) of the Burgersdorp Formation.

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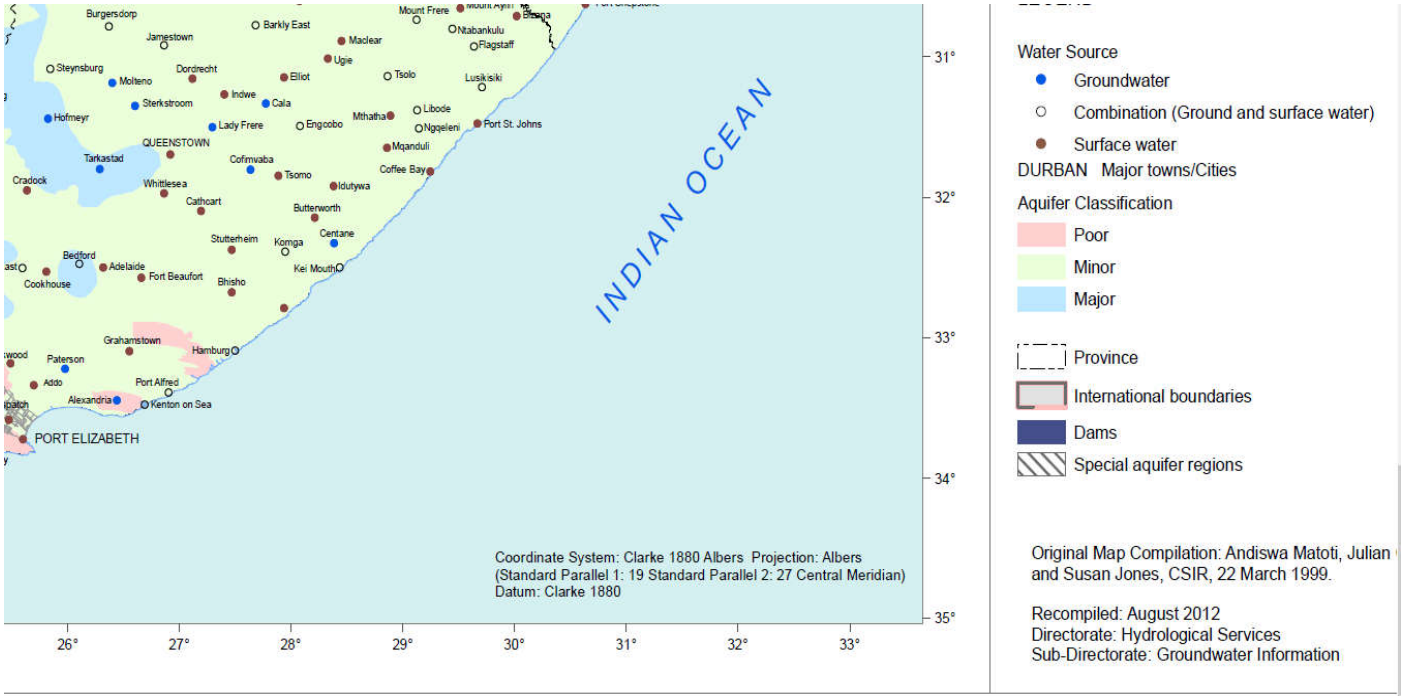

Figure 4. Portion of the groundwater aquifer classification map (CSIR &DWS 1999).

6.2 Existing borehole data

Data from DWAF's Groundwater Resource Information Programme (GRIP) and the National Groundwater Database differ in the number of boreholes within the study area. Generally a borehole yield analysis indicates that about 42% of boreholes yield less than 0.5l/s (outside of the study area in the greater King Williams Town area). Borehole yields in excess of 3 l/s can be obtained in joint, fault and fold structures (contact zones with intrusive dolerites), provided favorable recharge conditions exist.

It must be noted that this report focuses on the proposed petrol station and residential mixed use. As such the effect on borehole and surface water is likely to be limited to those affected by the petrol station primarily and the residential area to a lesser extent.

Within the study area and a 1km radius of the petrol station there is a disused windpump within the small alluvial plain as shown below.

A satellite image of the collapsed windpump and associated alluvium.

With the exception of the old farmhouse in the image above, the rest of the area has their domestic water supplied by the Municipality.

6.4 Static water levels (SWL)

The static water level tries to mimic the surface topography, but is slow to react to steep gradients. The SWL in the area varies from 12 mbgl and tends to reflect not only the topography but the type of aquifer (primary alluvial and secondary sandstone/ mudstone). The SWLs therefore reflect primary and secondary aquifer types and in cases a combination of both. The budget did not allow for a detailed hydrosensus.

6.5 Water quality

Groundwater quality associated with the Beaufort Group varies between 70 and 1200 mS/m. The water sampled onsite had an EC of 549 mS/m. This was scooped out of the collapsed borehole and may have collected from the recent rains that the area experienced. About 30% of boreholes recorded (collated data, but not from the immediate study area) had ECs of less than 200mSm and 5% in excess of 500 mS/m. Sodium, chloride, total alkalinity and fluoride may exceed maximum recommended limits. The groundwater from the Beaufort rocks generally displays a sodium- chloride-bicarbonate nature.

6.6 Piezometry and groundwater flow

Insufficient water levels for interpolations are available, however it is generally accepted that groundwater flow will mimic topography and slope. In the case of the fractured aquifer, the regional hydraulic gradient is generally towards the lower areas. However, due to the geological setting of the area, a deviation from the regional groundwater flow can be expected where dolerite intrusions occur.

The almost horizontal dip of the sandstone measured at the site and the direction of basal flow found would strengthen the view that the groundwater or sub surface flow in the saturated flood irrigated alluvium would be dictated by the changes in gradient along the Komani River.

If open fractures are present on the top of the Beaufort sandstones, mudstones or dolerite formation, a part of the water will percolate to a greater depth.

Diagram 3. Conceptual model of groundwater flow.

The entire development is on the north east slope of the Yellowwoods River and naturally any surface and unlikely groundwater flow would be in an easterly direction. The slope and thin soils together with homogenous near surface sandstone that is evident onsite will result in sheet run-off with very little likelihood of groundwater flow into the river.

6.7 Groundwater monitoring requirements

Should DWS grant a license for the development and associated petrol station then it is recommended that both surface and groundwater quality (monitoring hole at petrol station) be completed on a quarterly basis in strategic points adjacent to the Yellowwoods River.

6.8 Pollution risk

The main risk of pollution for surface and groundwater pre and post construction would be:

- Construction activity onsite. This is dealt with in the overarching EIA report.
- The erodibility of the sandy soils onsite, especially once vegetation is removed.
- Spillage from the petrol station and the remote leakage from storage tanks.

- Inadequate storm water drainage.
- Sewage infrastructure and package plant.

The aquifer vulnerability concept is based on the assumption that the physical environment may provide a degree of protection against contaminants imposed by human activities entering the ground surface. Natural attenuation of pollutants occurs when the pollutants pass through the unsaturated zone and physical, chemical and biological interactions between the material present and the pollutants result in the reduction of the pollutant concentrations. It therefore follows that a potential natural attenuation depends on both, the pollutant properties as well as the properties of the unsaturated zone (Sililo et al., 2001).

The vulnerability of an area depends not only on the contaminant attenuation capacity of the unsaturated zone , but also on the travel time of infiltrating water and contaminants as well as on the relative quantities of contaminants that can reach the groundwater. All 3 of these factors are a function of geological and hydrogeological attributes like sub-soils overlying the groundwater, type of recharge (point or diffuse) and thickness of the unsaturated zone (Sililo et al., 2001).

According to the map "An evaluation of groundwater vulnerability and pollution risk assessment in the preparation of a groundwater protection strategy for South Africa" (Reynders, 1996), the groundwater underlying the study area is of a medium pollution risk. Due to the scale of the map and data input limitations; the assessment neglects site-specific settings and should be only seen as a general indicator of the vulnerability of the area.

6.9 Classification of groundwater

The GQM (Groundwater Quality Management) Index is calculated at 5, and based on high aquifer vulnerability rating of 3, suggests that the underlying aquifer would require a medium level of protection. Although the GQM classification method used above suggests medium level of protection, cognizance of the highly permeable overburden in the small alluvial area must be considered. Thus any potential pollution source entering the overburden will most likely be stored and transmitted laterally and vertically to underlying aquifer(s). The rate of movement is also expected to be high. It is therefore believed that the overall GQM Index should be elevated to a much higher status, where significantly more levels of aquifer protection are required. Here we are referring to the alluvial portion of the development. Fortunately the entire development is above the 1:100 year flood line.

All boreholes collared in the Burgersdorp Formation are all relatively medium to low yielding typically around 0.49 l./s. Based on the aquifer classification system (Parsons, 1995), the area immediately surrounding the site may be classified as a minor aquifer system (point rating of 2). These are characterized by (a) low primary permeability, (b) moderate extent, (c) variable water quality and (d) seldom produce large quantities of water. The GQM Index is calculated at 3, and based on low aquifer vulnerability rating of 1, suggests that the underlying Burgersdorp aquifer would require a low level of protection.

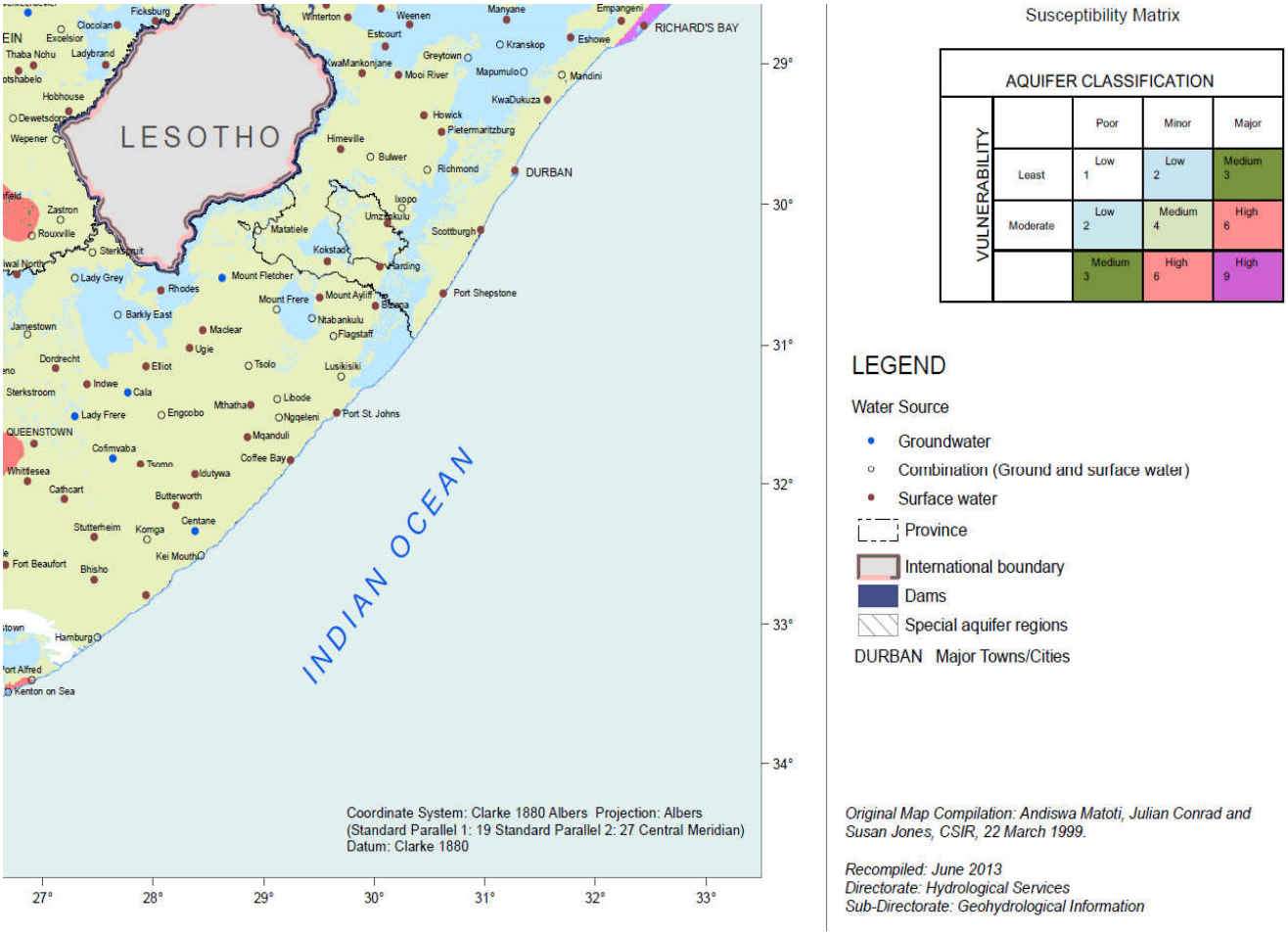

Figure 5. Portion of the vulnerability matrix on aquifer classification (CSIR & DWS 2013).

7.0 GROUND WATER RESOURCE ASSESSMENT

The following sections give a broad assessment of the available groundwater resources that can be used for abstraction.

7.1 Groundwater harvest potential

The groundwater harvest potential (after Seward & Seymore, 1995) in the local area is restricted to approximately 26 500 m^3/ a / km^2, due to the medium storage potential of the aquifer and also based on rainfall data.

7.2 Groundwater recharge

Annual recharge to groundwater is the volume of rainfall that contributes to groundwater held in storage and expressed as a percentage of MAP. Two methods to determine recharge are applicable. The first method (after Vegter, 1995) considers rainfall, geology and other criteria and depicts recharge in mm on a regional scale map. The

second method (chloride method) uses a mass balance approach to relate the chloride input (rainfall and dry deposition) to the chloride output (groundwater recharge). The methodologies are not included in this report.

It has however been estimated that under good conditions up to 40 boreholes spread over an area of 50 km² are required for a supply of 1 million m³ / annum or 20 000 m³ per km². This figure is close to that in section 7.1.

7.3 Ground Water Storage

The aquifer storage is difficult to determine accurately without access to several costly, long-duration pumping tests for the determination of the specific storativity of the aquifer. No reliable site-specific storativities could be determined based on the pumping test results. However, as the aquifer type is known to be fractured sandstone, the specific storativity can be estimated from a literature values to be around 0.001. If an exploitable part of the aquifer of 20m is assumed (i.e., restricting the draw down to - 20m to limit potential environmental impacts), the volume of water released from storage is given by:

Volume = Area x Change in head x Storativity = 6 000 000 m^2 x 20 m x 0.001 (example).

= 2120000 m^3/a

This would exclude the alluvium within the study area.

8. IMPACT ASSESSMENT OF THE BREIBACH MIXED USE DEVELOPMENT.

The following groundwater related impact activities require hydrogeological specialist involvement for the intended project.

- Where effluent or chemicals with the potential to change groundwater quality is handled as part of the project, or discharged into the environment e.g. petrol stations, waste disposal sites, wastewater treatment works.
- The volume of groundwater in storage or entering groundwater storage is changed beyond what is allowed by the DWS General Authorizations e.g. starting or ending a groundwater abstraction scheme, surface water impoundments, impact on wetlands, surface hardening that changes natural rainwater infiltration and groundwater recharge, stream flow reduction activities.
- The groundwater flow regime is changed by the proposed project e.g. excavations and cuttings, developments on floodplains that restrain/restrict subsurface flow and the connectivity between groundwater and surface water systems, operations that result in the draining of wetlands etc.

The key issues requiring hydrogeological specialist input are given in the following chapters.

8.1 Shallow Water Table / Surface Water

8.1.1 Petrol Station / Breibach Mixed Development

a) Influence on groundwater abstraction / Groundwater Water Infiltration and Flow / Aquifer vulnerability.

Since the aquifer has no perched water table and is classified as minor, there is a low probability of spillage

affecting the deeper secondary fractures of the homogenous sandstones found in the area (refer to photographic gallery in appendix 2). However the proximity to the Yellowwood River would be of concern as this play an important conduit for water transfers by DWS with some of the local community members also utilizing the surface water from the river. There are also alluvial patches further downstream of the proposed petrol station .Although the aquifer could be classified as a low significance; the **surface water has a high significance.**

Mitigation.

The design, construction and operation of the petrol station should be discussed holistically as the mitigation factors are interlinked. The protocols as per the various acts and stringent safety designs with monitoring are summarized below.

1) Contamination of soil & groundwater pollution (surface spillages).

Direct impacts: Contamination of surface water runoff from the forecourt area may result from spillages during vehicle refuelling and from vehicle leaks whilst parked at the service station during the operational phase when the surface is paved.

The extent of the impact will be local. The duration of the impact is anticipated to be short term to permanent.
Significance prior to mitigation:

- Medium (Negative).

Significance post mitigation:

- Low (Negative).

Mitigation measures:

All dispenser pumps will be located on pump islands surrounded by hardened surfaces, which will prevent downward migration of any free phase product and promote horizontal flow into the collection pit/s. The filler points are located inside containment manholes, which are surrounded by concrete hard standing. The containment manholes will be able to contain minor spillages from flexible fuel delivery pipe disconnection. Shear-off valves will be anchored below fuel dispensers, so that no spillage occurs if the dispenser is accidentally knocked over. There are also breakaway couplings on the hoses in case a vehicle pulls away from the pump dispenser while the nozzle is still in the filler. Experience has shown that minor spillages on the forecourt readily evaporate. The volatile components contain the more problematic compounds such as benzene, which readily evaporate leaving behind the less volatile, less mobile and less harmful heavier components. Given sufficient time, natural attenuation will completely break down these compounds. Automatic cut-off devices are built into both the underground storage tanks and the pump dispensers, to prevent tank overfills and spillages. As a natural product, hydrocarbons will ultimately naturally breakdown and attenuate themselves.

2) Contamination of soil & groundwater pollution (subsurface leaks).

Direct impacts: Leaking tanks/pipe work and incorrect delivery procedures create pathways for pollutions to migrate into permeable sub soils beneath the site and to the water table below.

The extent of the impact will be local to regional depending on response time. The duration of the impact depends on response time.

Significance prior to mitigation:

- Medium (Negative)

Significance post mitigation:

- Low (Negative).

The proposed installation will comply with SANS 1535 (relating to tank manufacture standards) and SANS 10089 Part 3 (relating to underground tanks and pipe installation standards). Consideration should be given to the installation of double composite tanks, steel with fibre glass outer. The outer coating is used to minimise the possibility of corrosive failure of the tank. Internationally approved non-corrosive pipe work systems should also be installed. This is to limit the possibility of pipe failure due to corrosion; this being the most common cause of pipe failure before this system was introduced to the RSA. Any joints in the fuel lines should be located within containment manholes, which also occur where the pipe work enters the underground storage tanks and under the pump dispensers. These manholes should be regularly inspected as part of the normal management procedures at the service station. Leak detectors have to be installed at various positions on the fuel delivery system. Delivery lines are pressurized at all times, and leak detectors will immediately switch off the submersible pump in the underground storage tank should a leak be detected. Vent and filler lines will be sloped back to the underground storage tank so that fuel does not remain in the pipes. Continuous electronic monitoring of underground stock should be done to allow for the early identification of abnormalities. Should these occur, management would review these and take appropriate action to rectify the situation.

Observation wells are also important and should be installed in the sand fill surrounding the underground storage tanks. They must be 500cm lower than the bottom of the tank base. These can be used to check for product losses (visual and or factory assessment), and may be used for product recovery/remediation purposes. As a natural product, hydrocarbons will ultimately naturally breakdown and attenuate themselves. All incidences in the event of contamination on site or pollution of water resources, including groundwater must be reported to the relevant authorities. A groundwater monitoring programme must be developed to the satisfaction of the Department of Water and Sanitation (DWS). A record of all the monitoring results must be submitted to the Department of Economic Development, Environmental Affairs and Tourism (DEDEAT) and DWS annually.

3) Storm water Impact: Increase in surface runoff.

Direct impacts: Increase in impervious surfaces which may promote erosion and flash floods.
The extent of the impact will be local. The duration of the impact will be temporary during the rainfall event.
Significance prior to mitigation:

- Medium (Negative)

Significance post mitigation:

- Low (Negative).

Soil Management (erosion control): Erosion control measures should be installed to stabilize the banks and prevent future erosion that may affect the development and the vegetation.

Pollution Control: Sewerage and waste water systems should be properly connected to the existing structures. Measures to mitigate against cumulative storm water impacts can only be controlled on and adjacent to the site and as such the proposed mitigation measures outlined above still apply.

4) Freshwater Impact: A decrease in effluent.

Direct Impacts: A decrease in the effluent discharged into the river system due to the service station and the rest of the Breibach Mixed Use Development being connected to municipal services and the related sewage infrastructure that has to be installed and people using these ablutions.

The extent of the impact will be local. The duration of the impact will be permanent.
Significance prior to mitigation:

- Medium (Positive)

Significance post mitigation:

- N/A

5) Pollution Control

Sewerage and waste water systems should be properly constructed and connected to the existing structures or package plant.

8.2 Groundwater Water Infiltration and Flow

The hydraulic conductivity of the small primary aquifer (Alluvium) is approximately 10 - 40 m/d, i.e., allowing very fast infiltration and flow in the primary aquifer. However, since the assessment of impacts related to rapid water infiltration and flow are not applicable for the project (residential and there is no development close to the floodplain), categories 2a (change in quantity of groundwater in storage) and 2b (change in groundwater recharge) (Saayman 2005), only impacts with regard to potential changes in groundwater quality due to rapid infiltration of polluted water will be assessed. The potential sources of pollutants are centralized (petrol station). Due to the low surface permeability of the underlying aquifer, there is a minimal possibility of leakage of wastewater into the underlying fractured aquifer and is considered of no significant consequence.

Imp. Sig.		Duration	Intensity	Status	Significance	Confidence	Probability
Without Mitigation		M	M	NEGATIVE	M	M	M
With Mitigation		M	L	NEGATIVE	L	M	L

Mitigation

Design

- Ensure due design, construction and maintenance of sewage pipeline.
- Ensure no sewage water is released into the environment

- Ensure correct siting of the sewage pipeline.
- Ensure that a back-up system is designed to reduce the risk of accidental sewage releases.

Construction .

- As per engineering drawing.

Operation

- Operate and maintain the pipelines according to best practice.
- Include monitoring or regular inspection to detect leakages or signs of stress.

8.3 Groundwater abstraction within 1 km of the Development

a) Change in quantity of groundwater in storage and groundwater recharge

The developments in the area are all on Municipal services and the proposed development will meet all engineering designs for sewage and waste removal. There are no functioning boreholes within a 1km radius of the development. The collapsed alluvium borehole depicted in the photographic gallery is no longer in use. The influence on these parameters is hence considered negligible.

		Duration	Intensity	Status	Significance	Confidence	Probability
Without Mitigation		M	L'	NEGATIVE	L	M	M
With Mitigation		M	L	NEGATIVE	L	H	L

Mitigation

Design

- If possible ensure dilution or diversion of any spillage due to unforeseen circumstances.

Construction

- N/a

8.4 Aquifer vulnerability

Based on the high hydraulic conductivity (10 - 40 m/d) and low retardation potential (mostly Alluvium /sand), the shallow aquifer is highly vulnerable to pollution. Due to its lower conductivity and a thicker vadose (unsaturated) zone, the deeper fractured Burgersdorp aquifer is less but - as proofed - still vulnerable to pollution. However, Reynders (1996) assessed the groundwater vulnerability and pollution risk of the overall area only as medium.

Imp. Sig.		Duration	Intensity	Status	Significance	Confidence	Probability
Without Mitigation		M	H	NEGATIVE	H	M	M
With Mitigation		M	M	NEGATIVE	M	M	L

Mitigation

Design

Existing or new groundwater sources should be designed as follows.

- Ensure no hydraulic shortcut between shallow and deeper aquifer (boreholes only screened at greater depth and proper sealing of upper borehole sections).
- Extract water as recommended at greater depth from the Burgerdorp aquifer.

Construction

- Drill abstraction boreholes to a depth of 120 m bgl.

Operation

- Monitor water levels and water quality on a regular basis
- Should a package sewage plant be included then maintain effluent standards as per DWS requirements for effluent discharge to rivers.
- Report any changes of groundwater quality to authorities.

9.0 IMPACT SIGNIFICANCE OF VARIOUS OPTIONS

The area has been a residential built up entity for decades with churches, schools, local spaza type shops and sporting amenities. The Breibach Mixed Use Development coincides with the new SANRAL intersection and will add impetus to the area with housing, supermarkets and a filling station.

This also is part of the spatial development node for the area. There are no other alternatives that will result in the employment and amenities that this development offers.

10. THE "NO GO" OPTION

The No-Go Alternative entails “the option of not implementing the activity”. In this case this entails the service station not being developed nor offices, supermarket, convenience store, car wash and housing, with the property remaining an empty lot.

The No-Go alternative does not entail development that contributes to economic growth and job opportunities in King Williams Town. The site will remain vacant when a development, such as the proposed service station and the proposed developments, can boost the local economy and give locals that obtain the available job positions a sense of purpose. The No-Go alternative does not meet the needs and requirements of the town and Buffalo City Municipality in terms of a conveniently-positioned service station and amenities servicing the N2 national road users. As such, alternatives are not considered to be reasonable or feasible for the proposed activity.

11. CONCLUSIONS

It is our opinion that provided the recommended mitigation measures are implemented and the filling station is managed in an environmentally sound manner and according to oil industry standards; there are no factors that should prevent the proposed development from taking place.

The rest of the Breibach Mixed Use Development is less of an issue and as above if due diligence is given to mitigating measures then there is also no reason for phase 1 and 2 to proceed. It is important that the mitigation measures stipulated within the EMP be followed during the construction, operational and decommissioning phases of the development and that they are policed by a suitably experienced environmental control officer.

12. RECOMMENDATIONS

Recommendations are given based on the information on hand taking into consideration the proposed plans forwarded and discussions with the other stakeholders.

- Complete a holistic study of the desirability of well maintained onsite sewage package plants such as the one at Crossways versus the Municipal Sewage plant that is prone to spillages and related pollution of the river.

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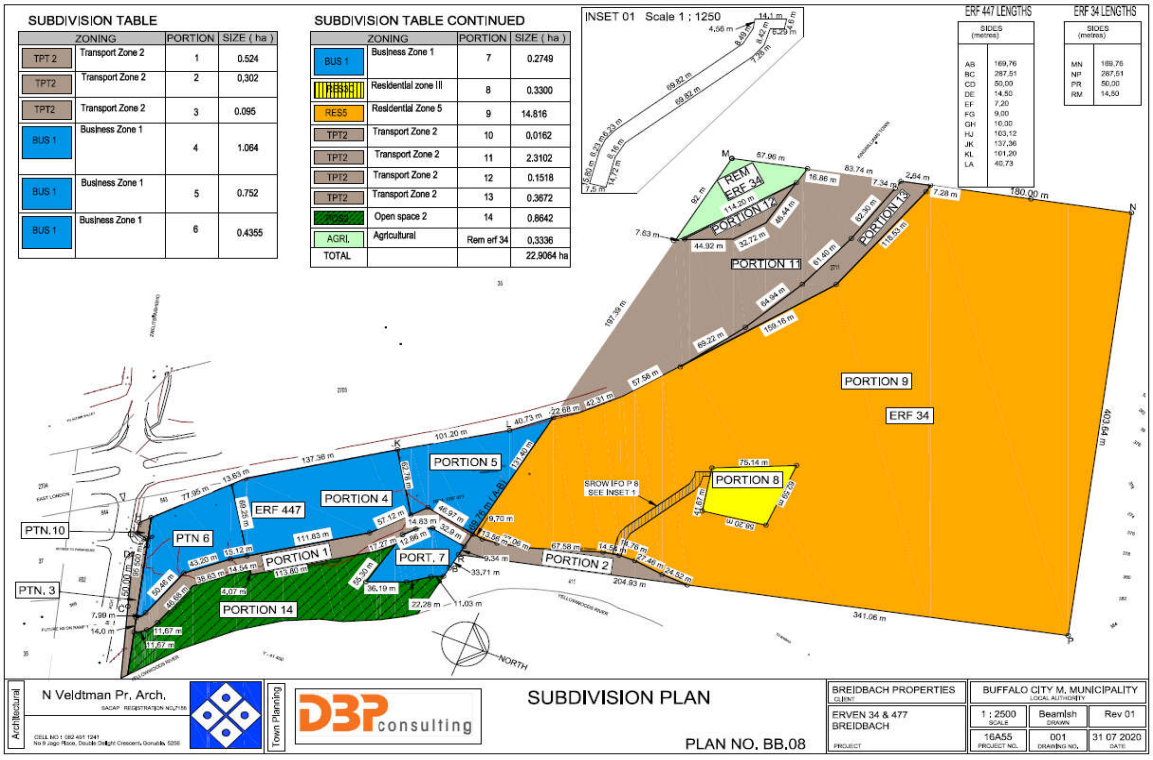
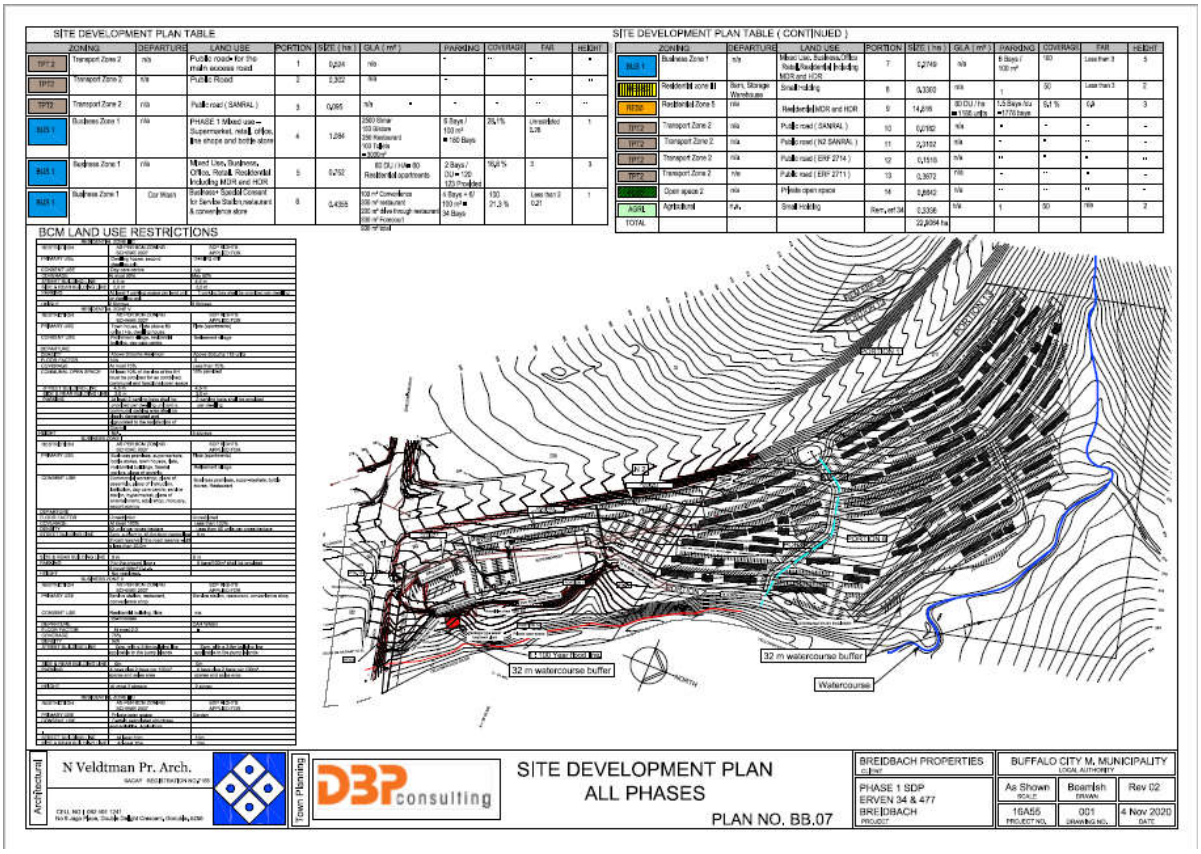
Appendix 1

The Sub Division Plan

The Site Development Plan, All Phases



The Sub Division Plan



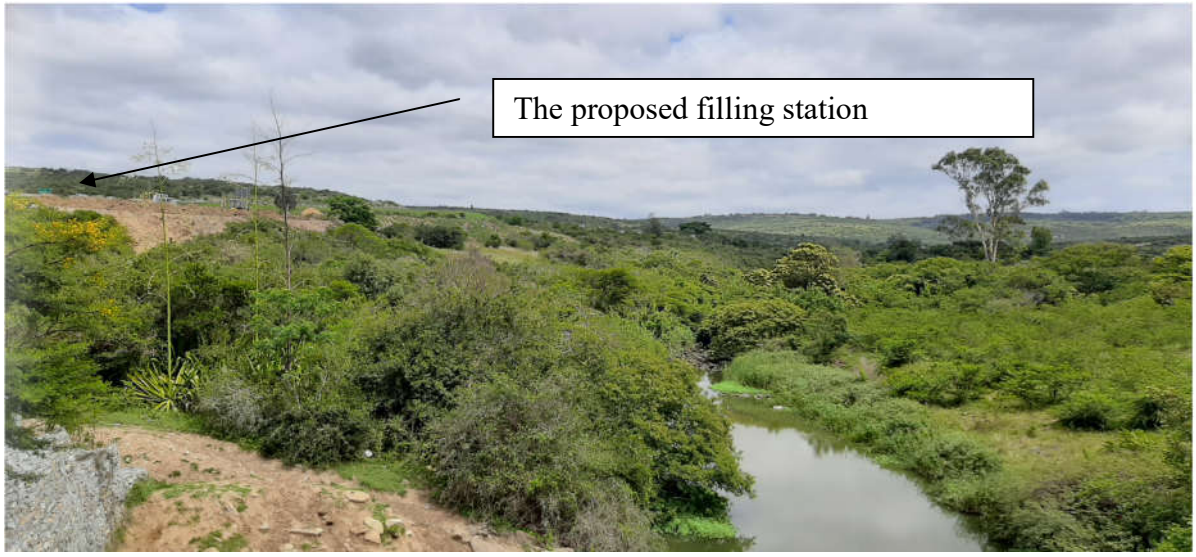
The Site Development Plan, All Phases

Appendix 1

Photographic Gallery

The entrance off Welcome Street with the N2 in front of the white vehicle.

The site of the proposed Filling Station.



The Yellowwoods River.


The residential area of Breibach.

The view from the residential site with the N2 in the background.

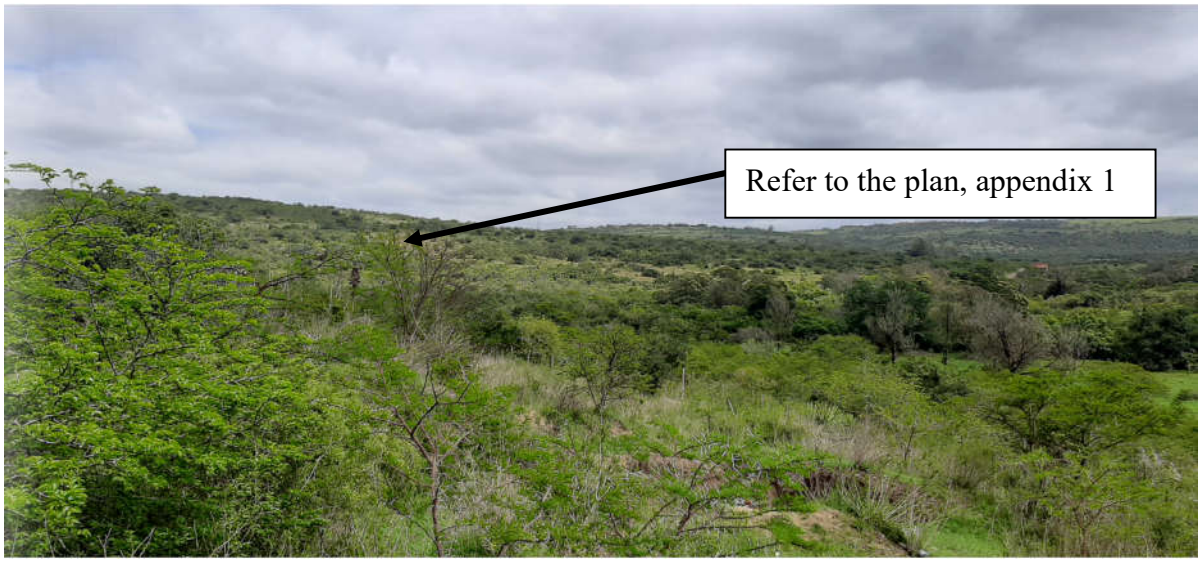
The collapsed windpump within the small alluvial area.

The pipeline beneath the N2 that feeds into a small stock dam.

The homogenous sandstones with virtually no soil profile at the stock dam (not a wetland).

The dam wall with the N2 in the background.

The slopes within the study area are concave with the soil profile increase towards the base.



An overview of the slopes where the majority of the residential housing will be constructed.

The soil profiles thin out towards the upper areas.

The bleached, weathered slightly clayey portion of the sandstones (foundation being dug at the farm house).