CLIENT:

PROJECT:

CIVIL ENGINEERING SERVICES
INVESTIGATION AND REPORT:
PROPOSED TOWNSHIP BARKLY WEST
(DIKGATLONG LOCAL MUNICIPALITY)

SERVICES PROVIDERS:

BARZANI HOLDINGS
CIVIL ENGINEERING SERVICES
INVESTIGATION AND REPORT:
PROPOSED TOWNSHIP BARKLY WEST
(DIKGATLONG LOCAL MUNICIPALITY)
JUNE 2020

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Date	:	June 2020 Revised
On behalf of	:	G3T CONSULT
For	:	BARZANI HOLDINGS
Attention	:	Mr I van der Westhuizen

CIVIL ENGINEERING SERVICES INVESTIGATION AND REPORT: PROPOSED TOWNSHIP BARKLY WES (DIKGATLONG LOCAL MUNICIPALITY)

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1. DEVELOPER AND SERVICE PROVIDERS DETAILS

1.1 Developers Details:

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2. BACKGROUND

Barkly West is a town in the Northern Cape province of South Africa, situated on the northern bank of the Vaal River north west of Kimberley as depicted in Figure 1. Barkly West was the site of the first major diamond rush, in 1870, on the South African Diamond Fields, and was initially known as Klipdrift. This Dutch name means "stony ford" and is a direct translation from a much older !Kora or Korana name, Ka-aub (or !a |aub) - "stony place along a river".

Figure 1: Town Location

Briefly the Klipdrift Diggers' Republic was declared (the town assuming the name Parkerton after President Stafford Parker), before colonial rule was extended here. It, with Kimberley, became one of the main towns in the Crown Colony of Griqualand West and was renamed Barkly West. Like Barkly East, the town is named after Sir Henry Barkly, Governor of Cape Colony and High Commissioner for Southern Africa from 1870 to 1877.

During the Anglo-Boer War the town was occupied by Boer forces and temporarily went by the name Nieuw Boshof.

The Parish Church of St Mary the Virgin was the first Anglican Church to be built on the Diamond Fields. Sir Henry Barkly laid the foundation stone in February 1871. The iron Barkly Bridge, the first over the Vaal River, was transported in sections from the United Kingdom (by sea, rail and over the last more than 100 km by ox wagon) and erected across the Vaal in 1885. Shops in Kimberley and Barkly West closed for the occasion when the bridge was opened. A new bridge was built alongside it in the 1970s. The toll house erected to recover revenues from those using the old bridge now serves as a museum, opened in 2000.
Barkly West found its humble beginnings in the diamond industry. In fact, this is where the very first diamond was discovered in South Africa in 1869. Originally established in 1849, Barkly West was a tiny mission village until the diamond rush saw hundreds of prospectors flocking to the town in search

of financial freedom. Barkly West is not only a historical destination but a town that is surrounded by natural beauty and many attractions for visitors to explore. The district of Barkly West is known for its large-scale dairy farming. Various crops are grown under irrigation with water drawn from the Vaal-Harts irrigation works. Surrounding the town, Canteen Kopje, Rekaofela Resort and the Oribi Game Reserve showcase the breath-taking fauna and flora of the region, including archeologically sites, namely:

- The Nooitgedacht Glacial Pavements, upstream along the Vaal River between Barkly West and Kimberley, with the Dwyka glaciation some 300 million years old.

- Rock engraving dating back some 1500 years.

Other activities taking place in the region include hiking, canoeing and archery.

3. SITE DESCRIPTION

3.1 LOCATION

Barkly West is situated in the Dikgatlong Local Municipality which is approximately 188 hectares in size. It is situated to the west, north western side of Barkly West and approximately 40 Km North West of Kimberley.

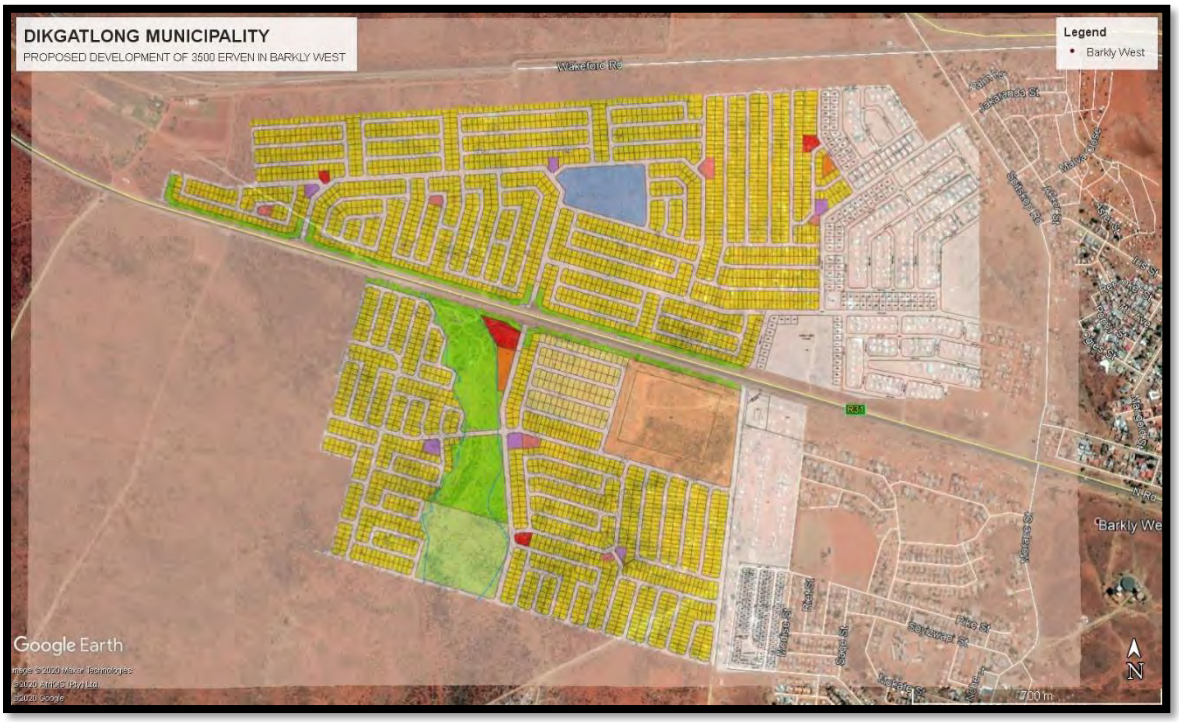


Figure 2: Proposed Development of 3500 Residential Erven

The 3500 erven are outlines in yellow as depicted in Figure 2.
From the diagram it is evident that the development consists of two portions situated on separate sides of the R31 provincial road leading to Postmasburg.

3.2 TOPHOGRAPHY

The sites are located to the western side of the existing Barkly West town.

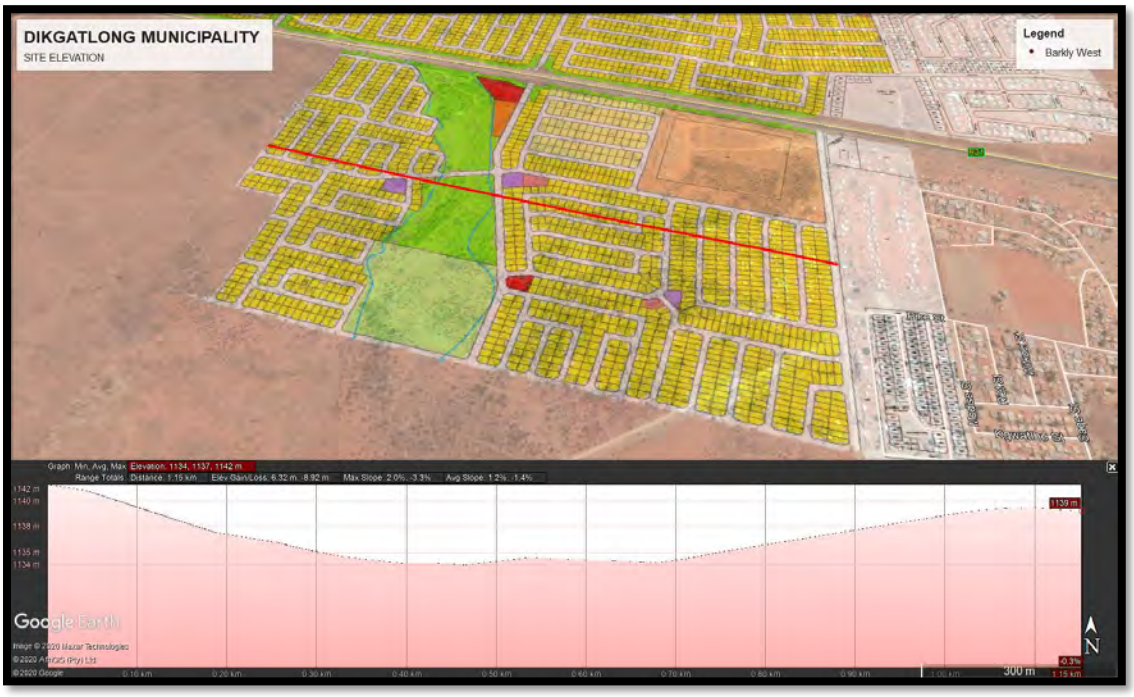


Figure 3: Site Elevation

Figure 4: Second Site Elevation

The first proposed site (Figure 3 above) has a gradual slope from the west towards the east of approximately 9.72m over a distance of 1.09kms, 1133 to 1141 Metres Above Sea Level. The site indicates an average slope of 1.2% to 1.5% across the entire site.

The second proposed site (Figure 4 above) has a gradual slope from the east towards the west of approximately 11.5m over a distance of 1.87kms, 1128 to 1139 Metres Above Sea Level. The site indicates an average slope of 0.8% to 1.1% across the entire site.

Figure 3 and Figure 4 above depicts the gradient of the proposed site.

3.3 CLIMATE

3.3.1 Rainfall

In Barkly West there is very little rainfall during the year. Normally Barkly West receives about 427mm of rain per year most of the precipitation falls during the month of Feb. It receives the lowest rainfall (0.2mm) in July and the highest (30mm) in Feb. On average, in Barkly West, most of the months of the year the days have dry climates and sunny.

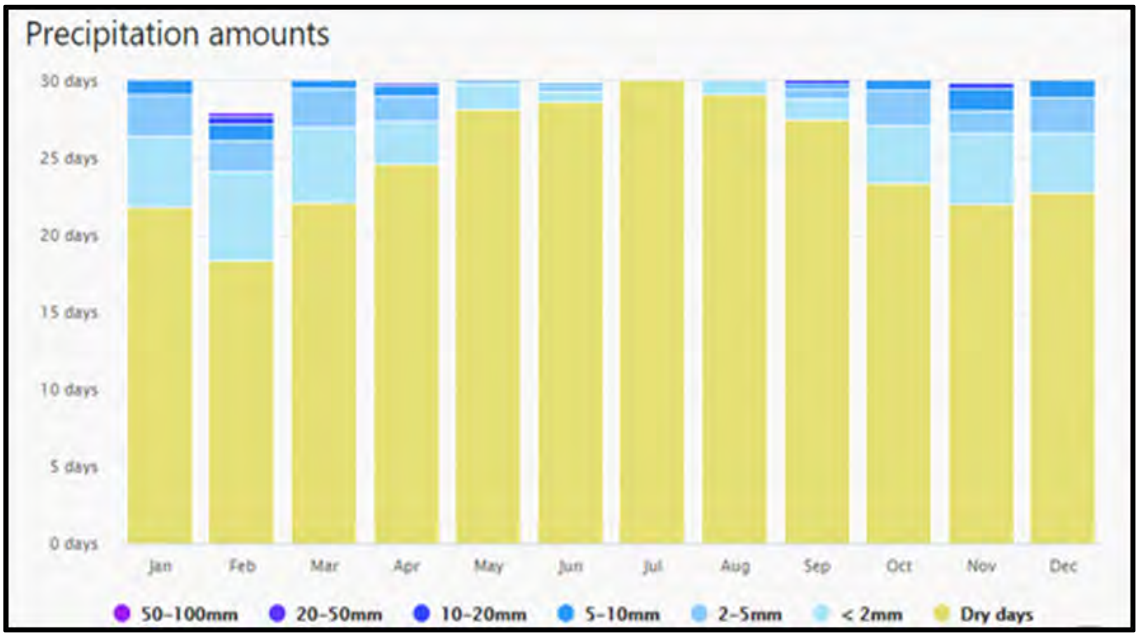


Figure 5: Precipitation

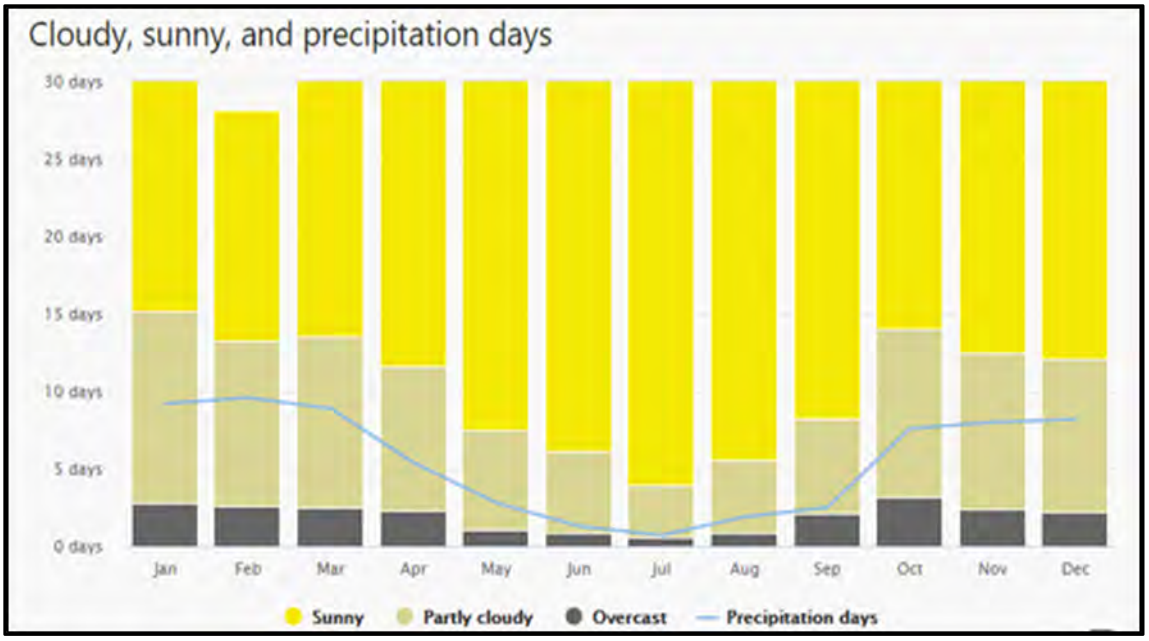


Figure 6: Cloudy & Sunny Days

3.3.2 Temperature

The monthly distribution of average daily maximum temperatures, that the average midday temperatures for Barkly West range from 0°C in July to 34°C in January. On average most of the days for each month of the year, experience dry and hot temperatures.

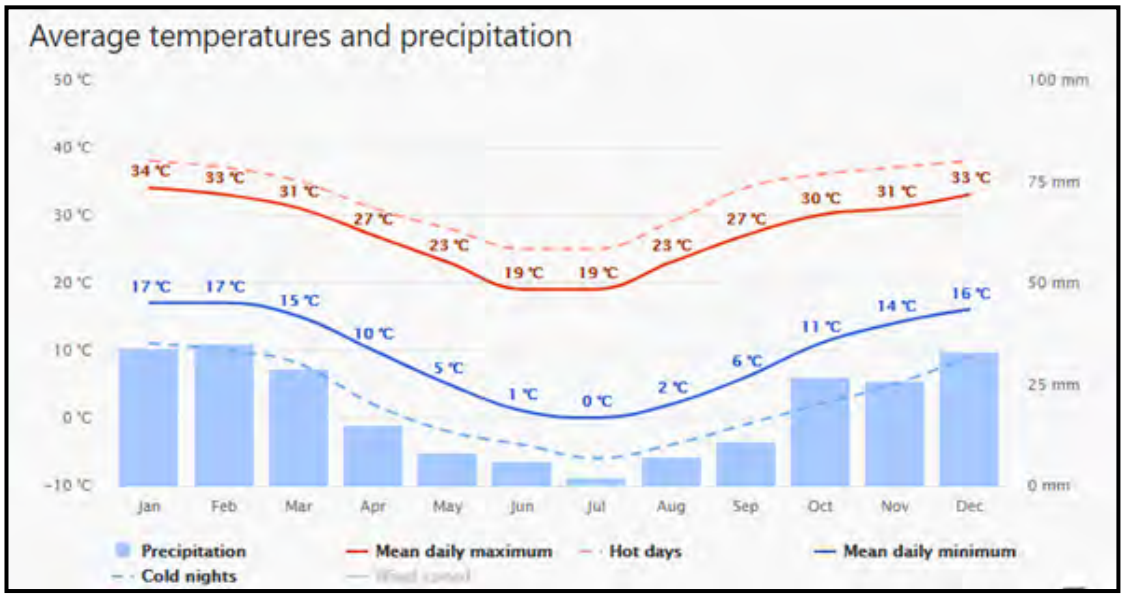


Figure 7: Temperatures & Precipitation

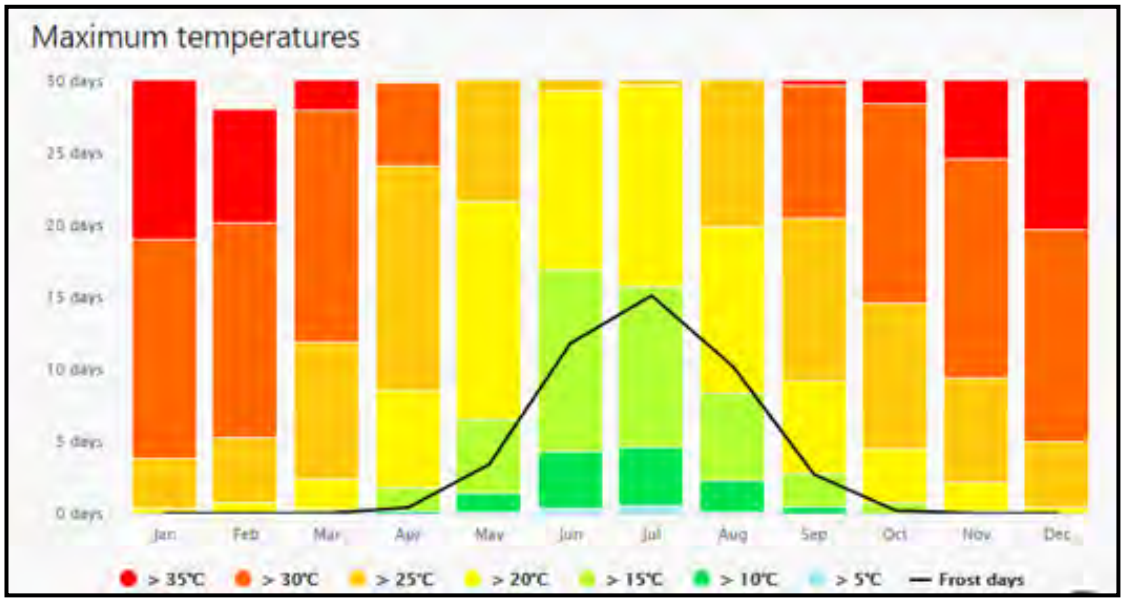


Figure 8: Maximum Temperatures

3.4 VEGETATION

In Barkly West the predominant vegetation type is Ghaap Plateau Vaalbosveld (63% cover), followed by Schmidsdrift Thornveld (19% cover) and Kimberley Thornveld (17% cover). Soils range from shallow and dominated by lime and calcrete moderately deep and sandy to high clay content and structured soils.

3.5 GEOLOGY

A phase 1 engineering geological investigation with reference to GSFH-2.

3.5.1 Drainage

Site A: drains from the western direction towards the east with a small hilltop/ flat surface formed in the middle of the site. The general direction for surface water is from the west towards the east.

Site B: drains from the southern and western side direction towards the northern, north eastern side of the site. In the eastern corner of the site a flat surface is located that will force surface water drainage around it.

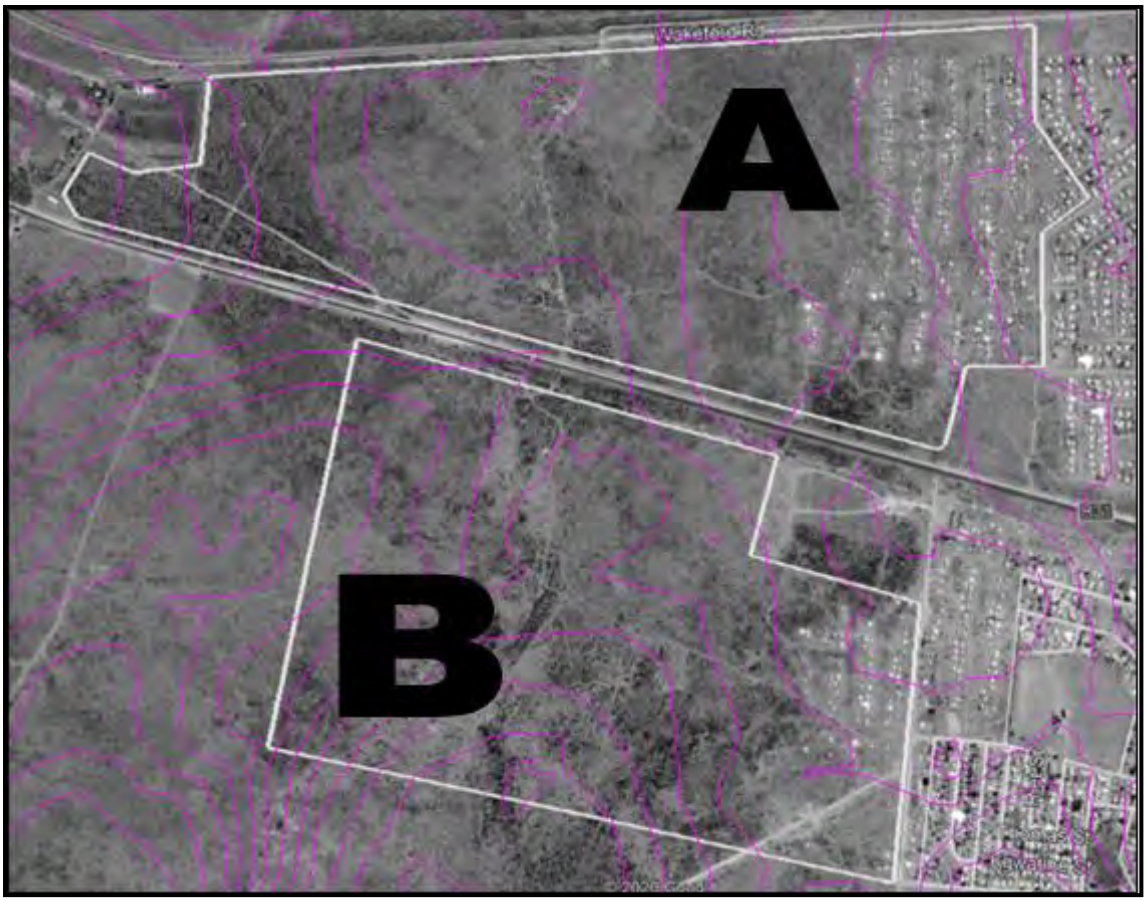


Figure 9: Drainage Patterns

3.6 DEMOGRAPHIC OVERVIEW

As indicated in Table 3-1, the population of the Dikgatlong Local Municipality (DLM) increased from 38 262 in 2001 to 46 841 in 2011 which represents an increase of ~ 2.02%. The town of Barkly West is the administrative centre for the DLM. Barkly West is situated on the Kimberley-Postmasburg growth corridor. The municipal area covers approximately 7 315 km² and borders with the Magareng Municipality in the north-east and Sol Plaatje in the south-east. Agriculture and mining form the economic basis of the area.

The sizes of the DLM household size have increased from 3.6 to 3.7 in 2011 census. The statistics indicate that the household sizes have increased and therefore indicate a stabilisation in the working 15-64 age group, staying at

the same percentage and a decrease in the young 0 -14 age group. A slight increase is also shown in the elderly 65+ age group.

Table 3-1: Overview of key demographic indicators for the DLM

	DLM	
ASPECT	2001	2011
Population	38 262	46 841
% Population <15 years	31.7	31.6
% Population 15-64	63.1	63.1
% Population 65+	5	5.3
Households	10 224	11 967
Agricultural Households	N/A	2 611
Household size (average)	3.6	3.7
Formal Dwellings %	73.2	78.5
Dependency ratio per 100 (15-64)	58.1	58.5
Unemployment rate (official) - % of economically active population	45.3	39.7
Youth unemployment rate (official) - % of economically active population 15-34	54.8	49
No schooling - % of population 20+	25.4	17.7
Higher Education - % of population 20+	3.6	2.7
Matric - % of population 20+	11.5	20.3

Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

The majority of the population in the DLM in 2011 was Black African (58.5%), followed by Coloured (28.5%), White (3.6%), Other (8.9%) and Indian/Asian (0.6%) (Census 2011). The dominant language spoken is Setswana (52.4%), followed by Afrikaans (39%), English (2.1%), Sesotho (1.7%), IsiXhosa (1.1%), IsiNdebele (1%) and IsiZulu (0.8%).

The dependency ratio in DLM increased from 58.1 to 58.5. The slight increase represents a stable socio-economic movement, indicating that there are an increased number of people dependent the economically active 15-64 age group. The age dependency ratio is the ratio of dependents, people younger than 15 or older than 64, to the working, age population, those ages 15-64. The reasons for the increased ratio may be because there was a slight increase in the elderly age group 65 + (5.3%) that may indicate that more people are reliable on government grant payments.

In terms of percentage of formal dwellings, the number of formal dwellings in DLM increased from 73.2% in 2001 to 78.5% in 2011. This represents a

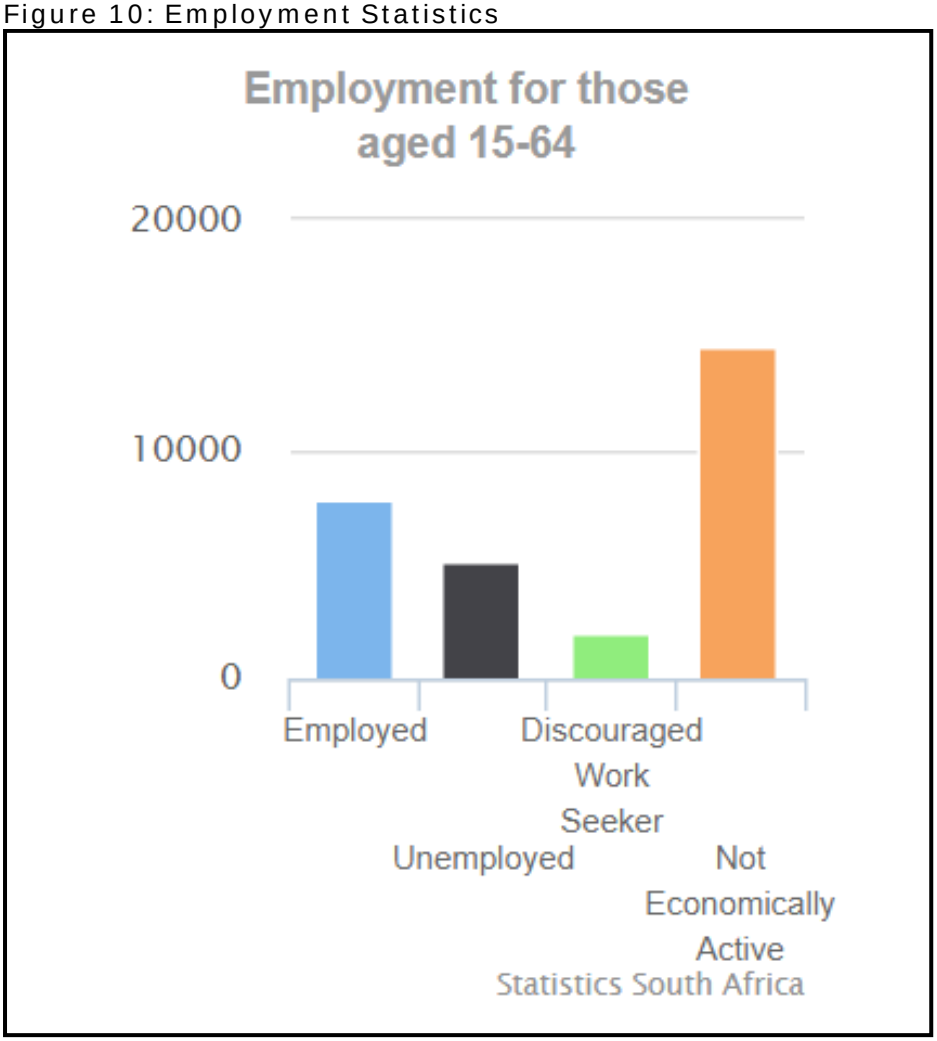
positive socio- economic movement for the DLM. The figure still reflects the challenges faced by the DLM associated with the influx of workers and job seekers to the area. This figure also indicates that there is likely to be a housing backlog in DLM.

3.6.1 Employment

The official unemployment rate in DLM decreased for the ten-year period between 2001 and 2011. In DLM the rate declined from 45.3% to 39.7%, a decrease of 5.6%. Youth unemployment in the DLM also declined over the same period. Youth unemployment in the DLM area decreased from 54.8% to 49%.

Livestock, irrigation farming and commercial mining drive the municipality's economy. The main contributing factor to the low levels of employment in DLM is the high percentage (86,2%) of the labour force that has not obtained a Grade 12 Senior Certificate and/or higher qualification, resulting in a primarily unskilled labour force.

Figure 10: Employment Statistics



Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

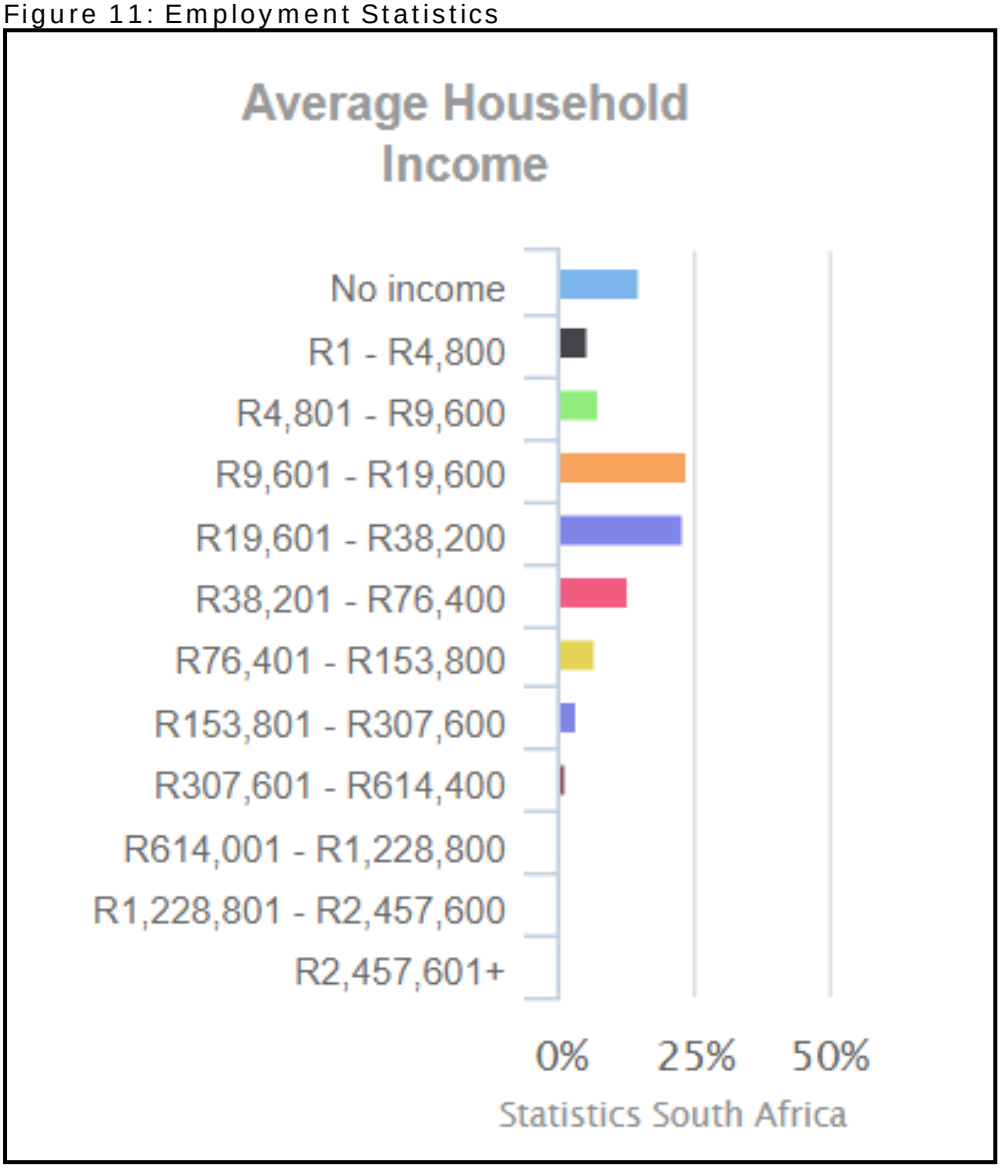
3.6.2 Household income

Based on the data from the 2011 Census, 15.2 % of the population of the DLM have no formal income, 5.2% earn between 1 and R 4 800, 7.2% earn between R 4 801 and R 9 600 per annum, 24.3% between R 9 601 and 19

600 per annum, 23.4% between R 19 601 and R 38 200 per annum, 12.7% between R 38 201 and R 76 400 per annum, 6.6% between R 76 401 and R 153 800 per annum, 3.4% between R 153 801 and R 307 600 per annum and 1.5% between R 307 601 and R 614 400 per annum. (Census 2011).

These figures are likely to be linked to the influx of job seekers to the area and the inability of all of them to secure work. This is also likely to result in an increasing number of individuals and households who are likely to be dependent on social grants. The low-income levels also result in reduced spending in the local economy and less tax and rates revenue for the district and local municipality.

Figure 11: Employment Statistics



Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

3.6.3 Education

The education levels at Dikgatlong local municipal level also improved, with the percentage of the population over 20 years of age, with no schooling in DLM the decrease was from 25.4% to 17.7%. The percentage of the population over the age of 20 with matric also increased in DLM, from 11.5% to 20.3%. However, despite this increase the figure for DLM are still below

the national (28.4%) levels in 2011. The figure for the DLM is also below the provincial level (22.7%).

3.6.4 Municipal services

As indicated in Table 3-2, the municipal service levels in DLM most have improved over the period 2001 to 2011, but the refuse removal services show a slight decrease over the same period.

This still represents a socio-economic improvement. The local service levels in the DLM have increased but are still lower than both the national and provincial averages, except for the access to flush toilets. The national averages for each of the relevant indicators are 57% (access to flush toilet), 62% (weekly waste removal), 46.3% (piped water inside dwelling) and 84.7% for electricity. This indicates a slow growth in the DLM service provider sector.

Table 3-2: Overview of access to basic services in the DLM

Municipal Services	DLM	
	2001	2011
% households with access to flush toilet	32.7	60.0
% households with weekly municipal refuse removal	55.2	49.6
% households with piped water inside dwelling	24.3	30.7
% households which uses electricity for lighting	61.3	75.9

Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

There are 11 967 households in the municipality with an average size of 3,9 persons per household. 48% of the population in the district has no income. Dikgatlong Local Municipality has only 47,1% of residents who own their housing, which is the lowest compared to other local municipalities in the district. In addition, 78,5% of the dwellings are formal dwellings, and 60,0% of these have a flush toilet connected to a sewerage system. 75,9% of the households use electricity for lighting and 30,7% have piped water inside their dwelling, which is also a lower percentage than those of the other local municipalities in the district.

3.6.5 Population Figures

Dikgatlong Local Municipality is a municipality in Frances Baard District Municipality in the Northern Cape. It has seven wards. The municipal areas are Barkly-West, Windsorton, Delportshoop and a portion of the former Diamantveld District Council. The head office of the municipality is situated in the town of Barkly West that is approximately 35 km north-west of the city of Kimberley on the northern bank of the Vaal River. Barkly West is situated on the Kimberley-Postmasburg growth corridor. The municipal area covers approximately 7 315 km² and borders with the Magareng Municipality in the north-east and Sol Plaatje in the south-east. Agriculture and mining form the economic basis of the area.

The municipality incorporates the towns of Barkly West, Delportshoop, Dikgatlong NU, Gong-Gong, Holpan, Kutlwano and Longlands only to name a few. The Municipality strives to deliver basic services to its community by ensuring that there is water, sanitation and electricity. The population figures for the Dikgatlong Local Municipality are depicted in Table 3-3 below.

Table 3-3: Beneficiaries 2011

Suburb Benefiting	Total Benefiting Population	Total No. Of Households Benefiting
Barkly West	8 258	2 014
Delportshoop	4 788	1 197
Dikgatlong NU	3 727	1 331
Gong-Gong	1 045	299
Holpan	646	208
Kutlwano	3 959	1 015
Longlands	2 933	793
Mataleng	11 847	3 038
Pniel Estate	695	188
Sydney on Vaal	33	9
Tidimalo	5 558	1 356
Ulco	860	287
Vaal-Gamagara	198	66
Windsorton	2 291	603
Total	46 838	12 404

Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

Dikgatlong Local Municipality has increased from 38 262 people in 2001 to 46 841 people in 2011 (Census 2011) at an average growth rate of 2.02% per annum.

Based on these figures the anticipated population in 2020 is displayed in Table 3-4 below.

Table 3-4: Anticipated Population by 2020		
Suburb Benefiting	Total Benefiting Population	Total No. Of Households Benefiting
Barkly West	9 887	2 411
Delportshoop	5 732	1 433
Dikgatlong NU	4 462	1 594
Gong-Gong	1 251	357
Holpan	773	249
Kutlwano	4 740	1 215
Longlands	3 511	949
Mataleng	14 183	3 637
Pniel Estate	832	225
Sydney on Vaal	40	14
Tidimalo	6 654	1 623
Ulco	1 030	343
Vaal-Gamagara	237	79
Windsorton	2 743	722
Total	56 075	14 851

4. TERMS OF REFERENCE

G3T Consult CC was appointed by Barzani Holdings on the 21 February 2020 for the compilation of Technical Service report for the Bulk Civil Services for the development of 3500 low cost/ subsidized residential erven towards the Western side of Barkly-West with in the Dikgatlong Local Municipality.

The proposed development will consist of the following:

- Residential Zone IV (Min. 260 m²) 3400 Erven
- Residential Zone IV (Min. 400 m²) 100 Erven
- Business Zone II 4 Erven
- Institutional Zone II (Church) 6 Erven
- Institutional Zone I (Creche) 6 Erven
- Institutional Zone I (School) 1 Erf
- Sports Field 1 Erf
- Institutional Zone III (Municipal) 2 Erven
- Cemetery 1 Erf
- Open Space Zone I (Park) 6 Erven
- Transport Zone II (Public Streets) unknown m²
- Total Area 3527 ha

5. INFORMATION

5.1 Information Obtained:

5.1.1 Existing Population Figures

As indicated previously in this report, the existing population figures for the town of Barkly-West where obtained from extrapolated figures based on the outcomes of censes 2011. These extrapolated figures may be summarised as follows:

- No. of Households: 2101
- Population per Household: 4.1
- Total Population: 8614

However, it must also be noted that at present, the existing municipal infrastructure under consideration, also serves the township of Mataleng situated to the south and west of Barkly-West, inclusive of approximately 1563 informal dwellings. These erven will thus also be included with in the existing population figures at an anticipated population per erf of 3.9 people as per census 2011. From this the existing population figures for Mataleng will be as follows:

- No. of Households: 3963
- Population per Household: 3.9
- Total Population: 15456

Thus, the total population of the town of Barkly-West will be 24070 people.

5.1.2 Town planning Zoning

The detailed layout plan was received from Maxim Planning Solutions on Tuesday 23rd June 2020.

5.1.3 Flood line information

The 1:100 flood lines have been determined and are depicted on the Draft Town Planning Layout received from Maxim Planning Solutions.

5.1.4 Sewer: Existing Municipal Infrastructure

Information regarding the existing municipal infrastructure was obtained from the local authorities as well as on site investigations.

Information obtained included the following:

- Horizontal alignments and pipe diameters of the existing municipal sewer network.
- Daily capacity of existing municipal wastewater treatment works (WWTW).
- No vertical alignments of the existing municipal sewer network could be obtained.

5.1.5 Water: Existing municipal infrastructure

Information regarding the existing municipal infrastructure was obtained from the local authorities as well as on site investigations.

Information obtained included the following:

- Horizontal alignments and pipe diameters of the existing municipal water network.
- Size of existing bulk water main from the water treatment works to the reservoirs.
- Size of existing municipal reservoirs.
- Size of the existing elevated storage tower.
- Size of the existing distribution main from the elevated storage tower to the reticulation network.

5.1.6 Geological investigation

Phase 1 engineering geological investigation report with reference to the GFSH2 specification of the NHBRC to determine the potential for township development for Barkly-West, was obtained, as prepared by Geoset CC (report no: GS202003B; dated March 2020).

5.1.7 Cadastral and Topographic survey

A Cadastral and Topographical survey is yet to be obtained.

6. TECHNICAL DESIGN PARAMETERS AND STANDARDS

The design criteria and specifications as contained in this report are based on the following:

- *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book").*

The existing capacity of bulk municipal infrastructure will be evaluated in accordance to the population figures as extrapolated from figures obtained from the 2011 senses, as represented in *5.1.1* of this report, in conjunction with design standards as mentioned above.

Proposed amendments and additions to bulk infrastructure will be designed to accommodate all requirements for developments of this nature, as well as existing developments where applicable. The services will be according to accepted engineering specifications and principles as well as acceptable environmental requirements and standards.

6.1 Proposed Design Criteria: Sewer Infrastructure

Table 6-1: Sewer Gravitational Network: Developing Areas: Proposed Design Criteria		
Parameter	Element	Guideline
1. Design Capita per Dwelling Unit	• Existing Erven: o Low Income; Waterborne Sanitation; Medium Density o Informal Housing o Residential; Medium Density • Proposed Erven: o Low Income; Waterborne Sanitation; Medium Density	 3.9 people 3.9 people 4.1 people 5 people
2. Effluent Generation: (PDDWF)	• Existing Erven: o Low Income; Waterborne Sanitation; Medium Density o Informal Housing o Residential; Medium Density • Proposed Erven: o Low Income; Waterborne Sanitation; Medium Density	 86 ℓ/capita/day 20 ℓ/capita/day 120 ℓ/capita/day 86 ℓ/capita/day
3. Sewer gradients	• Maximum (all diameters) • Minimum 110mm Ø • Minimum 160mm Ø	1:60 1:120 1:200
4. Flow Velocity	• Minimum (all diameters; self-cleansing) • Maximum (all diameters)	0.6 m/s 1.2 m/s
5. Dry weather Peak Factor (PF)	Design Peak	1.8
6. Ground Water Infiltration	Infiltration for estimated theoretical pipe length.	0.03 ℓ/min/m Ø/m pipe length/day
7. Storm Water Infiltration	Design Peak	30% additional to Dry Weather Peak Flow
8. Pipe Location	All Areas	Road reserve – 1.5 m from roads edge
9. Pipe Materials	All pipe diameters	uPVC Class 34
10. Pipe Size	Minimum diameter	160mm Ø
11. Cover to Pipes	Minimum: Road reserves Other Areas	1,000 mm 800 mm

6.2 Proposed Design Criteria: Water Infrastructure

Table 6-2: Water Distribution Network: Developing Areas: Proposed Design Criteria		
Parameter	Element	Guideline
1. Design Capita per Dwelling Unit	• Existing Erven: o Low Income; Waterborne Sanitation; Medium Density o Informal Housing o Residential; Medium Density • Proposed Erven: o Low Income; Waterborne Sanitation; Medium Density	 3.9 people 3.9 people 4.1 people 5 people
2. Demand	• Existing Erven: o Low Income; Waterborne Sanitation; Medium Density o Informal Housing o Residential; Medium Density • Proposed Erven: o Low Income; Waterborne Sanitation; Medium Density	 90 ℓ/capita/day 25 ℓ/capita/day 230 ℓ/capita/day 90 ℓ/capita/day

3. Pressure	• Maximum (Static) • Minimum: Trunk Mains • Minimum: Reticulation Mains	90 m (9.0 bar) 25 m (2.5 bar) 10 m (1.0 bar)		
4. Flow Velocity	• Minimum (all diameters • Maximum (all diameters)	0.6 m/s 1.2 m/s		
5. Peak Factor (P)	• Existing Erven:	P_w	P_d	P_h
	o Low Income; Waterborne Sanitation; Medium Density o Informal Housing	1.4	1.8	3.4
	o Residential; Medium Density	1.5	1.9	3.4
	• Proposed Erven:	1.6	2.0	4.0
	o Low Income; Waterborne Sanitation; Medium Density	1.4	1.8	3.4
6. Pipe Location	All Areas	Road reserve – 2.0 m from roads edge		
7. Pipe Materials	All pipe diameters	uPVC Class 09		
8. Cover to Pipes	Minimum: Road reserves Other Areas	1,000 mm 800 mm		

7. SEWER

7.1 Existing Municipal Infrastructure

A desk top study was done to confirm the status quo of the bulk and gravitational sewer system for Barkly-West

Barkly-West is served by a waterborne sewer gravitational network of varying pipe diameters, draining effluent from parts of the existing township to a number of lifting pump stations throughout Barkly-West and Mataleng. These lifting stations lift the effluent to the Mataleng sewer pump station. The effluent is pumped westward and gravitates via a 250 mm Ø bulk gravity sewer main to the existing Wastewater Treatment Works.

The existing wastewater treatment works is situated approximately 1.4 km south of the R31 and 1.3 km west of Mataleng. The WWTW have a daily capacity of 7.5 Mℓ/day, and consists of the following components:

- Inlet works
- Aeration channel complete with 5 electrically driven aerators.
- Clarifier.
- Chemical treatment plant.
- Dosing Contact Channel

It must be noted that as of the date of this report the treatment works are in a state of disrepair due to lack of maintenance. The chemical treatment plant is in complete disuse due to damage and loss of major components, chemical contact dosing being executed directly within the Dosing Contact Channel hand. In addition, all mechanical and electrical installations are currently inoperable due to main electrical supply faults to the treatment works.

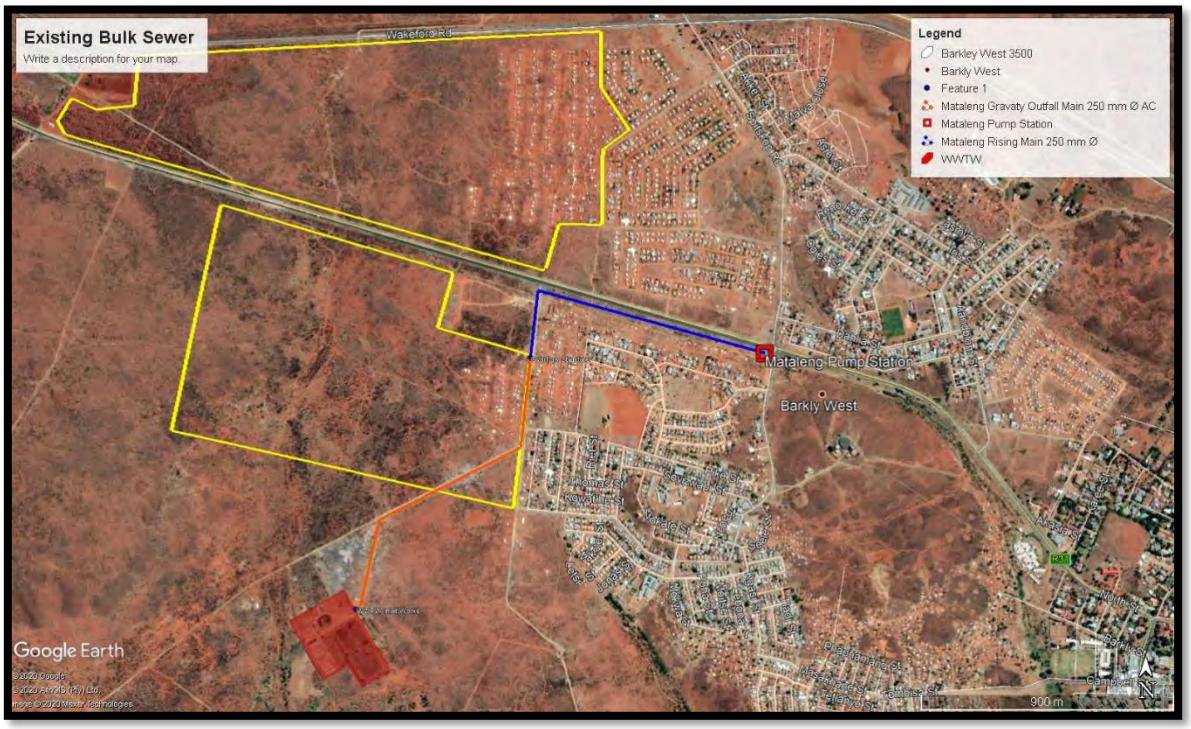


Figure 12: Existing Bulk Sewer Infrastructure

In order to perform a comprehensive evaluation of the bulk infrastructures suitability to serve the current demand as well as the proposed future demand, a logical process must be followed, and may be summarized as:

- Determination of existing demand.
- Determination of proposed additional demand.
- Determination of existing maximum capacity of bulk infrastructure.
- Determination of reserve capacity of bulk infrastructure with relation to current demand.
- Evaluation of bulk services reserve capacity with relation to the proposed additional demand.

7.2 Existing Total Effluent Generation

The existing peak flow will be based on figures and peak factors as obtained from *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book")* as set out in Table 7-1, in conjunction with the estimated population for the year 2020.

7.2.1 Peak Daily Dry Weather Flow (PDDWF):

The total Peak Daily Dry Weather Flow (PDDWF) for the estimated existing population for 2020' as depicted in the table below, amounts to 1,960.56m³/day (22.69**ℓ/s)**.

Table 7-1: Peak Daily Dry Weather Flow: Existing Population

Description	Capacity (ℓ/capita/day)	Area (ha)	Unit factor (no of people)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	86.0	-	9360	804.96

Table 7-1: Peak Daily Dry Weather Flow: Existing Population				
Description	Capacity (ℓ/capita/day)	Area (ha)	Unit factor (no of people)	m³/day
• Informal Housing	20.0		6096	121.91
• Residential; Medium Density	120.0		8614	1033.69
TOTAL				**1'960.56**

7.2.2 Instantaneous Peak Dry Weather Flow (IPDWF):

The estimated existing population served is 24070 people. With reference to Figure 13 below the Dry Weather Peak Factor (DWPF) will be approximately 1.8.

From the above, the total Instantaneous Peak Dry Weather Flow for the existing population served will be as follows:

- (PDDWF from table 4.2.1) x (DWPF) = (IPDDWF).
- 1,960.56 m³/day x 1.8 = 3,529.01m³/day (40.85**ℓ/s**).

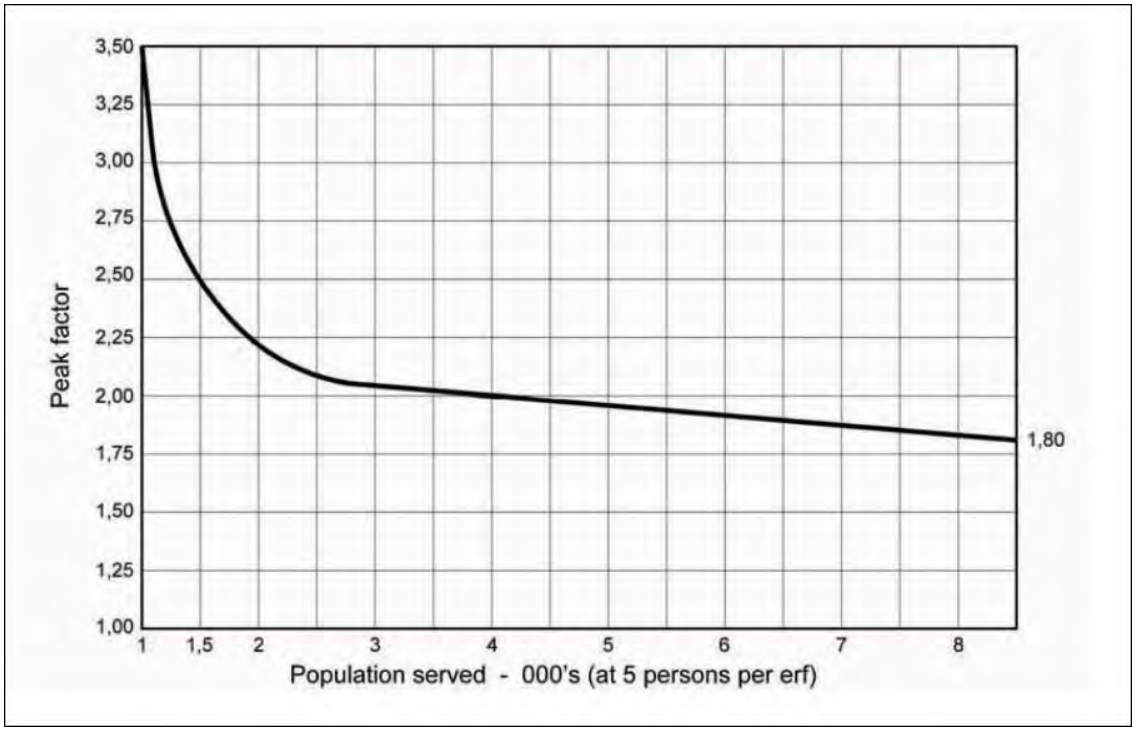


Figure 13: Peak Factors

7.2.3 Instantaneous Peak Wet Weather Flow (IPWWF):

Considering storm water infiltration rate of 30%, and groundwater at a rate of 0.03ℓ/min/mØ/m pipe length, the Instantaneous Peak Wet Weather Flow (IPWWF) amounts to the following:

- ((IPDWF) + Ground Water) / (1-0.3) = (IPWWF)

For ground water infiltration estimation an assumption of 160 mm Ø pipes will be taken over an estimated pipe length/erf for the formal erven only as

indicated in figure 7 below. The estimated ground water infiltration will be as follows:

Table 7-2: Ground Water Infiltration: Existing Infrastructure					
Description	Capacity (ℓ/min/m Ø/m pipe length)	Ø of pipe (m)	Length (m/erf)	Unit factor (no of Erven)	m³/day
• Low Income; Waterborne Sanitation; Medium Density • Informal Housing • Residential; Medium Density	0.03 n/a 0.03	0.160 0.160 0.160	10.0 n/a 13.0	9360 n/a 8614	172.80 n/a 196.65
TOTAL					369.45

Table 7-3: Typical pipe length (reticulation) per stand/plot			
Land use		Stand Size #1	Length #2
		m²	m
Residential stands	High density, Small Sized	400 to 670	10 to 13
	Medium density medium sized	670 to 1 000	13 to 16
	Low density, large sized	1 000 to 1 600	16 to 20
	Very low density, extra-large sized	1 600 to 2 670	20 to 26
Stands for low income housing (waterborne sanitation)	High density, small sized	270 to 400	8 to 10
	Medium density, medium sized	400 to 670	10 to 13
	Low density, extra-large sized	670 to 1 000	13 to 16
Group/cluster housing	High density	130 to 200	6 to 7
	Medium density	200 to 270	7 to 8
	Low density	270 to 400	8 to 10
Flats	Very high density	80 to 100	4 to 5
	High density	100 to 130	5 to 6
	Medium density	130 to 160	6 to 6
	Low density	160 to 200	6 to 7
Agricultural holdings	Including irrigation	< 2 670	> 26
	Domestic water only	< 2 670	> 26
Golf estate - excluding golf course water requirements		< 2 670	> 26
Retirement village		400 to 670	10 to 13

Thus, from the previous, the IPWWF will be as follows:

- IPWWF = ((IPDWF) + Ground Water) / (1-0.3)
- IPWWF = (3,529.01 m³/day + 369.45 m³/day) / (1-0.3)
- IPWWF = 5,569.23 m³/day (64.46 **ℓ/s)**

7.3 Proposed Additional Effluent Generation

The proposed peak flow will be based on figures and peak factors as obtained from *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book")* as set out in Table 7-4, in conjunction with the estimated population for proposed development as set out below:

- (No. of proposed erven) x (capita/ erf) = (Estimated Population)
- 3,500 erven x 5 people/erf = 17,500 people

7.3.1 Peak Daily Dry Weather Flow (PDDWF):

The total Peak Daily Dry Weather Flow (PDDWF) for the estimated additional population as depicted in the table below, amounts to 1,505.00m³/day (17.42 **ℓ/s)**.

Table 7-4: Peak Daily Dry Weather Flow: Proposed Population

Description	Capacity (ℓ/capita/day)	Area (ha)	Unit factor (no of people)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	86.0	-	17,500	1,505.00
TOTAL				1,505.00

7.3.2 Instantaneous Peak Dry Weather Flow (IPDWF):

The estimated additional population served is 17,500 people. With reference to Figure 13, the Dry Weather Peak Factor (DWPF) will be approximately 1.8.

From the above, the total Instantaneous Peak Dry Weather Flow for the proposed additional population will be as follows:

- (PDDWF from table 4.2.1) x (DWPF) = (IPDDWF).
- 1,505.00 m³/day x 1.8 = 2,709.00 m³/day (31.35 **ℓ/s**).

7.3.3 Instantaneous Peak Wet Weather Flow (IPWWF):

Taking into account storm water infiltration rate of 30%, and groundwater at a rate of 0.03 ℓ/min/m Ø/m pipe length thus the Instantaneous Peak Wet Weather Flow (IPWWF) amounts to the following:

- ((IPDWF) + Ground Water) / (1-0.3) = (IPWWF)

For ground water infiltration estimation an assumption of 160 mm Ø pipes will be taken over an estimated pipe length/erf for the formal erven only as indicated in Table 7-3. Thus, estimated ground water infiltration will be as follows:

Table 7-5: Ground Water Infiltration: Proposed Infrastructure					
Description	Capacity (ℓ/min/m Ø/m pipe length)	Ø of pipe (m)	Length (m/erf)	Unit factor (no of Erven)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	0.03	0.160	10.0	3500	252.00
TOTAL					252.00

Thus from the previous, the IPWWF will be as follows:

- IPWWF = ((IPDWF) + Ground Water) / (1-0.3)
- IPWWF = (2,709.00 m³/day + 252.00 m³/day) / (1-0.3)
- IPWWF = 4,230.00 m³/day (48.96 **ℓ/s)**

7.4 Maximum Capacity of Bulk Sewer Infrastructure:

7.4.1 250 mm Ø Bulk Gravity Main:

In order to determine the full flow (maximum) capacity of the existing 250 mm Ø bulk main, one must consider the formula:

- Q = v*A

- Where:
- Q = Flow in m³/s
- v = Velocity of flow in m/s
- A = Area of flow in m^2

However, to maintain a non-pressurised gravitational system, a free water surface must be maintained within the bulk main. To this end, full flow (Q) is considered to be 80% of the absolute maximum capacity of the bulk main, thus flow area is considered to be 80% of total pipe cross sectional area.

Considering the above, assuming a minimum self-cleansing velocity (v) = 0.7m/s at full flow, the following:

- Q = v*(A x 0.8)
- Q = (0.7 m/s) x [((∏/4) x 0.233^2) x 0.8] m^2
- Q = 0.024m³/s

The total estimated maximum capacity of the bulk main is 0.024m³/s (24.0 **ℓ/s)**. When applied over a 24-hour period, the total volume of effluent at IPWWF = 1,438.43 m³/day.

From the above, taking into account constant storm water and ground water infiltration as calculated previously, as well as DWPF of 1.8, the maximum PDDWF may be derived as follows:

- ((IPWWF - Ground Water) x Storm Water) / 1.8 = PDDWF
- PDDWF = ((2,230.00 m³/day – 369.45 m³/day) x (1-0.3)) / 1.8
- PDDWF = 723.54 m³/day (8.37 **ℓ/s)**

Assuming a demand of 86 ℓ/capita/day, the total capacity of the bulk main may be expressed as a total maximum population as follows:

- (PDDWF) / (86 ℓ/capita/day) = Total Maximum Population
- (723.54m³/day) / (86 ℓ/capita/day) = 8,413 people

7.4.2 Wastewater Treatment Works

As stated previously, the existing wastewater treatment works has a maximum capacity of 7.5 M ℓ / day of IPDWF.
From the above, considering constant ground water infiltration as calculated previously, as well as DWPF of 1.8, the maximum PDDWF may be derived as follows:

- (IPWWF - Ground Water) / 1.8 = PDDWF
- PDDWF = (7,500.00 m³/day – 369.45 m³/day) / 1.8
- PDDWF = 3,961.42 m³/day (45.85 **ℓ/s)**

Assuming a demand of 86 ℓ/capita/day for Low income housing, the total capacity of the bulk main may be expressed as a total maximum population as follows:

- (PDDWF) / (86 ℓ/capita/day) = Total Maximum Population
- (3,961.42m³/day) / (86 ℓ/capita/day) = 46,063 people

7.5 Evaluation of Capacity of Bulk Infrastructure:

From 7.4 the maximum capacity for the bulk infrastructure may be summarised as indicated in column 1 of Table 7-6 in the form of the total population that may be served.

Table 7-6: Summery of Bulk Infrastructure Capacity.

Bulk Infrastructure	Maximum Effective Capacity (people)	Current Capacity Served (people)	Reserve Capacity (people)	Proposed Additional Capacity (people)	Remainder (people)
250 mm Ø pipeline	8,413	24,070	-15,657	17,500	-33,157
WWTW	46,063	24,070	21993	17,500	4,493

From the Table 7-6 it can be seen that the 250 mm Ø bulk sewer main does not contain sufficient capacity to serve the existing demand, and thus does not contain sufficient spare capacity to accommodate the proposed additional erven, with a negative deficit 15,657 people on the existing demand alone.

The WWTW contains sufficient capacity to serve the addition of a further 17,500 people (3500 erven at 5 people / erf), with a residual capacity of 4,493 people.

7.6 Recommendations for Bulk Infrastructure:

7.6.1 Bulk Sewer Mains

It is recommended that all parts of the proposed new development be drained to the existing Waste Water Treatment Works, via a newly constructed 400 mm Ø bulk sewer gravitational main (length: 570 m) from a low point situated to the south of the proposed new development (see Figure 14).

Furthermore, it must be noted that due to the topography of the proposed site, there exists three distinct drainage zones, each with their own low points (see Figure 14). The location and elevation of these low points preclude the possibility of effective drainage via gravity toward a single common low point. In order to overcome this, it is recommended that pump stations be included at low points 1 and 2 to elevate the effluent via rising mains to higher elevations along the R31, from where it may be gravitated toward the propose 400 mm Ø bulk main as mentioned before.

The proposed pump stations and rising mains were sized according to the approximate erf count/area, based on the relative area of the drainage zones draining to the respective low points, 750 erven and 1160 erven for area 1 and 2 respectively. Applying the rational used to determine the effluent generated by the proposed development; drainage area 1 and 2 will have an expected IPWWF of 10.50 **ℓ/s** and 16.23 **ℓ/s** respectively. From this inflow rate, assuming a constant minimum velocity of 06 m/s with in the rising mains and pump flow equal to 2 x inflow rate for optimum storage duration at 6 starts/ minute, the proposed Ø of rising main 1 and 2 may be as follows:

- Rising Main 1: 250 mm Ø (1109 m)
- Rising Main 2: 300 mm Ø (1091 m)

And the required sump volumes may be as follows:

- Pump Station 1: 3.2 m^3
- Pump Station 1: 4.9 m^3

7.6.2 Wastewater Treatment Works

As stated, 7.5, the existing wastewater treatment work contains sufficient capacity to serve the need of both the existing population as well as the proposed additional development. However, as stated in 7.1, the WWTW are in state of disrepair, and may need a high degree of maintenance and refurbishment to return it to serviceable condition.

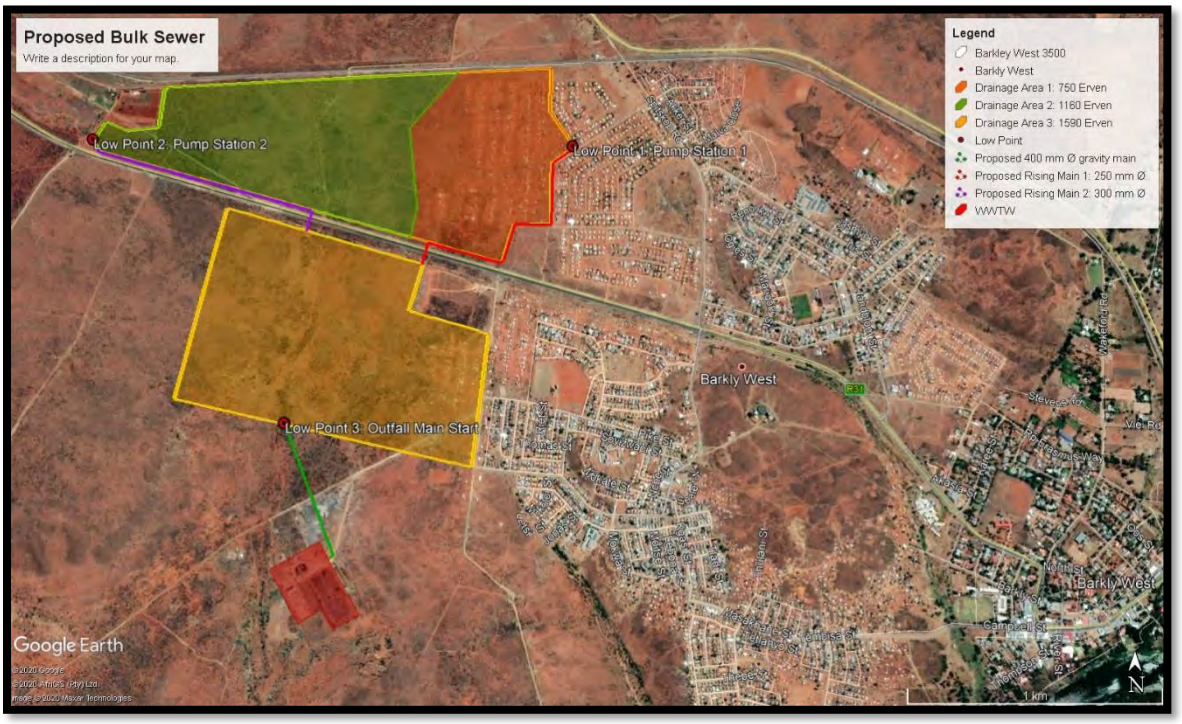


Figure 14: Proposed Bulk Sewer Infrastructure

7.7 COSTING OF PROPOSED BULK SEWER INFRASTRUCTURE:

Table 7-7: Estimated Cost for Bulk Sewer Infrastructure

Item	Description	Amount
A	Pump Station 1 (3,2m³ Sump)	R15 000 000,00
B	Pump Station 2 (4,9m³ Sump)	R17 500 000,00
C	Rising Main 1 (1109m of 250mmØ uPVC Class 12 Pipe)	R1 885 300,00
D	Rising Main 2 (1091m of 300mmØ uPVC Class 12 Pipe)	R2 056 500,00
Sub Total		R36 441 800,00
Contingencies (10%)		R3 644 180,00
Sub Total		R40 085 980,00
Professional Fees		R8 017 196,00
Sub Total		R48 103 176,00
VAT (15%)		R7 215 476,40
Total		R55 318 652,40

8. WATER

8.1 Existing Municipal Infrastructure

A desk top study was done to confirm the status quo of the Barkly-West bulk water and water distribution system, and may be summarised as follows:

- Extraction and treatment from the Vaal River.
- 250 mm Ø Dedicated trunk main to the water storage reservoir.
- 7.16 Mℓ Concrete reservoirs.
- 160 mm Ø distribution main from concrete reservoirs to Lower elevation reticulation network of the Barkly-West township.
- 90 mm Ø distribution main from concrete reservoirs to Lower elevation reticulation network of the Mataleng township
- 850 kℓ Elevated storage and pumping equipment.
- 315 mm Ø distribution main from elevated storage to higher elevation reticulation network of Barkly-West and Mataleng townships.
- Gravity fed water reticulation network of varying pipe diameters.

Barkly-West is supplied with treated potable water by a Water Treatment Plant situated on the bank of the Vaal River, via a 250 mm Ø trunk main conveys the potable water to two concrete reservoir of a combined total capacity of 7.15 Mℓ, situated on a hill located between Barkly-west and Mataleng, approximately 300 m south of the R31. From here water is distributed via a 160 mm Ø and 90 mm Ø gravity fed water distribution mains to the lower elevation eastern and southern portions of the Barkly-West and Mataleng townships. Furthermore, water is lifted into a 850 kℓ elevated segmental storage tank from the concrete reservoirs, via a 250 mm Ø steel pipe and pumping equipment, and subsequently a 315 mm Ø uPVC distribution main for the higher elevation northern portions of the township.

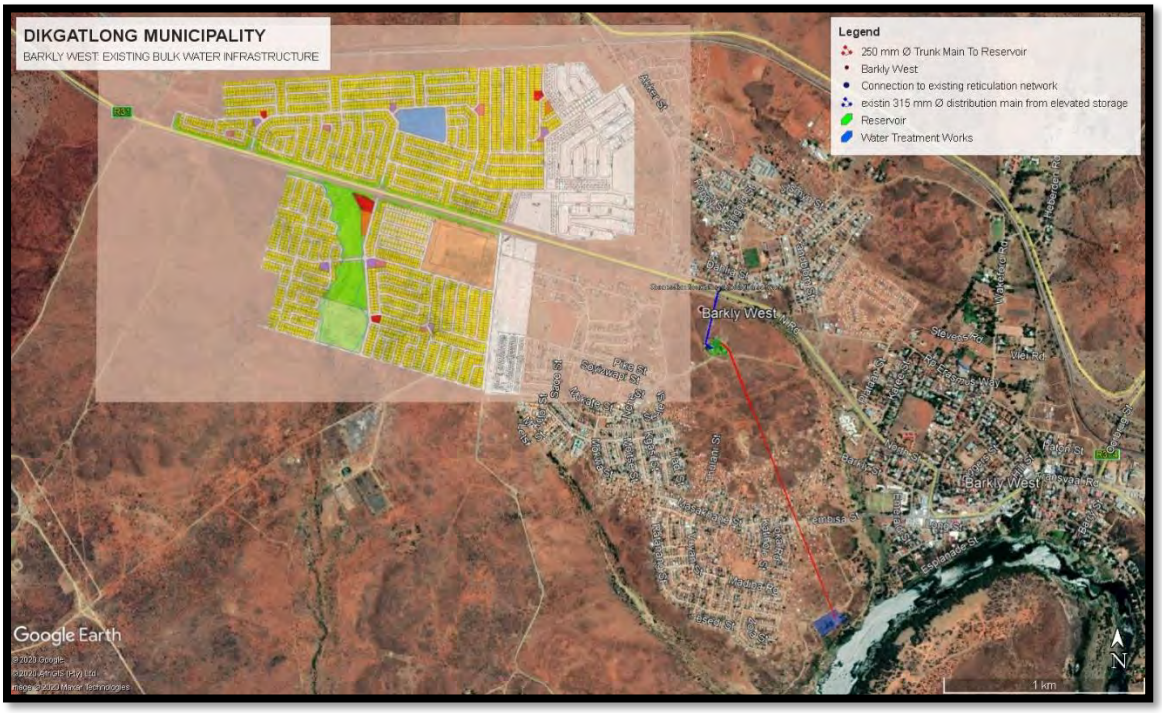


Figure 15: Existing Bulk Water Infrastructure

In order to perform a comprehensive evaluation of the bulk infrastructure's suitability to serve the current demand as well as the proposed future demand, a logical process must be followed, and may be summarized as:

- Determine relevant infrastructure to be assessed.
- Determination of existing demand.
- Determination of proposed additional demand.
- Determination of existing maximum capacity of bulk infrastructure.
- Determination of reserve capacity of bulk infrastructure with relation to current demand.
- Evaluation of bulk service's reserve capacity with relation to the proposed additional demand.

8.2 Relevant Infrastructure

Due to the location of the proposed development in the higher elevation Norther portion of the township, the following infrastructure is deemed to be of relevance:

- Water treatment works
- 250 mm Ø Dedicated trunk main to the water storage reservoir.
- 7.16 Mℓ Concrete reservoirs.
- 850 kℓ Elevated storage and pumping equipment.
- 315 mm Ø distribution main

8.3 Existing Total Water Demand

The existing total water demand will be based on figures and peak factors as obtained from *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book")* as set out in table 3.2, in conjunction with the estimated population for the year 2020.

The Total Annual Average Daily Demand (TAADD) for the estimated existing population for 2020' as depicted in table 5.3a below, amounts to 3,968.05m³/day (45.93 **ℓ/s)**.

Table 8-1: Total Annual Average Daily Demand: Existing Population

Description	Capacity (ℓ/capita/day)	Real Losses (%)	Unit factor (no of people)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	90.0	25	9360	1123.200
• Informal Housing	25.0	25	6096	203.190
• Residential; Medium Density	230.0	25	8614	2641.657
TOTAL				3968.047

However it must be noted that the above is true when considering up to and including the reservoirs only, as the elevated storage and subsequent infrastructure serves only a portion of the existing population, thus the

TAADD for the elevated storage will amount to 1,721.06m³/day (19.92 **ℓ/s)**

Table 8-2: Total Annual Average Daily Demand: Existing Population: Elevated Storage				
Description	Capacity (ℓ/capita/day)	Real Losses (%)	Unit factor (no of people)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	90.0	25	1,872	224.64
• Informal Housing	25.0	25	1,213	40.43
• Residential; Medium Density	230.0	25	4,748	1,455.99
TOTAL				1,721.06

8.4 Proposed Additional Total Water Demand

The proposed additional peak flow will be based on figures and peak factors as obtained from *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book")* as set out in Table 8-2, in conjunction with the estimated population for proposed development as set out below:

- (No. of proposed erven) x (capita/ erf) = (Estimated Population)
- 3500 erven x 5 people/erf = 17,500 people

The Total Annual Average Daily Demand (TAADD) for the estimated proposed population as depicted in Table 8-3 below, amounts to 2,100.000m³/day (24.31**ℓ/s)**.

Table 8-3: Total Annual Average Daily Demand: Additional Population				
Description	Capacity (ℓ/capita/day)	Real Losses (%)	Unit factor (no of people)	m³/day
• Low Income; Waterborne Sanitation; Medium Density	90.0	25	17,500	2,100.000
TOTAL				2,100.000

8.5 Maximum Capacity of Bulk Water Infrastructure:

8.5.1 Water Treatment Works

To date no information regarding the maximum daily capacity of the existing treatment works has been made available by the municipal authorities to use as assessment criteria. To the end of this report, it will be assumed that the water treatment works contains sufficient capacity to serve a population equal to the capacity of the 250 mm Ø trunk main as describe below.

8.5.2 250 mm Ø Trunk Main:

In order to determine the maximum capacity of the existing 250 mm Ø trunk main to the existing reservoir, one must consider the formula:

- Q = v*A
- Where:

- Q = Flow in m^3/s = TAADD x Pw
- TAADD = Total Annual Average Daily Demand
- Pw = Peak weak factor
- v = Velocity of flow in m/s
- A = Area of flow in m^2

Considering the above, assuming a maximum velocity of 1.2 m/s to maintain a maximum discharge at minimum frictional losses, the following:

- Q = v*A
- Q = (1.2 m/s) x ((∏/4) x 0.233^2) m^2
- Q = 0.051m^3/s (50.97 **ℓ/s)**

  Thus:
- TAADD = (0.051m^3/s) / (Ave. Pw)
- TAADD = (0.051m^3/s) / (1.5)
- TAADD = 0.034 m^3/s (33.98 **ℓ/s)**

Thus, the total estimated maximum capacity of the trunk main is 0.034 m^3/s (33.98 **ℓ/s)**. The above discharge taken over a 24-hour period may be taken as the maximum demand that can be served by the existing 250 mm Ø trunk main, namely 2,935.572m^3/day.

From the above, if the real losses are applied in reverse, the maximum AADD may be derived as follows:

- (TAADD) x (1-0.25) = AADD
- AADD = (2,935.572m^3/day) x (1-0.25)
- AADD = 2,201.679m^3/day (25.48 **ℓ/s)**

Assuming a demand distribution % as for the existing demand, the total maximum capacity of the trunk main may be expressed as a total maximum population as follows:

Table 8-4: Maximum Capacity: 250 mm Ø Trunk Main

Description	AADD (m^3/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Low Income; Waterborne Sanitation; Medium Density	2,201.679	28.3	90.0	6,925
• Informal Housing	2,201.679	5.1	25.0	4,510
• Residential; Medium Density	2,201.679	66.6	230.0	6,373
TOTAL				17,807

8.5.3 Existing Concrete Reservoir:

As stated previously, the total capacity of the existing concrete reservoir is 7.16 Mℓ, thus 7,160 m^3. By design standard this existing capacity is representative of 48 hours of TAADD.

Thus TAADD:

- TAADD = (7,160m³) / (2 days)
- TAADD = 3,580 m³/day

From the above, if the real losses are applied in reverse, the maximum AADD may be derived as follows:

- (TAADD) x (1-0.25) = AADD
- AADD = (3,850m³/day) x (1-0.25)
- AADD = 2,685 m³/day (31.08 **ℓ/s)**

Assuming a demand distribution % as for the existing demand, the total maximum capacity of the concrete reservoirs may be expressed as a total maximum population as follows:

Table 8-5: Maximum Capacity: Concrete Reservoir

Description	AADD (m³/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Low Income; Waterborne Sanitation; Medium Density	2,685	28.3	90.0	8,445
• Informal Housing	2,685	5.1	25.0	5,500
• Residential; Medium Density	2,685	66.6	230.0	7,772
TOTAL				21,716

8.5.4 Existing Elevated Storage:

As stated previously, the total capacity of the existing Elevated storage is 850 kℓ, thus 850 m³.By design standard this existing capacity is representative of 6 hours of TAADD, considering that the existing pumping infrastructure serving the elevated tower does not have an independent electrical supply.

Thus TAADD:

- TAADD = ((0.850 m³) / (6 x 60 x60)) x (24 x 60 x60)
- TAADD = 3,400 m³/day

From the above, if the real losses are applied in reverse, the maximum AADD may be derived as follows:

- (TAADD) x (1-0.25) = AADD
- AADD = (3,400 m³/day) x (1-0.25)
- AADD = 2,550 m³/day (29.51 **ℓ/s)**

Assuming a demand distribution % as for the existing demand for the elevated storage, the total maximum capacity of the elevated storage may be expressed as a total maximum population as follows:

Table 8-6: Maximum Capacity: Elevated Storage				
Description	AADD (m^3/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Low Income; Waterborne Sanitation; Medium Density	2,550	13.1	90.0	3,698
• Informal Housing	2,550	2.3	25.0	2,396
• Residential; Medium Density	2,550	84.6	230.0	9,379
TOTAL				15,474

8.5.5 <u>315 mm Ø Distribution Main:</u>

In order to determine the maximum capacity of the existing 315 mm Ø distribution main, one must consider the formula:

- Q = v*A
- Where:
- Q = Flow in m^3/s = (TAADDx2) + FF
- TAADD = Total Annual Average Daily Demand
- FF = Fire Flow
- v = Velocity of flow in m/s
- A = Area of flow in m^2

Considering the above, assuming a maximum velocity of 1.2 m/s to maintain a maximum discharge at minimum frictional losses, the following:

- Q = v*A
- Q = (1.2 m/s) x ((π/4) x 0.293^2) m^2
- Q = 0.081m^3/s (80.87 **ℓ/s)**

  Thus:
- 0.081m^3/s = (TAADDx2) + FF
- (TAADDx2) + FF = 6,987.147 m^3/day

With the aim of determining the TAADD and further the AADD, the fire demand for the above must first be determined. From Table 8-7 and Table 8-8 below, total fire flow for Low Income Housing at Moderate risk 2 will be as follows:

- FF = 25 ℓ/s for 2-hour duration
- FF = 25 ℓ/s x (2 x 60 x 60)
- FF = 180 m^3/day

Table 8-7: Design Criteria for provision of fire flow				
Fire-Risk Classification	Total Fire Flow(l/s)	Minimum Flow at One Hydrant (l/s)	Minimum Pressure at Fire Node (m)	Minimum Pressure at Rest of System (m)
High-risk: CBD and High Risk Industrial	100	25	15	5

Table 8-7: Design Criteria for provision of fire flow				
Fire-Risk Classification	Total Fire Flow(l/s)	Minimum Flow at One Hydrant (l/s)	Minimum Pressure at Fire Node (m)	Minimum Pressure at Rest of System (m)
Moderate-risk 1: Industrial, Business, High Rise Flats ≥ Four Stories	50	25	15	5
Moderate-risk 2: Cluster & Low-Cost Housing, High Rise Flats ≤ Three Stories	25	25	10	5
Low risk: Single Residential Housing	15	15	10	5

Table 8-8: Duration of fire flow	
FIRE-RISK CATEGORY	DURATION OF DESIGN FIRE FLOW(h)
High-risk	6
Moderate risk 1	4
Moderate risk 2	2
Low risk	1

From above:

- TAADD = (6,987.147 m³/day - 180 m³/day) / 2
- TAADD = 3,493.561 m³/day (40.44 **ℓ/s)**

Thus, the total estimated maximum capacity of the trunk main is 3,493.561m³/day.

From the above, if the real losses are applied in reverse, the maximum AADD may be derived as follows:

- (TAADD) x (1-0.25) = AADD
- AADD = (3,493.561 m³/day) x (1-0.25)
- AADD = 2,620.171 m³/day (30.33 **ℓ/s)**

Assuming a demand distribution % as for the existing demand, the total maximum capacity of the distribution main may be expressed as a total maximum population as follows:

Table 8-9: Maximum Capacity: 315 mm Ø Distribution Main				
Description	AADD (m³/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Low Income; Waterborne Sanitation; Medium	2,620.171	13.1	90.0	3,800
Density	2,620.171	2.3	25.0	2,462
• Informal Housing	2,620.171	84.6	230.0	9,637

Table 8-9: Maximum Capacity: 315 mm Ø Distribution Main				
Description	AADD (m^3/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Residential; Medium Density				
TOTAL				15,899

8.6 Evaluation of Capacity of Bulk Infrastructure:

From 8.5 the maximum capacity for the bulk infrastructure may be summarised as indicated in column 1 of Table 8-9 in the form of the total population that may be served.

Table 8-10: Summery of Bulk Infrastructure Capacity.					
Bulk Infrastructure	Maximum Effective Capacity (people)	Current Capacity Served (people)	Reserve Capacity (people)	Proposed Additional Capacity (people)	Remainder (people)
• Water Treatment Works	17,807	24,070	-6,263	17,500	-23,763
• 250 mm Ø main	17,807	24,070	-6,263	17,500	-23,763
• Reservoir	21,716	24,070	-2,354	17,500	-19,854
• Elevated Storage	15,474	7,833	7,641	17,500	-9,859
• 315 mm Ø main	15,899	7,833	8,066	17,500	-9,433

From the Table 8-10 it can be seen that the current bulk services for Barkly-West does not contain sufficient capacity to serve the addition of a further 17,500 people (3,500 erven at 5 people / erf), with a resultant negative deficit when the additional populations is applied to the reserve capacity.

8.7 Recommendations for Bulk Infrastructure:

Considering 8.5 above, the following recommendations:

- Upgrade existing water treatment works.
- Upgrade existing trunk main to reservoir
- Construct additional reservoir capacity at reservoir site.
- Upgrade elevated storage capacity to serve proposed new development.
- Construct dedicated distribution main for proposed new development.

The above recommendations are discussed in detail below.

8.7.1 Upgrading of Existing Water Treatment Works

As stated previously, due to the lack of information regarding the existing water treatment works, it is assumed that the current capacity of the WTW is equal to the current maximum capacity of the 250 mm Ø trunk from the WTW to the Reservoir. Thus from 5.5.2 the TAADD that may be served by the WTW is assumed to be 2,935.572 m^3/day. Taking into consideration for losses as per design standard (25%), this equals a total effective maximum capacity of 17,807 people (see Table 8-10) that may be served, at a shortfall of the current required capacity.

From the above it is clear that in order to accommodate the proposed new development, the WTW must first be upgraded to serve both the current demand as well as the proposed additional demand. To this end the total required capacity may be expressed as follows:

- Total Required Capacity = (TAADD current) + (TAADD future)
- Total Required Capacity = 3,968.047 m³/day + 2,100.000 m³/day
- Total Required Capacity = 6,068.047 m³/day

Considering the above, the additional required capacity:

- Additional Required Capacity = Total Required − Current
- Additional Required Capacity = 6,068.047 m³/day + 2,935.572 m³/day
- Additional Required Capacity = 3,132.475 m³/day

Thus, the WTW must be upgraded to accommodate a minimum additional capacity of approximately 3.2 M **ℓ/day**

8.7.2 Upgrading of Existing 250 mm Ø Trunk Main to Reservoir

From 8.5.2 the TAADD that may be served by the existing trunk main is 2,935.572 m³/day. Taking into consideration for losses as per design standard (25%), this equals a total effective maximum capacity of 17,807 people (see Table 8-10) that may be served, at a shortfall of the current required capacity.

From the above it is clear that in order to accommodate the proposed new development, the existing trunk main must first be upgraded to serve both the current demand as well as the proposed additional demand. To this end the total required capacity may be expressed as follows:

From design standards: Capacity = TAADD x Peak weak Factor (Pw)

Table 8-11: Required Capacity: Trunk Main to Reservoir

Description	TAADD (m³/day)	Pw	Capacity (m³/day)
• Existing Erven:			
o Low Income; Waterborne Sanitation; Medium Density	1,123.200	1.4	1,572.480
o Informal Housing	203.190	1.5	304.785
o Residential; Medium Density	2,641.657	1.6	4,226.651
• Proposed Erven:			
o Low Income; Waterborne Sanitation; Medium Density	2,100.000	1.4	2,940.000
TOTAL			9,043.916

From above the required pipe diameter may be determined from:

- Q = v*A
- Where:
- Q = Flow in m³/s = TAADD/ (24 x 60 x60)

- TAADD = Total Annual Average Daily Demand
- v = Velocity of flow in m/s
- A = Area of flow in m^2 = (π/4) x $\varnothing^2$

Thus, assuming a maximum velocity with in proposed rising main of v = 1.2 m/s to maintain a minimum pipe diameter:

- 0.105 m^3/s = (1.2 m/s) x ((π/4) x $\varnothing^2$)
- $\varnothing$ = $\sqrt{}$(0.150/ (1.2 x 0.785))
- $\varnothing$ = 0.333 m

Therefor the minimum required pipe diameter for the trunk main to the reservoir is a 350 mm $\varnothing$ pipe.

8.7.3 New Concrete Reservoir:

From 8.5.3 the TAADD that may be served by the existing concrete reservoirs is 3,580.0 m^3/day. Taking into consideration for losses as per design standard (25%), this equals a total effective maximum capacity of 21,716 people (see Table 8-10) that may be served, at a shortfall of the current required capacity.

It is recommended that a new reservoir to serve the proposed development, as well as the shortfall in the existing required capacity, be constructed in position at the site of the existing reservoirs.

From the above, the total required capacity may be expressed as:

- Total Req. Capacity = 45 hours of total TAADD required
- Total Req. Capacity = 2 days x (current TAADD + proposed TAADD)
- Total Req. Capacity = 2 days x (3,968 m^3/day + 2,100 m^3/day)
- Total Req. Capacity = 12,136 m^3

Considering the above, the additional required capacity:

- Additional Required Capacity = Total Required − Current
- Additional Required Capacity = 12,136 m^3 + 7,160 m^3
- Additional Required Capacity = 4,967 m^3

Thus, the minimum additional capacity required for the proposed new reservoir is 5.0 Mℓ.

8.7.4 Upgrade Existing Elevated Storage:

From 8.5.4 the TAADD that may be served by the existing elevated storage is 2,550 m^3/day. Taking into consideration for losses as per design standard (25%), this equals a total effective maximum capacity of 15,474 people (see Table 8-10) that may be served, at an excess of the current required capacity. However, it must be noted that the excess capacity of 7,641 people is insufficient to serve the additional demand that will be experienced due to the addition of the proposed development, at a total additional population count of 17,500 people.

To the end of accommodating the proposed development, it will be required to increase the available elevated storage capacity. However, due to the difficulty of increasing the size of an existing elevated segmental steel tank, resulting in the effective demolition and reconstruction, it is recommended that one of the two following options be considered:

- Construct a new elevated storage tank to serve the proposed development.
- Supply existing elevated storage with an independent backup electrical supply (i.e. diesel generator) to reduce the effective design storage duration from the previous mentioned 6 hour to 2 hours.

The above options are discussed below:

8.7.4.1 New Elevated Storage Tank:

The required capacity of a dedicated elevated storage tank may be defined as follows for the proposed development:

- Req. Capacity = 6 hours of TAADD required
- Req. Capacity = (6 /24) x 2,100 m^3/day
- Req. Capacity = 0.525 m^3

Thus, the minimum capacity required for the proposed new elevated storage is **525 kℓ**.

It must be noted that the above recommendation is based on the absence of an independent backup electrical supply as this is the current norm at the existing reservoir site. However, as mentioned previously, should a backup electrical supply be made available, the required time of storage may be reduced from 6 hours to 2 hours. The required storage capacity would be as follows:

- Req. Capacity = 2 hours of TAADD required
- Req. Capacity = (2 /24) x 2,100 m^3/day
- Req. Capacity = 0.175 m^3
- Req. Capacity = 175 **kℓ**

Thus, it is strongly recommended that, in the event that this option is preferred, a backup electrical generator, independent of the main electrical supply is provided in order to minimise the required storage capacity.

8.7.4.2 Provision of Backup Electrical Supply to Existing Elevated Storage

As indicated in 8.7.4.1, the provision of an independent backup electrical supply to pumping infrastructure serving an elevated tower may reduce the required storage volumes by approximately two-thirds. From this it is logical to assume that applying this principal to an existing elevated storage; the effective storage capacity may be increased by the same relative amount.

By applying the above principal to the existing 850 kℓ elevated storage, the total capacity it may serve if equipped with a backup electrical supply, may be defined as follows:

- TAADD = ((0.850 m^3) / (2 x 60 x60)) x (24 x 60 x60)
- TAADD = 10,200 m^3/day

From the above, if the real losses are applied in reverse, the maximum AADD may be derived as follows:

- (TAADD) x (1-0.25) = AADD
- AADD = (10,200 m^3/day) x (1-0.25)
- AADD = 7,650 m^3/day (88.54 **ℓ/s)**

Therefore, assuming a demand distribution % as for the existing demand for the elevated storage, the total maximum capacity of the elevated storage may be expressed as a total maximum population as follows:

Table 8-12: Maximum Capacity: Elevated Storage Assuming. 2 hours Storage

Description	AADD (m^3/day)	Demand Distribution %	Capacity (ℓ/capita/day)	Population
• Low Income; Waterborne Sanitation; Medium Density	7,655	13.1	90.0	7,188
• Informal Housing	7,655	2.3	25.0	11,095
• Residential; Medium Density	7,655	84.6	230.0	28,138
TOTAL				46,421

Table 8-12 above represents an increase in available capacity of approximately 300% and an effective reserve capacity of 38,588 people based on estimated existing demand patterns. Thus, the existing elevated storage would contain ample capacity to serve the existing population as well as the proposed development.

It must however be noted that the existing elevated storage tank is currently in state of disrepair, with apparent major leaks along all joints between the segmental plates, as well as along pipe in and outlets. Thus, in the event that this option may be preferred, it must be noted that considerable maintenance and possible refurbishment will have to be undertaken to render this infrastructure serviceable.

8.7.5 <u>New Distribution Main to Proposed Development:</u>

In light of the two proposed options as described in 8.7.4, it is recommended that a dedicated distribution main be constructed to serve the proposed new development, with either a second connection to the existing elevated storage or a connection to the proposed new elevated storage, which ever option is preferred.

From design standards, assuming a TAADD of 2,100 m^3/day for the proposed development; and a constant fire demand as described in 8.5.5:

- Capacity = (2 x TAADD) + Fire Demand
  Thus:
- Capacity = (((2,100 m^3/day) / (24 x 60 x 60)) x 2) + 0.025 m^3/s

- Total Capacity = 0.049 m^3/s + 0.025 m^3/s
- Total Capacity = 0.074 m^3/s

Assuming a maximum velocity within proposed distribution main of v = 1.2 m/s to maintain a minimum pipe diameter:

- 0.074 m^3/s = (1.2 m/s) x ((∏/4) x $Ø^2$)
- Ø = √(0.074/ (1.2 x 0.785))
- Ø = 0.280 m

Therefor the minimum required pipe diameter for the dedicated distribution main is a 315 mm Ø pipe.

8.7.6 Summary of Recommendations

The recommendations for the bulk water infrastructure may be summarised as follows:

- Upgrade WTW to accommodate an additional capacity of 3.2 M **ℓ/day**
- Upgrade existing 250 mm Ø trunk main to reservoir to 350 mm Ø main (approximate length = 1,482 m).
- Construct new 5.0 M**ℓ** on site at the existing reservoirs.
- Upgrade existing elevated storage.
  - Option 1: Construct new 175 **kℓ** elevated segmental storage tank complete with 1 duty and 1 stand-by pump; independent buck-up electrical supply; and associated works, to serve the proposed development.
  - Option 2: Upgrade existing elevated storage with new independent back-up electrical supply to increase effective storage volume to accommodate existing demand as well as proposed development.
- Construction of new 315 mm Ø pipe (approximate length = 1,700 m) dedicated distribution main to serve the proposed development.

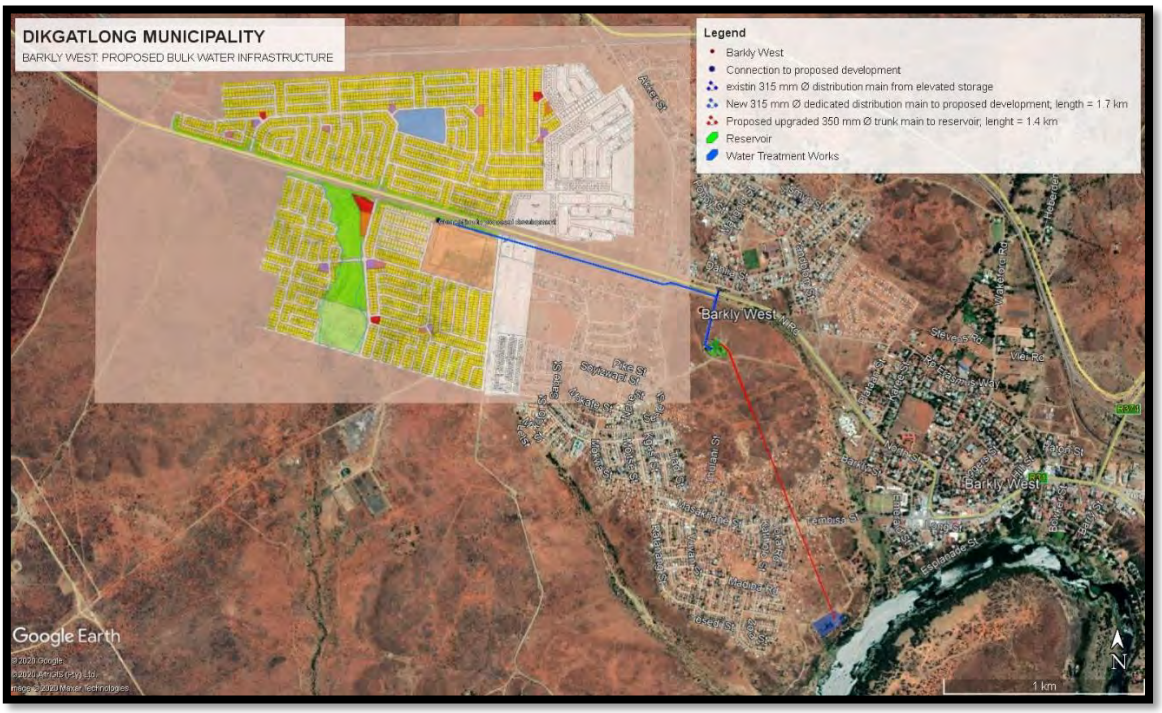


Figure 16: Proposed Bulk Water Infrastructure

8.8 COSTING OF PROPOSED BULK WATER INFRASTRUCTURE:

Table 8-13: Costing of Proposed Bulk Water Infrastructure

Item	Description	Amount
A	Upgrading WTW Additional Capacity (3.2mℓ/day)	R3 200 000,00
B	Upgrade existing 250 mm Ø trunk main to reservoir to 350 mm Ø main (approximate length = 1,482 m).	R2 800 000,00
C	Construct new 5.0 Mℓ on site at the existing reservoirs.	R16 500 000,00
D	Upgrade existing elevated storage with new independent back-up electrical supply to increase effective storage volume to accommodate existing demand as well as proposed development.	R650 000,00
E	Construction of new 315 mm Ø pipe (approximate length = 1,700 m) dedicated distribution main to serve the proposed development.	R2 975 000,00
Sub Total		R26 125 000,00
Contingencies (10%)		R2 612 500,00
Sub Total		R28 737 500,00
Professional Fees		R5 747 500,00
Sub Total		R34 485 000,00
VAT (15%)		R5 172 750,00
Total		R39 657 750,00

9. ROADS

9.1 Existing Municipal Infrastructure:

Currently Barkly-West has two main point of access from the R31 regional road with one surfaced arterial road linking these two points of access, while forming part of the R31. This arterial road, travels through the centre of the town from north-west to south-east and passes between the two portions of the proposed development. The remainder of the towns existing roads infrastructure consists mainly of lower order surfaced and gravel roads.

9.2 Access to the Proposed Development:

Currently the site of the proposed development is situated adjacent to the R31, which splits the site into a norther and southern portion. Additional to the R31, the northern portion of the site is currently bordered by existing surfaced roads infrastructure to the north and east, while the southern portion is bordered by an existing gravel road to the east.

It is recommended that the main access to the two portions of the proposed development be provided from the R31 by means of an adequately designed higher order intersection. Such an intersection should be constructed complete with turning and deceleration lanes; and associated geometric elements to facilitate the safe entry and exit to traffic while maintaining the uninterrupted flow of through traffic.

Furthermore, it is recommended that additional smaller access points be provided from the existing municipal roads infrastructure bordering the site of the proposed development.

9.3 COSTING OF PROPOSED BULK ROAD INFRASTRUCTURE:

Table 9-1: Costing of Proposed Bulk Water Infrastructure

Item	Description	Amount	
A	Traffic Impact Assessment	R	35,000.00
B	Construction of intersection	R	2,200,000.00
Sub Total		R	2,235,000.00
Contingencies (10%)		R	223,500.00
Sub Total		R	2,458,500.00
Professional Fees		R	491,700.00
Sub Total		R	2,950,200.00
VAT (15%)		R	442,530.00
Total		R	3,392,730.00

10. STORM WATER

10.1 Existing Municipal Infrastructure:

Currently Barkly-West has no existing formal storm water infrastructure in close proximity to the proposed development, with all storm water in the immediate area draining at surface within the existing roads infrastructure toward the natural watercourses.

10.2 Proposed Bulk Infrastructure:

It is proposed that all portions of the proposed development be drained at surface, with in the proposed roads network, toward and discharged at low points, into natural drainage channels and water courses.

11. SUMMARY OF PROPOSED BULK INFRASTRUCTURE

Table 11-1: Estimated Cost for Bulk Infrastructure

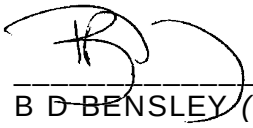
Item	Description	Amount
A	PROPOSED BULK SEWER INFRASTRUCTURE	R48 103 176,00
B	PROPOSED BULK WATER INFRASTRUCTURE	R34 485 000,00
C	PROPOSED BULK ROADS INFRASTRUCTURE	R2 950 200,00
Sub Total		R85 538 376,00
VAT (15%)		R12 830 756,40
Total		R98 369 132,40

12. REFERENCES

- *The Neighbourhood Planning and Design Guide, 2019 (a.k.a. the "Red Book").*
- South African Local Government Association (SALGA) Planning and *Design Guidelines Part II (K-Sanitation).*
- *WSIG: Barkly West: Upgrading of Water Supply System to Buffer Zone Development Technical Report Prepared by MVD Kalahari in February 2019.*

13. CONCLUSION

We trust this will enable you to make the necessary decisions. MVD Kalahari will gladly assist with additional information should the need arise.



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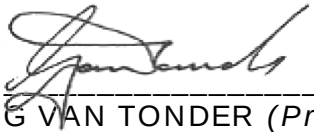

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G VAN TONDER *(Pr Tech Eng)*
G3T CONSULT CC

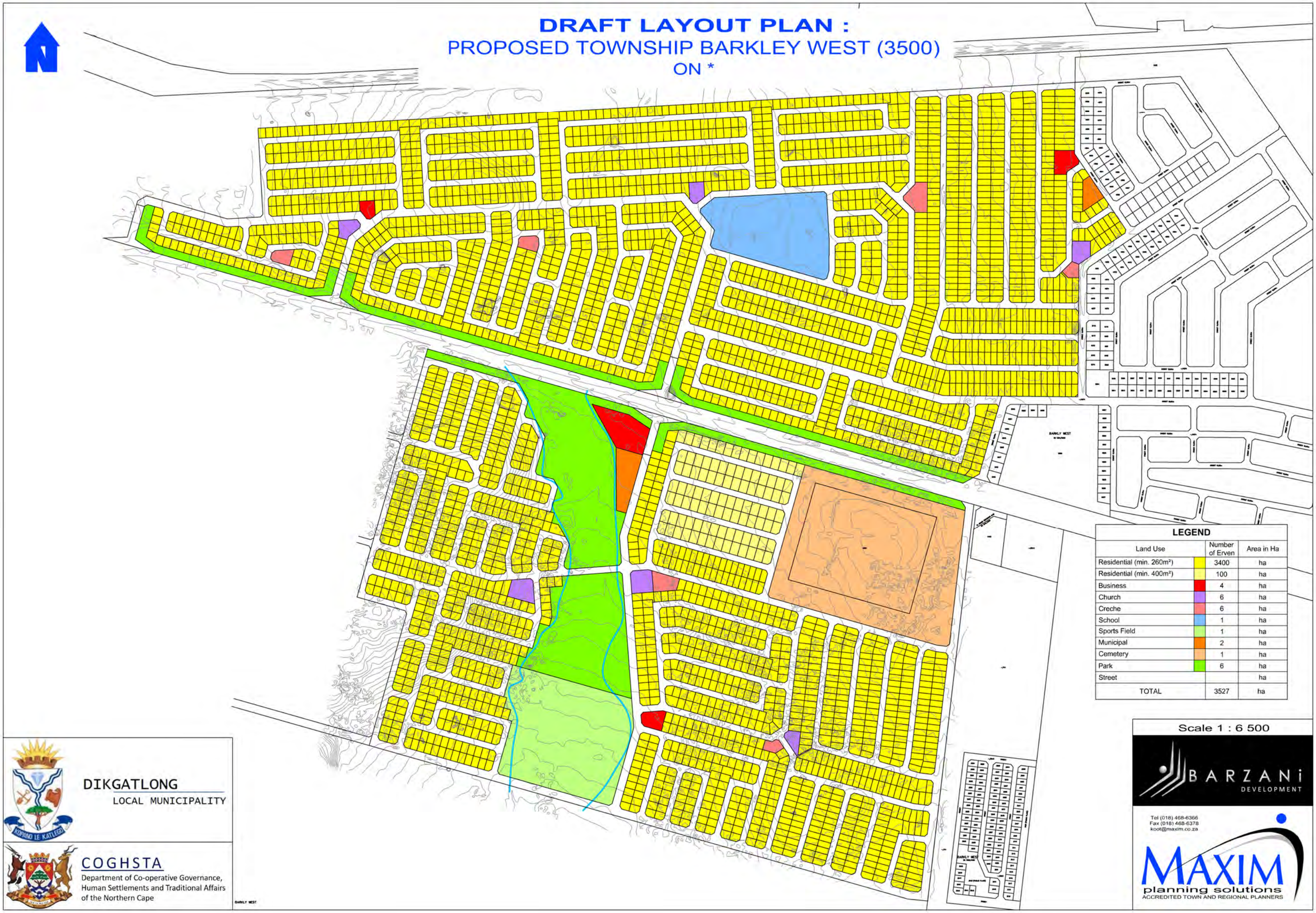
Annexures

Annexure A:
Town Planning Layout

DRAFT LAYOUT PLAN :

PROPOSED TOWNSHIP BARKLEY WEST (3500)

ON *



LEGEND			
Land Use		Number of Erven	Area in Ha
Residential (min. 260m²)		3400	ha
Residential (min. 400m²)		100	ha
Business		4	ha
Church		6	ha
Creche		6	ha
School		1	ha
Sports Field		1	ha
Municipal		2	ha
Cemetery		1	ha
Park		6	ha
Street			ha
TOTAL		3527	ha

Scale 1 : 6 500

DIKGATLONG
LOCAL MUNICIPALITY

KOPANO LE KATLEGO

COGHSTA
Department of Co-operative Governance, Human Settlements and Traditional Affairs of the Northern Cape

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Annexure B:
Geotechnical Investigation Report

BARKLY WEST

DIKGATLONG LOCAL MUNICIPALITY

PHASE 1 ENGINEERING GEOLOGICAL INVESTIGATION

to DETERMINE the POTENTIAL for TOWNSHIP DEVELOPMENT

at BARKLY WEST,

DIKGATLONG LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE.

Georeference: 2824CB Barkly West

GEOSET cc

CK 1999/65610/23

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Pr. Sci. Nat. Reg. Nr. 400057/96; MSAIEG Reg. Nr. 93/154; NHBRC Reg. Nr. 600444.

March 2020 **Report number: GS202003B**

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David S. van der Merwe: Pr Sci Nat, MSAIEG.

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION CONDUCTED AT BARKLY WEST, DIKGATLONG LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE.

Executive Summary

A phase 1 engineering geological investigation with reference to GSFH-2 specification was conducted on the proposed development site at Barkly West, Dikgatlong Local Municipality, Northern Cape Province, with the aim to assess aspects such as geology, relief and subsoil conditions which may influence the planned urban development in the area. The area is underlain by amygdaloidal lava, agglomerate and tuff of the Platberg Group, Ventersdorp Supergroup, but is locally covered by recent aeolian sand and calcrete gravel. No dolomite occurs on site and no stability investigation or evaluation is required. The mechanical properties of the soil layers were determined by means of laboratory tests performed on disturbed samples taken during the profiling of trial pits. The obtained site information is evaluated with regard to the development of masonry structures by the application of standard evaluation techniques. Development zonation for township development according to the NHBRC and SAIEG guidelines were done, indicating the geotechnical conditions of the site. **Normal construction** techniques will be required to enable proper development. This includes the use of **compaction techniques** and **site drainage** as described. Some problems regarding **excavatability** are be expected across the site inducing an elevated development cost, and a competent TLB, excavator, pneumatic tools and blasting will be required to reach installation depths for services in many places. These proposed mitigation measures will be sufficient to successfully address the anticipated geotechnical problems and to ensure the sustainable development as planned.

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APPENDIX D: TABULAR EXPLANATION OF ZONING

Extract from: THE SOUTH AFRICAN INSTITUTE OF ENGINEERING GEOLOGISTS (SAIEG), 1997. Guidelines for Urban Engineering Geological Investigations.

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Table 2. Geotechnical Classification for Urban Development: Partridge, Wood & Brink (1993)

Table 3. Residential Site Class Designations: SAICE, SAIEG & NHBRC (1995)

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ENGINEERING GEOLOGIST / INGENIEURSGEOLOOG:
David S. van der Merwe: Pr Sci Nat, MSAIEG.

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION CONDUCTED AT BARKLY WEST, DIKGATLONG LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE.

1. INTRODUCTION AND TERMS OF REFERENCE

On request of Maxim Planning Solutions, and on behalf of Barzani, an engineering geological investigation was conducted for the proposed development on the property for the Barkly West, Dikgatlong Local Municipality, Northern Cape Province, and communication between us and the abovementioned parties lead to the field work, commencing on 5 March 2020.

The aim of this investigation was to identify and evaluate any possible engineering geological problems before commencement of proper township proclamation.

This report is based on the in-situ evaluation of all the representative soil horizons within the ground profile, visual results of the site visit and other relative exposed geotechnical properties on site and derived from interpretation of laboratory results.

The proposed site is located at Barkly West, Dikgatlong Local Municipality, approximately 188 hectares in size. It is situated adjacent west of the existing Barkly West town. Figures 1-4 in Appendix A delineates the site.

2. INFORMATION USED IN THE STUDY

The following was consulted during the investigation:

1.3.1 The geological map 2824 Kimberly. Scale 1:250 000. The Geological Survey of South Africa.

1.3.2 The topography map 2824CB Barkly West. Scale 1:50 000.The Chief Directorate: Surveys and Land Information, Mowbray.

3. SITE DESCRIPTION

3.1 PHYSIOGRAPHY

3.1.1 Topography

The site is located on a slope from 1125 to 1134 masl towards the western portion of the site, and then westwards into the Vaal River.

3.1.2 Climate

The region is characterized by summer rainfall with thunderstorms, with annual very low rainfall figures of 427 mm for Barkly West recorded at the closest weather stations to the site. Winters are dry with frost common.

The warmest months are normally December and January with February the warmest month, and the coldest months are June and July.

An analysis of the data confirms a Weinert's N-Value in the order of 2 for Barkly West.

The mechanical disintegration of rocks will therefore be dominant over chemical decomposition, and shallow soil horizons will be expected in areas of poor drainage, underlain by igneous rocks.

Storm water drainage and road pavement design must incorporate the climatic extremes above.

3.1.3 Vegetation

The area is typically characterized by Kalahari Thornveld *veld type* (Acocks, 1988).

The site itself is covered by sparse grasslands of which some was used as agriculture land, and a few indigenous thorn trees are present on site.

4. NATURE OF INVESTIGATION

4.1 SITE INVESTIGATION

All available information (paragraph 1.3) was studied before and during the site visit.

The investigation commenced with a desk study, where all relevant information is collected and compiled on a base map. The site was divided into land forms, after which the accuracy of the information was checked by means of a field visit.

Test pits were dug and representative disturbed samples were collected and tested. The position of the test pits are represented in FIGURE 4 (Appendix A). The soil profiles were described by a registered engineering geologist according to the methods described by Jennings *et al* (Jennings 1973). This method describes each horizon in terms of moisture content, colour, consistency, structure, type of soil and origin of the soil.

Disturbed samples of the soil materials were taken for laboratory analysis. The grading of the soils were determined by sieve and hydrometer analysis, resulting in cumulative grading curves.

The mechanical properties of the soil material are described in terms of the liquid limit and plasticity index (determined by means of the Atterberg Limit tests) and the linear shrinkage. These values can be used to calculate the potential expansiveness of the soils, and to evaluate the materials for use as construction material. The consistency of a soil is described by means of its Atterberg limits, where the effect of a change in the moisture content on the consistency of a cohesive soil is measured. According to Cernica (1982) these tests are useful "mostly for soil identification and classification".

It can also be used to determine the mechanical properties of cohesive soil material[1].

The linear shrinkage test to determine the percentage shrinkage that can be expected, is performed by wetting a soil to approximately its liquid limit and drying the resultant paste in a linear shrinkage mould.

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral, its chemical composition and mechanical character. A material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):

- a clay content greater than 12 percent,
- a plasticity index of more than 12,
- a liquid limit of more than 30 percent, and
- a linear shrinkage of more than 8 percent.

The potential expansiveness (low, medium, high, very high) is calculated by means of Van der Merwe's method (Van der Merwe, 1964), where the equivalent plasticity index versus the clay content of the material is plotted on a graph divided into heave categories. If any sample in the study area classifies as potentially expansive, the amount of heave or mobilization in mm measured on the surface will be calculated.

4.2 LABORATORY TESTS

The minimum requirements for areas 188ha large is 18 samples for foundation indicator tests (GFSH-2 guideline). This may vary and is sometimes limited according to the variability of the geotechnical character such as limited depths of test pits before refusal of the TLB, as well as the uniformity or simplicity of a site. Only 13 samples were tested as the material consisted mainly of gravel and lava rock without the possibility of sampling matrix material or soil.

No free swell tests were done as all these areas falls within the drainage features and outside the developable areas.

No consolidometer or collapse potential tests were done as it was impossible to secure any undisturbed soil sample required for these tests.

No soil chemistry samples were tested as all new developments use synthetic pipes

[1] Note that cohesionless soils (i.e. sandy material) cannot be tested for plasticity or collapse potential as this material does not contain enough fines to exhibit consistency. The taking of undisturbed samples is not possible due to disintegration.

not reactive to soil aggressiveness.

The disturbed samples taken during the investigation were tested by the accredited laboratory of Specialised Testing Laboratory in Pretoria to determine their physical properties. Indicator tests include a grading analyses, the determination of Atterberg limits and linear shrinkage. The original laboratory results and a summary of results are represented in Table A, Appendix C.

5. SITE GEOLOGY AND GROUNDWATER CONDITIONS

5.1 Geology

The site is underlain by amygdaloidal lava, agglomerate and tuff of the Platberg Group, Ventersdorp Supergroup, but is locally covered by recent aeolian sand, alluvial and calcrete gravel.

No dolomite occurs on site and a stability investigation and evaluation is not required.

5.2 Groundwater Conditions

Plate flow is the dominant drainage pattern on site, with a drainage channel in the centre portion of the site. Drainage occurs in a westerly direction towards a drainage feature and then in a southern direction towards the Vaal River.

The permanent or perched water table on site is deeper than 1,5m below ground surface.

6. GEOTECHNICAL EVALUATION

6.1 ENGINEERING AND MATERIAL CHARACTERISTICS

6.1.1 SOIL PROFILES

According to the generic specification GFSH-2 guidelines, the minimum number of test pits for an area of 188ha is calculated to 56 test pits, but according to the specification

of SAIEG in our document on Guidelines for Urban Engineering Geological Investigation, 1997, Table 1 (Appendix D), at least 19 test pits should be adequate for areas with a low variable geotechnical character and sites where extensive development with services exist with limited access and almost fully built-up and fenced, or where more than half of the site is developed and serviced and for the formalization of the planning process such as this site. We recorded positions, photographed, described and characterized 44 test positions covering this site.

All terrain land forms or mapping units were extensively sampled and more than adequate representative characterization of each unit took place.

The soil profiles with accompanied plates of profiles and rock outcrop are represented in Appendix B.

Typical soil profile

Dry to slightly moist, red brown, loose to dense, open textured sand with gravel of calcrete. Hillwash.
Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles, clast supported in a subordinate matrix of the above. Pebble marker. Consistency is dense.
Slightly moist, grey green mottled white, dense, intact, sandy gravel. Moderately to slightly weathered lava sometimes with large core stones.

Some severe problems regarding excavatability can be expected on the site, and a competent TLB, excavator, pneumatic tools and even blasting will be required to reach installation depths for services in many places, and the average refusal depth was calculated at 1,15m.

To ensure the stability of excavations, it will need standard sidewall protection in excavations exceeding 1,5m.

6.1.2 LABORATORY RESULTS

The laboratory tests indicated a slight collapse potential and compressibility of the matrix material with a low expansive potential of the material (according to the method of Van der Merwe, 1964). It had an expected range of total soil movement measured at surface as collapse calculated to less than 5mm consolidation or less than 7,5 mm swell, with a site classification of CR.

The laboratory result indicated that the samples had a clay content of less than 15%, a linear shrinkage of less than 3,5%, the plasticity index was not determined as the material consisted of a slightly plastic matrix resulting that no liquid limit could be determined, and with a low expansive potential.

The Unified classification was SC-SM (7 samples) as clayey silty sand to SM (5 samples) as silty sand, poorly graded sand silt mixtures, and A-2-4 (12 samples) as sand and gravel with low plasticity silt fines, according to the PRA classification.

The limited amount of samples tested are justified as the high gravel content with limited sandy matrix material have the same character across the site, as well as the limited depth of refusal of the competent TLB.

No mining activities on site or history of mining or contaminated land in the area were found. Previous local diamond alluvial gravel mining were noted on portions of the site.

The site is located far from any mining activities and in an inactive area regarding seismic activity.

Due to the level of development surrounding the area, the likelihood for the development of borrow pits on site are low.

All road building and construction materials for the building industry will be sourced from established commercial activities in and around Barkly West.

6.2 SLOPE STABILITY AND EROSION

The potential for lateral soil movement or erosion is medium to high, and the loose sand is easily washed away during thunderstorms. Except for local slope instability within opened trenches and the collapse of pit side walls, no other slope instability is expected within these relative flat areas.

6.3 EXCAVATION CLASSIFICATION WITH RESPECT TO SERVICES

The excavation characteristics of the different soil horizons encountered have been evaluated according to the South African Bureau of Standards standardized excavation classification for earthworks (SABS – 1200D) and earthworks (small works – SABS 1200DA). In terms of this classification and the in-situ soil/rock consistencies as profiled, the relationships given below are generally applicable:

1. “soft excavation” - very loose/very soft through to dense or stiff.
2. “intermediate excavation” - very dense/very stiff through to very soft rock.
3. “hard excavation” - soft rock or better

Severe problems regarding excavatability can be expected on the site, and sub outcrop, shallow rock or outcrop areas were found that were classified as hard rock excavation, and the average refusal depth was calculated at 1,15m.

Problems regarding excavations of the upper material is expected and it is difficultly excavated by the competent TLB, and it was classified as intermediate in restricted and non-restricted excavation (SANS 1200 D).

Severe problems regarding excavatability can be expected for excavations deeper than 1,5m on the site, and a competent TLB or excavator, pneumatic tools and blasting will be required to reach installation depths for services. It was classified as intermediate to hard excavation in restricted and non-restricted excavation (SANS 1200 D).

To ensure the stability of excavations, it will need standard sidewall protection in excavations exceeding 1,5m.

6.4 IMPACT OF THE GEOTECHNICAL CHARACTER OF THE SITE ON SUBSIDY HOUSING DEVELOPMENTS

During the engineering geological investigation it is essential to determine and quantify the extent of potential problems associated with the area (addressed in **bold** below), before proper township proclamation. The ideal conditions for urban development may be listed as follows:

* A smooth surface gradient with slopes less than 12°. Accessibility should not be restricted by topography (plateau areas).
* No potential for slope instability features - landslides, mud flows.
* Easy **excavation** for foundations and installation of services (normal depth of 1,5 m required).
* Foundations above the ground water level or perched water table, with not too low permeability.
* Development above the **1:50 year flood line**.
* Adequate surface and subsurface drainage conditions, with minimal erosion potential.

* No presence of problematic soils, for example heaving clays, **compressible clays, sand with some collapse potential,** or dispersive soils, that will require expensive remedial measures.
* No potential for surface subsidence due to the presence of dolomite (sinkholes) or undermining.
* No damaging differential subsidence or movement (less than 5mm total movement at the surface allowed).
* The site should be placed away from potential pollutants such as waste disposal sites.

6.4.1 EVALUATION FOR URBAN DEVELOPMENT

Seepage and the presence of perennial fluctuations of ground water were not encountered on site, but a seasonal perched water table may exist.

Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures.

The site contains slightly collapsible and compressible and soil with a low expansive potential, and foundations will require normal treatment to withstand movement associated with the variable moisture content of the soil.

Severe problems regarding excavatability to 1,5m can be expected on the site, and shallow lava rock and outcrop were noted on many portions of the site.

Large lava rock core stones and boulders on surface, possibly from previous diamond gravel mining activities will restrict accessibility and movement of small vehicles on portions of the site.

Retaining walls as well as slope stabilization measures are recommended on all constructed embankments exceeding 1,5m.

Storm water diversion measures such as ponding pools are recommended to control peak flows during thunderstorms.

All embankments must be adequately compacted and planted with grass to stop any excessive erosion and scouring of the landscape.

7. SITE CLASSIFICATION

By grouping together all the land facets with the same geotechnical characteristics, the site can be divided into development zones, this being the main objective or result of a phase 1 engineering geological investigation. Each zone can therefore be defined as a grouping of areas with specific geotechnical properties placing similar constraints upon development.

With the above-mentioned criteria in mind, the study area can be divided into typical development zones for residential development (SAICE, SAIEG & NHBRC, 1995):

Land suitable for development: Standard foundation techniques and normal construction with normal site drainage and standard building practice will be adequate for development.

Land suitable for development with precaution or risk: A few precautionary measures for problematic soils in this zone are necessary before urban development can be initiated, with a higher than normal cost implication to overcome geotechnical constraints. The risk of restricted excavatability for the placing of services induces a higher cost for development.

Land not suitable for development typically comprises of the drainage features that are susceptible to annual flooding below the 1:50 year flood line, and is also associated with perched water tables. Land in close proximity of unstable ground such as a potential slope failure or mud flow induced by rainfall is also not suitable for development.

On account of the field observations, laboratory results, previous experience and engineering properties of the soil, it is zoned as follows (SAIEG,1997 - See tabular explanation of classification in Appendix D):

7.1 Engineering Geological Zonation

Normal Development with risk:

Site Class CR/1A3F:

This zone represents the majority of the area and comprises of a relative thin top layer sandy material less than 0,75m in thickness of slightly collapsible and compressible or

low expansive soil underlain by a competent pebble marker and lava, with estimated total movement of less than 7,5mm measured at surface with the risk of shallow rock, core stones or lava rock outcrop adding a R site class designation to the zone with problems relating to restricted excavation to less than 1,5m. Development on shallow rock or lava rock core stones will have an inflated cost where special pneumatic tools and blasting will be required for the installation of services. Normal foundation techniques will be adequate to enable proper development, with proper compaction within standard strip foundations and drainage provision will be required. It is classified as CR in terms of the SAIEG & NHBRC guidelines (1995) or the SAICE Code of practice (1995), and 1A3F according to the classification for urban development (Partridge, Wood & Brink)(1993).

Suitable for development with precaution

Site Class PQ:

Areas where small quarries or filling or dumping of spoil (Pq1) were identified must be rehabilitated before any construction, and backfilling with an engineer's material may improve the developability of these zones, but these operations will increase the development cost in this zone.

Undevelopable:

Site Class PD:

Perennial drainage features with local steeper slopes within the upper channels and towards the river. The development is usually restricted to 32m from the centre of the river, and outside the 1:100 year floodline.

The geotechnical problems encountered will require normal foundation techniques and construction, with proper standard compaction techniques.

8. FOUNDATION RECOMMENDATIONS AND SOLUTIONS

8.1 *Consolidation or collapse settlement*

Site Class C (Estimated total Settlement of less than 5mm):

Normal Construction:

Minor collapse settlement requires normal construction (strip footing and slab on the ground) with compaction in foundation trenches and good site drainage.

Site Class C1 (Estimated total Settlement of between 5 and 10mm):

Modified normal construction:

Reinforced strip footing and slab on the ground.
Articulation joints at some internal and all external doors and openings.
Light reinforcement in masonry.

Site drainage and service/plumbing precautions recommended.
Foundation pressure not to exceed 50 kPa (single storey buildings).

Compaction of in situ soils below individual footings:
Remove in situ material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
Normal construction with light reinforcement in strip foundation and masonry.

Deep strip foundations
Normal construction with drainage precaution.
Founding on a competent horizon below problem horizon.

Soil Raft
Remove in situ material to 1,0m beyond perimeter of building to a depth and width of 1,5 times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content.
Normal construction with lightly reinforced strip footings and masonry.

9. DRAINAGE

The site is located on a shallow slope towards the centre portion of the site, and then southwards into the Vaal River.

Plate flow is the dominant drainage pattern on site, and a prominent drainage channel intersects the site.

Although no seepage or the presence of perennial fluctuations of ground water were not encountered on site, we expect that a seasonal perched water table may exist. A calcified profile indicates that some perennial water level fluctuations occur.

Ground water in the form of seepage was not intersected in any test pits during the investigation, but some problems are foreseen and normal water tightening techniques such as damp course on foundation levels are required.

The expected high permeability of the silty sand may lead to leachate from sanitation systems to reach the ground water, and a closed water borne sewage system is recommended.

Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures.

Storm water diversion measures such as ponding pools are recommended to control peak flows during thunderstorms. All embankments must be adequately compacted and planted with grass to stop any excessive erosion and scouring of the landscape.

10. CONCLUSIONS

1. A site of approximately 188 hectares, Barkly West, Dikgatlong Local Municipality, was investigated to determine the engineering geological properties that will influence township proclamation.

2. The site is underlain by amygdaloidal lava, agglomerate and tuff of the Platberg Group, Ventersdorp Supergroup, but is locally covered by recent aeolian sand and calcrete gravel.

3. Some severe problems are foreseen regarding the excavatability to 1,5m depth on site, and shallow rock, core stones and rock outcrop of lava were identified almost across the site. Large lava rock core stones and boulders on surface, possibly from previous diamond gravel mining activities will restrict accessibility and movement of small vehicles on many portions of the site.

4. Zoning of the site revealed zones with minor constraints regarding the **compressibility, collapse potential** and the **expansive potential** of the soil.

5. The following zones were identified on the site:

Normal Development with risk:

Site Class CR/1A3F: This zone represents the majority of the area and comprises of a relative thin top layer sandy material less than 0,75m in thickness of slightly collapsible and compressible or low expansive soil underlain by a competent pebble marker and lava, with estimated total movement of less than 7,5mm measured at surface with the risk of shallow rock, core stones or lava rock outcrop adding a R site class designation to the zone with problems relating to restricted excavation to less than 1,5m. Development on shallow rock or lava rock core stones will have an inflated cost where special pneumatic tools and blasting will be required for the installation of services. Normal foundation techniques will be adequate to enable proper development, with proper compaction within standard strip foundations and drainage provision will be required. It is classified as CR in terms of the SAIEG & NHBRC guidelines (1995) or the SAICE Code of practice (1995), and 1A3F according to the classification for urban development (Partridge, Wood & Brink)(1993).

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Site Class PQ: Areas where small quarries or filling or dumping of spoil (Pq1) were

identified must be rehabilitated before any construction, and backfilling with an engineer's material may improve the developability of these zones, but these operations will increase the development cost in this zone.

Undevelopable:

Site Class PD: Perennial drainage features with local steeper slopes within the upper channels and towards the river. The development is usually restricted to 32m from the centre of the river, and outside the 1:100 year floodline.

6. **Normal and special construction** techniques will be required to enable proper development. This includes the use of **compaction techniques** and **site drainage** as described.

7. **This investigation was done to reveal the geotechnical properties on site with the techniques as described to form our opinion. Although every possible factor during the investigation was dealt with, it is possible to encounter variable local conditions. This will require the inspection of foundations by a competent person to verify expected problems.**

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Pr. Sci. Nat. Reg. Nr. 400057/96; MSAIEG Reg. Nr. 93/154; NHBRC Reg. Nr. 600444.

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APPENDICES

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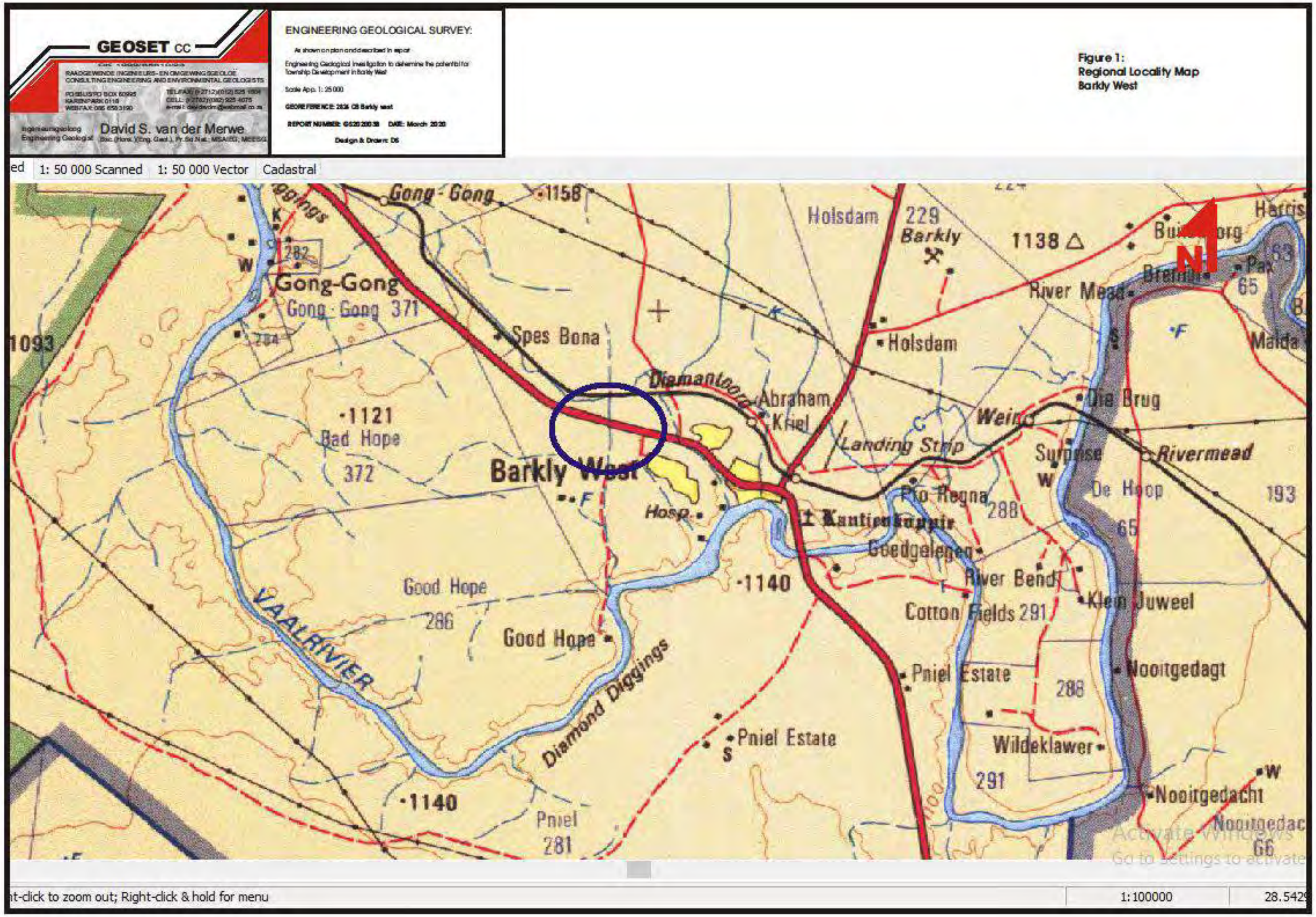
GEOSET cc
David S. van der Merwe
ENGINEERING GEOLOGICAL SURVEY:
Figure 1:
Regional Locality Map
Barkly West
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
Gong - Gong
1158
Holsdam
229
Barkly
1138
River Mead
Gong-Gong
Gong Gong 371
Spes Bona
Holsdam
Diamantoord
Abraham Kriel
Die Brug
1121
Bad Hope
372
Barkly West
Landing Strip
Surprise
Rivermead
De Hoop
193
Hosp.
Pro Regna
288
Goedgelegen
River Bend
Klein Juweel
Good Hope
286
1140
Cotton Fields 291
VAALRIVIER
Good Hope
Diamond Diggings
Pniel Estate
Nooitgedagt
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Pniel Estate
Wildeklawer
291
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1140
Pniel
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1093
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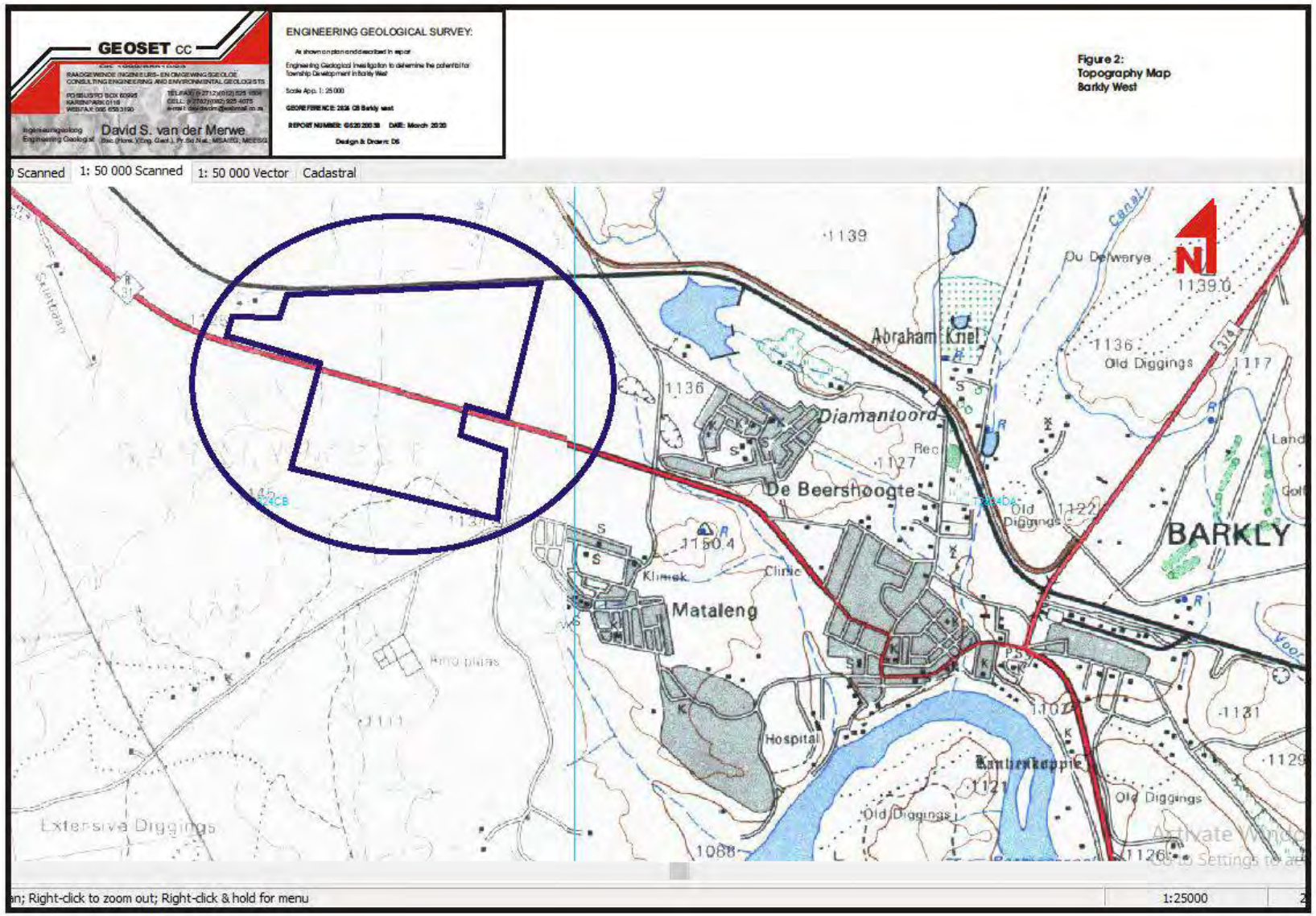
GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
David S. van der Merwe
Figure 2:
Topography Map
Barkly West
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
Abraham Kriel
Diamantoord
De Beershoogte
Mataleng
BARKLY
Hospital
Old Diggings
Extensive Diggings
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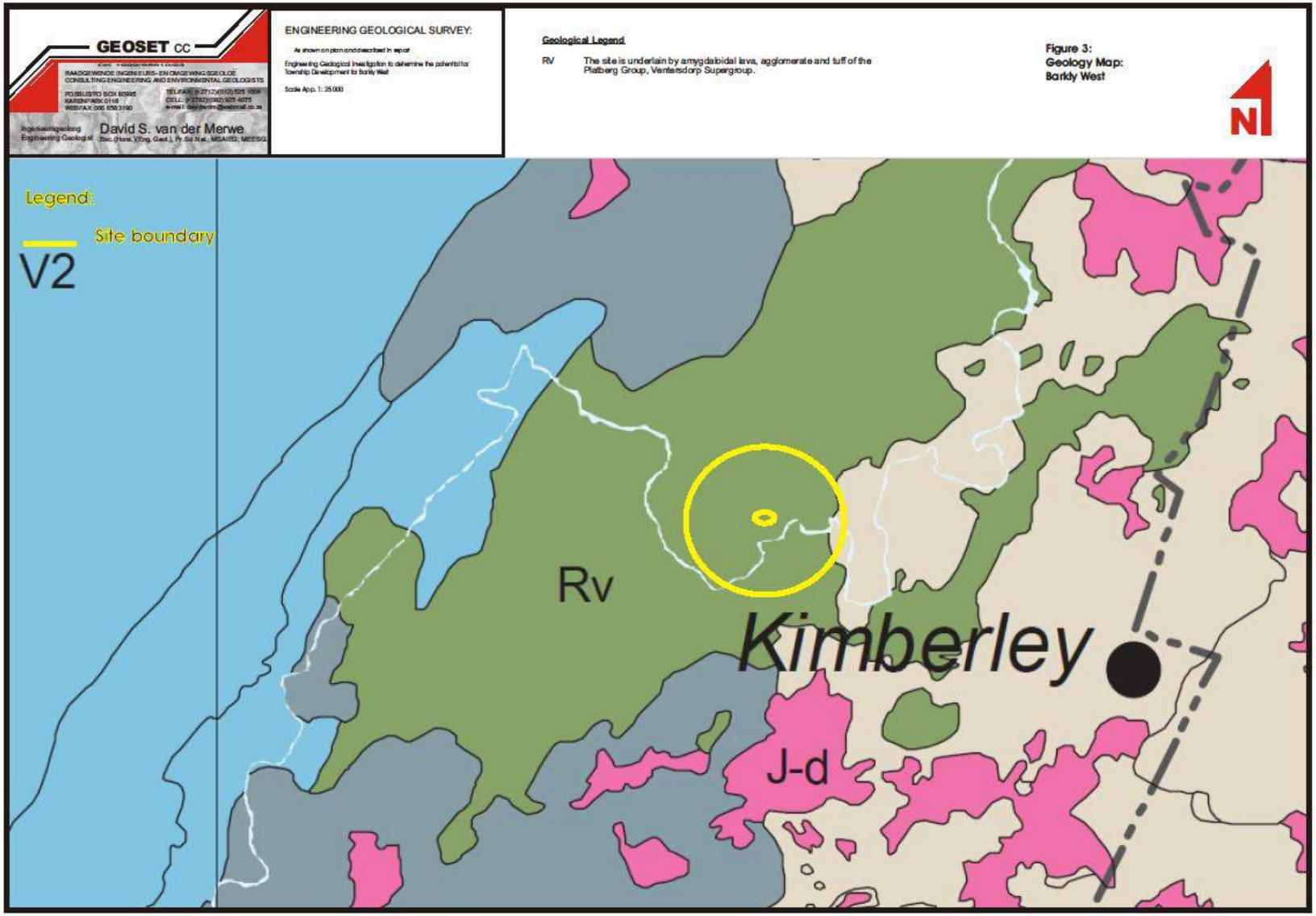
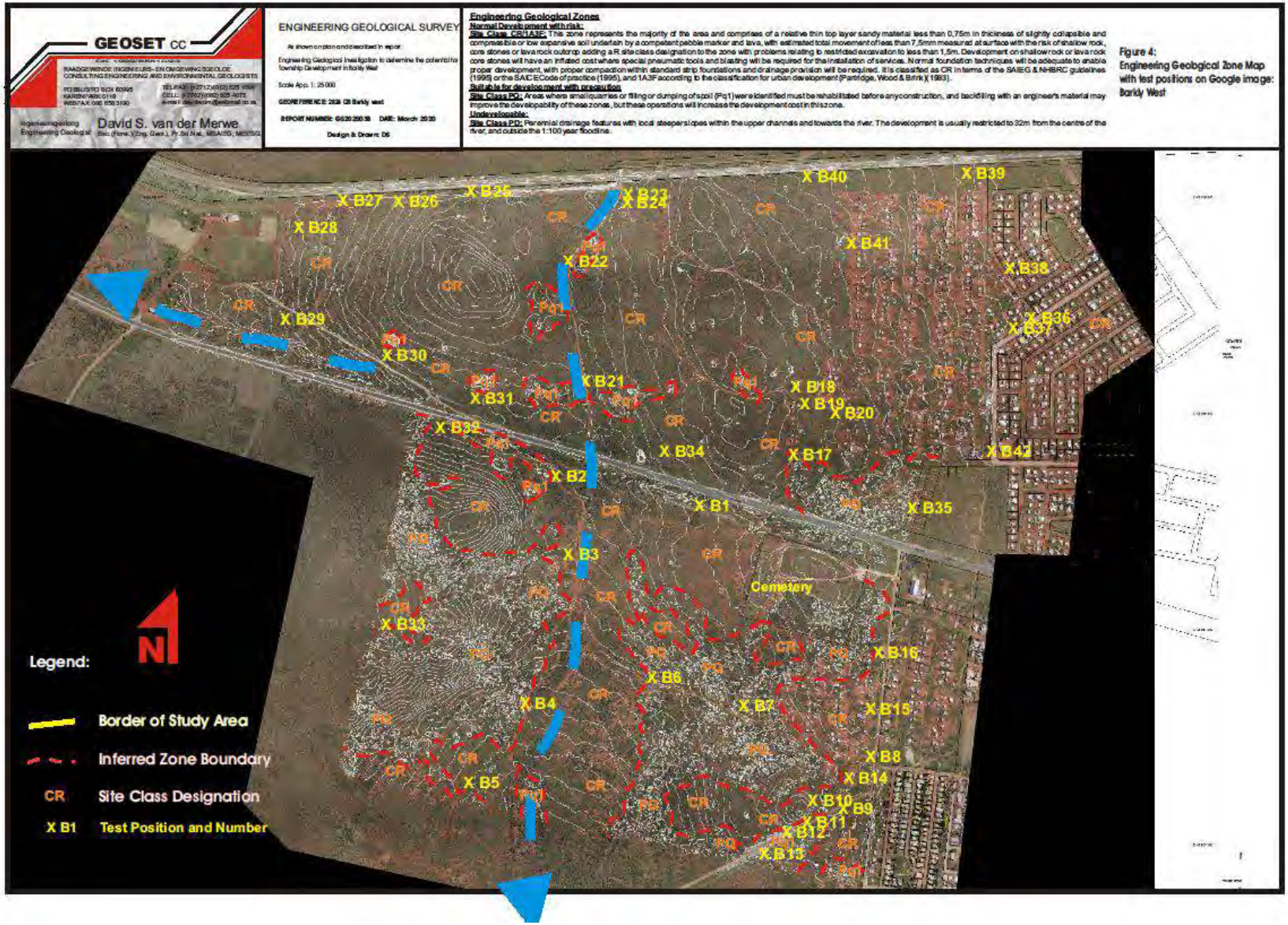

GEOSET CC
ENGINEERING GEOLOGICAL SURVEY:
As shown on plan and described in report
Engineering Geological Investigation to determine the potential for Township Development for Barkly West
Scale App. 1: 25 000
David S. van der Merwe
Geological Legend
RV The site is underlain by amygdaloidal lava, agglomerate and tuff of the Platberg Group, Ventersdorp Supergroup.
Figure 3:
Geology Map:
Barkly West
N
Legend:
Site boundary
V2
Rv
Kimberley
J-d


GEOSET CC
ENGINEERING GEOLOGICAL SURVEY
David S. van der Merwe
Engineering Geological Zones
Normal Development with risk:
Site Class CR1A3F:
Suitable for development with precaution
Site Class PQ:
Undevelopable:
Site Class PD:
Figure 4:
Engineering Geological Zone Map with test positions on Google image: Barkly West
X B40
X B39
X B27
X B26
X B25
X B23
X B24
X B28
X B41
X B22
X B38
X B29
X B36
X B37
X B30
X B21
X B18
X B31
X B19
X B20
X B32
X B34
X B17
X B42
X B2
X B1
X B35
X B3
Cemetery
X B33
X B16
X B6
X B4
X B7
X B15
X B8
X B14
X B5
X B10
X B9
X B11
X B12
X B13
Legend:
Border of Study Area
Inferred Zone Boundary
CR
Site Class Designation
X B1
Test Position and Number

APPENDIX B: SOIL PROFILES

Soil Profiles Tabled Summary
Soil Profile Descriptions
Soil Profile Photographs

Test Pit Nr		Samples Depth m	Hillwash Depth 0m to m	Pebble Marker to m	Residual Lava to m	Site Class	Remarks	GPS Coordinates X Coord	GPS Coordinates Y Coord	Test Pit Nr	
B	1	0.2	0.3	0.6	1,0+	CR	Refusal on Lava boulders.	28°31,29,53" S	24°29'28,98" E	B	1
B	2	0.4	0.6	0.8	1,0+	CR	Refusal on lava.	28°31,27,48" S	24°29'18,03" E	B	2
B	3		0.3	0.5	1,0+	CR	Refusal on lava.	29°31,33,60" S	24°29'19,00" E	B	3
B	4	0.4	0.5	0.8	1,2+	CR	Refusal on lava.	29°31,44,47" S	24°29'14,64" E	B	4
B	5		0.4	0.6	1,0+	CR	Refusal on lava.	28°31,50,65" S	24°29'09,11" E	B	5
B	6			0.4	1,0+	CR	Refusal on lava.	28°31,42,63" S	24°29'25,06" E	B	6
B	7	0.3	0.8	1.1	1,4+	CR	Refusal on lava.	28°31,45,43" S	24°29'34,78" E	B	7
B	8		0.3	0.8	1,2+	CR	Refusal on Lava boulders.	28°31,50,03" S	24°29'43,88" E	B	8
B	9			0.8	1,4+	CR	Refusal on Lava boulders.	28°31,51,90" S	24°29'42,61" E	B	9
B	10					CR	Photo: hill / outcrop?	28°31,51,05" S	24°29'40,89" E	B	10
B	11					CR	Photo: Lava core stones	28°31,52,41" S	24°29'39,91" E	B	11
B	12					CR	Photo: Sewage spillage	28°31,53,47" S	24°29'37,32" E	B	12
B	13					CR	Photo: Lava core stones	28°31,55,35" S	24°29'24,03" E	B	13
B	14					CR	Photo: Waste with rubble & gravel	28°31,51,24" S	24°29'42,38" E	B	14
B	15					CR	Photo: Lava core stones	28°31,47,20" S	24°29'43,99" E	B	15
B	16	0.7	0.9	1.2	1,4+	CR	Filling up to 0,5m	28°31,40,49" S	24°29'45,07" E	B	16
B	17			1.0	1,4+	CR	Refusal on Lava boulders.	28°31,25,41" S	24°29'37,79" E	B	17
B	18	0.2	0.3	1.0	1,4+	CR	Refusal on lava.	28°31,20,62" S	24°29'37,55" E	B	18
B	19					CR	Photo: Lava pebbles at fence	28°31,21,83" S	24°29'37,61" E	B	19
B	20					CR	Photo: Well rounded pebbles	28°31,24,10" S	24°29'39,17" E	B	20
B	21	0.2	0.3	0.6	1,0+	CR	Refusal on lava.	28°31,21,70" S	24°29'20,91" E	B	21
B	22	0.2	0.2	0.6	1,1+	CR	Refusal on lava.	28°31,11,88" S	24°29'18,61" E	B	22
B	23					CR	Quarry with well rounded lava pebbles	28°31,05,52" S	24°29'22,75" E	B	23
B	24		0.2	0.9		CR	Refusal on Lava boulders.	28°31,06,18" S	24°29'23,04" E	B	24
B	25	0.2	0.4	0.7	1,1+	CR	Refusal on lava.	28°31,06,30" S	24°29'08,62" E	B	25
B	26					CR	Photo: large lava boulders on surface	28°31,06,92" S	24°28'57,13" E	B	26
B	27					CR	Photo: lava pebbles in road	28°31,06,92" S	24°28'57,13" E	B	27
B	28	0.2	0.3	0.8		CR	Refusal on Lava boulders.	28°31,07,98" S	24°28'55,25" E	B	28
B	29		0.4	0.8	1,2+	CR	Refusal on Lava boulders.	28°31,15,14" S	24°28'55,41" E	B	29
B	30		0.3	0.7	1,2+	CR	Refusal on Lava boulders.	28°31,18,60" S	24°29'04,17" E	B	30
B	31	0.4	0.6	1.1	1,3+	CR	Refusal on Lava boulders.	28°31,21,49" S	24°29'11,96" E	B	31
B	32	0.5	1.0	1.2	1,4+	CR	Refusal on Lava boulders.	28°31,24,48" S	24°29'09,32" E	B	32
B	33		0.4	1.0	1,3+	CR	Refusal on Lava.	28°31,38,17" S	24°29'02,28" E	B	33
B	34		0.4	0.6	1,4+	CR	Refusal on Lava.	28°31,25,26" S	24°29'28,89" E	B	34
B	35			0.7	0.9+	CR	Refusal on Lava boulders.	28°31,28,90" S	24°29'47,90" E	B	35
B	36			0.6	0.8+	CR	Refusal on Lava boulders.	28°31,15,26" S	24°29'57,47" E	B	36
B	37					CR	Photo: lava core stones & pebbles	28°31,16,30" S	24°29'55,70" E	B	37
B	38					CR	Photo: lava core stones & pebbles	28°31,12,14" S	24°29'55,69" E	B	38
B	39			0.8	1,0+	CR	Refusal on Pebblemarker.	28°31,04,93" S	24°29'52,95" E	B	39
B	40	0.2	0.3	0.7	1,0+	CR	Refusal on Pebblemarker.	28°31,05,42" S	24°29'38,33" E	B	40
B	41		0.2	0.8	1,2+	CR	Refusal on Pebblemarker.	28°31,09,95" S	24°29'42,46" E	B	41
B	42					CR	Photo: Lava outcrop	28°31,25,27" S	24°29'53,92" E	B	42
B	43		0.2	0.7	1,2+	CR	Refusal on Lava.	28°31,25,27" S	24°29'53,92" E	B	43
B	44					CR	Photo: lava core stones & pebbles	28°31,25,47" S	24°29'52,74" E	B	44

13 Disturbed samples were taken.

No water was encountered in any test pit

A JCB 3DX 4X4 TLB was supplied by Corne Berg, operated by Jonas.

All the test pits were dug to the refusal depth of the TLB usually in lava.

The moisture content of the soil profiles were usually described as dry and sometimes as slightly moist.

The consistency of the soil increased with increasing depth and was described as very loose with refusal on lava as medium hard rock.

Refusal on lava was noted in all test pits, with an average refusal depth of 1,15m.

Soil Profile Nr: B1

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Consulting Engineering & Environmental Geologists
Raadgewende Ingenieurs- en Omgewingsgeoloë
P.O. Box / Posbus 60995 **Tel:** 012 525 1004
KARENPARK 0118 **Webfax:** 086 658 3190
e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2		●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3		B1-0,2	
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			
1,0+			

Notes:
1. Refusal of TLB on large lava boulders.
2. No groundwater was intersected.
3. ● Disturbed sample B1-0,2.

Lat/long	X Coord:	28°31,29,53" S
WGS84 datum	Y Coord:	24°29'28,98" E

Soil Profile Nr: B1

Soil Profile Nr: B2

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3			
0.4		●	
0.5		B2-0,4	Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			
1,0+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B2-0,4.

Lat/long	X Coord:	28°31,27,48" S
WGS84 datum	Y Coord:	24°29'18,03" E

Soil Profile Nr: B2

Soil Profile Nr: B3

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3	I:I:I:I:I:I:I:		
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			
1,0+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	29˚31,33,60" S
WGS84 datum	Y Coord:	24˚29'19,00" E

Soil Profile Nr: B3

Soil Profile Nr: B4

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		
0.3	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.4	I:I:I:I:I:I:I:	●	
0.5	I:I:I:I:I:I:I:	B4-0,4	
0.6			
0.7			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.8			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			
1,2+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B4-0,4.

Lat/long	X Coord:	29˚31,44,47" S
WGS84 datum	Y Coord:	24˚29'14,64" E

Soil Profile Nr: B4

Soil Profile Nr: B5

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:		
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			
1,0+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28°31,50,65" S
WGS84 datum	Y Coord:	24°29'09,11" E

Soil Profile Nr: B5

Soil Profile Nr: B6

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.3			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.4			
0.5			
0.6			
0.7			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.8			Moderately weathered lava
0.9			
1.0			
1,0+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28˚31,42,63" S
WGS84 datum	Y Coord:	24˚29'25,06" E

Soil Profile Nr: B6

Soil Profile Nr: B7

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		
0.3	I:I:I:I:I:I:I:	●	
0.4	I:I:I:I:I:I:I:	B7-0,3	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.5	I:I:I:I:I:I:I:		
0.6	I:I:I:I:I:I:I:		
0.7	I:I:I:I:I:I:I:		
0.8	I:I:I:I:I:I:I:		
0.9			
1.0			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
1.1			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
1.2			
1.3			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.4			Moderately weathered lava
1,4+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B7-0,3.

Lat/long	X Coord:	28°31,45,43" S
WGS84 datum	Y Coord:	24°29'34,78" E

Soil Profile Nr: B7

Soil Profile Nr: B8

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3	I:I:I:I:I:I:I:		
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			
1,2+			

Notes:
1. Refusal of TLB on large lava boulders.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28°31,50,03" S
WGS84 datum	Y Coord:	24°29'43,88" E

Soil Profile Nr: B8

Soil Profile Nr: B9

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:		Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.5	I:I:I:I:I:I:I:		clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.6	I:I:I:I:I:I:I:		
0.7	I:I:I:I:I:I:I:		
0.8	I:I:I:I:I:I:I:		
0.9			
1.0			
1.1			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.2			Moderately weathered lava
1.3			
1.4			

Notes:
1. Refusal of TLB on large lava boulders.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28°31,51,90" S
WGS84 datum	Y Coord:	24°29'42,61" E

Soil Profile Nr: B9

Soil Profile Nr: B16

DATE: 5 March 2020

JOB NR: GS202003B

Local Municipality of Dikgatlong

Town: Barkley-West

CLIENT: Barzani

TLB Contractor: Corne Berg Contracto

TLB Machine: JCB 3DX 4X4

TLB Operator: Jonas

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Consulting Engineering & Environmental Geologists

Raadgewende Ingenieurs- en Omgewingsgeoloë

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Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	<#$%^&*>		
0.2	<#$%^&*>		
0.3	<#$%^&*>		Filling consisting of building rubble and lava gravel & pebbles.
0.4	<#$%^&*>		
0.5	<#$%^&*>		
0.6	I:I:I:I:I:I:I:		
0.7	I:I:I:I:I:I:I:	●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.8	I:I:I:I:I:I:I:	B16-0,7	
0.9	I:I:I:I:I:I:I:		
1.0			
1.1			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
1.2			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
1.3			
1.4			
1.5			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.6			Moderately weathered lava
1,2+			

Notes:

1. Refusal of TLB on large lava boulders.
2. No groundwater was intersected.
3. ● Disturbed sample B16-0,7.

Lat/long	X Coord:	28˚31,40,49" S
WGS84 datum	Y Coord:	24˚29'45,07" E

Soil Profile Nr: B16

Soil Profile Nr: B17

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Consulting Engineering & Environmental Geologists
Raadgewende Ingenieurs- en Omgewingsgeoloë
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KARENPARK 0118 **Webfax:** 086 658 3190
e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:		
0.5	I:I:I:I:I:I:I:		Slightly moist, dark brown, well rounded, small & medium, intact lava pebbles,
0.6	I:I:I:I:I:I:I:		clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7	I:I:I:I:I:I:I:		
0.8	I:I:I:I:I:I:I:		
0.9	I:I:I:I:I:I:I:		
1.0	I:I:I:I:I:I:I:		
1.1			
1.2			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.3			Moderately weathered lava
1.4			

Notes:
1. Refusal of TLB on lava pebbles & core stones.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28°31,25,41" S
WGS84 datum	Y Coord:	24°29'37,79" E

Soil Profile Nr: B17

Soil Profile Nr: B18

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2		B18-0,2	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3		●	
0.4			
0.5			
0.6			
0.7			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.8			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.9			
1.0			
1.1			
1.2			
1.3			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.4			Moderately weathered lava
1,4+			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B18-0,2.

Lat/long	X Coord:	28°31,20,62" S
WGS84 datum	Y Coord:	24°29'37,55" E

Soil Profile Nr: B18

Soil Profile Nr: B21

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:	B21-0,2	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3	I:I:I:I:I:I:I:	●	
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B21-0,2.

Lat/long	X Coord:	28°31,21,70" S
WGS84 datum	Y Coord:	24°29'20,91" E

Soil Profile Nr: B21

Soil Profile Nr: B22

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:	B22-0,2	
0.2	I:I:I:I:I:I:I:	●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3			
0.4			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.5			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.6			
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			
1.1			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B22-0,2.

Lat/long	X Coord:	28°31,11,88" S
WGS84 datum	Y Coord:	24°29'18,61" E

Soil Profile Nr: B22

Soil Profile Nr: B24

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.2	I:I:I:I:I:I:I:		clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.3			
0.4			
0.5			
0.6			Slightly moist, grey green mottled white, dense, intact, sandy gravel with lava boulders
0.7			Moderately weathered lava
0.8			
0.9			
1.0			
1,0+			

Notes:
1. Refusal of TLB on lava boulders.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	28˚31,06,18" S
WGS84 datum	Y Coord:	24˚29'23,04" E

Soil Profile Nr: B24

Soil Profile Nr: B25

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2		B25-0,2	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3		●	
0.4			
0.5			
0.6			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.7			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.8			
0.9			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.0			Moderately weathered lava
1.1			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B25-0,2.

Lat/long	X Coord:	28°31,06,30" S
WGS84 datum	Y Coord:	24°29'08,62" E

Soil Profile Nr: B25

Soil Profile Nr: B24

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:	B28-0,2	
0.2	I:I:I:I:I:I:I:	●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3	I:I:I:I:I:I:I:		
0.4			
0.5			
0.6			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.7			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.8			

Notes:
1. Refusal of TLB on lava boulders.
2. No groundwater was intersected.
3. ● Disturbed sample B28-0,2.

Lat/long	X Coord:	28˚31,07,98" S
WGS84 datum	Y Coord:	24˚28'55,25" E

Soil Profile Nr: B24

Soil Profile Nr: B29

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:		
0.5			
0.6			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.7			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.8			
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,15,14" S
WGS84 datum	Y Coord:	24°28'55,41" E

Soil Profile Nr: B29

Soil Profile Nr: B30

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3	I:I:I:I:I:I:I:		
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,18,60" S
WGS84 datum	Y Coord:	24°29'04,17" E

Soil Profile Nr: B30

Soil Profile Nr: B31

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3	I:I:I:I:I:I:I:	B31-0,4	
0.4	I:I:I:I:I:I:I:	●	
0.5	I:I:I:I:I:I:I:		
0.6	I:I:I:I:I:I:I:		
0.7			
0.8			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.9			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
1.0			
1.1			
1.2			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.3			Moderately weathered lava

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B31-0,4.

Lat/long	X Coord:	28°31,21,49" S
WGS84 datum	Y Coord:	24°29'11,96" E

Soil Profile Nr: B31

Soil Profile Nr: B32

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:	B32-0,5	
0.5	I:I:I:I:I:I:I:	●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.6	I:I:I:I:I:I:I:		
0.7	I:I:I:I:I:I:I:		
0.8	I:I:I:I:I:I:I:		
0.9	I:I:I:I:I:I:I:		
1.0	I:I:I:I:I:I:I:		
1.1			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
1.2			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
1.3			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.4			Moderately weathered lava

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B32-0,5.

Lat/long	X Coord:	28°31,24,48" S
WGS84 datum	Y Coord:	24°29'09,32" E

Soil Profile Nr: B32

Soil Profile Nr: B33

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3			
0.4			
0.5			
0.6			
0.7			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.8			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.9			
1.0			
1.1			
1.2			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.3			Moderately weathered lava

Notes:
1. Refusal of TLB on lava core stones.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,38,17" S
WGS84 datum	Y Coord:	24°29'02,28" E

Soil Profile Nr: B33

Soil Profile Nr: B34

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:		
0.2	I:I:I:I:I:I:I:		Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillw ash
0.3	I:I:I:I:I:I:I:		
0.4	I:I:I:I:I:I:I:		
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately to slightly weathered lava
1.2			
1.3			
1.4			

Notes:
1. Refusal of TLB on slightly weathered lava.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28˚31,25,26" S
WGS84 datum	Y Coord:	24˚29'28,89" E

Soil Profile Nr: B34

Soil Profile Nr: B35

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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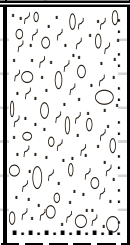
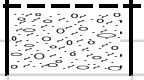
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.4			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.5			
0.6			
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava

Notes:
1. Refusal of TLB on lava boulders.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,28,90" S
WGS84 datum	Y Coord:	24°29'47,90" E

Soil Profile Nr: B35

Soil Profile Nr: B36

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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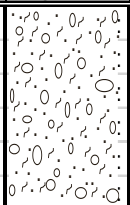
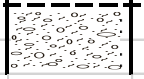
e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.4			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.5			
0.6			
0.7			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.8			Moderately weathered lava

Notes:
1. Refusal of TLB on lava boulders.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28˚31,15,26" S
WGS84 datum	Y Coord:	24˚29'57,47" E

Soil Profile Nr: B36

Soil Profile Nr: B39

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Consulting Engineering & Environmental Geologists
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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			
0.3			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.4			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.5			
0.6			
0.7			
0.8			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
0.9			Moderately weathered lava
1.0			

Notes:
1. Refusal of TLB on lava boulders.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28˚31,04,93" S
WGS84 datum	Y Coord:	24˚29'52,95" E

Soil Profile Nr: B39

Soil Profile Nr: B40

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1		B40-0,2	
0.2		●	Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3			
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. ● Disturbed sample B40-0,2.

Lat/long	X Coord:	28°31,05,42" S
WGS84 datum	Y Coord:	24°29'38,33" E

Soil Profile Nr: B40

Soil Profile Nr: B41

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3			
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, kaki grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,09,95" S
WGS84 datum	Y Coord:	24°29'42,46" E

Soil Profile Nr: B41

Soil Profile Nr: B43

DATE: 5 March 2020
JOB NR: GS202003B
Local Municipality of Dikgatlong
Town: Barkley-West
CLIENT: Barzani
TLB Contractor: Corne Berg Contracto
TLB Machine: JCB 3DX 4X4
TLB Operator: Jonas

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Consulting Engineering & Environmental Geologists
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KARENPARK 0118 **Webfax:** 086 658 3190
e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075
Engineering Geologist: David S. van der Merwe.
Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Slightly moist, reddish brown, loose to very loose, open textured clayey sand. Hillwash
0.3			
0.4			
0.5			Slightly moist, dark brown, well to sub rounded, small & medium, intact lava pebbles,
0.6			clast supported in a subordinate matrix of the above. Pebble marker. Consistency is de
0.7			
0.8			
0.9			
1.0			Slightly moist, kaki grey green mottled white, dense, intact, sandy gravel.
1.1			Moderately weathered lava
1.2			

Notes:
1. Refusal of TLB on lava.
2. No groundwater was intersected.
3. No samples.

Lat/long	X Coord:	28°31,25,27" S
WGS84 datum	Y Coord:	24°29'53,92" E

Soil Profile Nr: B43


B1


B1


B3


B4


B7


B8


B16


B17


B18


B21


B22


B24


B25


28


B29


B30

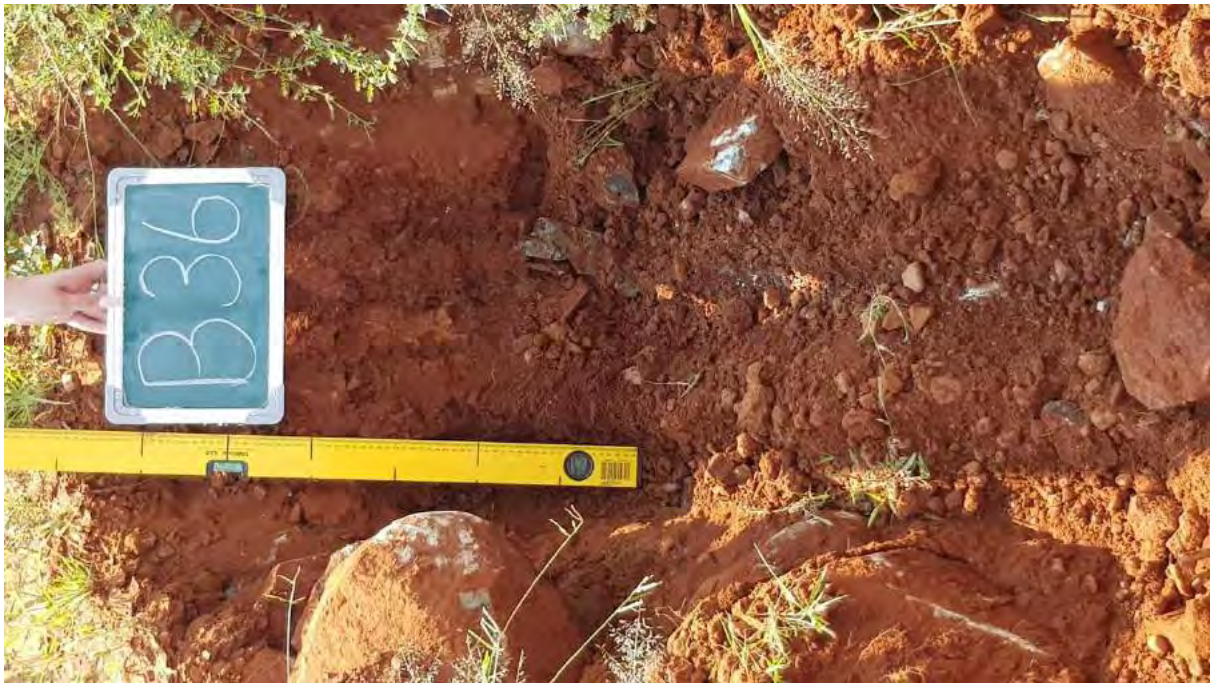

B31


B32


B33


B34


B35


B36


B39


B40


B41

APPENDIX C: LABORATORY RESULTS

Table A: Summary of Laboratory Results
STL Summary of Laboratory Results
STL Laboratory Results

Table A Summary of Laboratory Results

Stats	Depth		Material	Clay	Classification		% Linear	Plasticity	Liquid	Expan-
13	Nr	m	Description	%	Unified	PRA	Shrinkage	Index	Limit	siveness
1	B1	0,2	Silty sand	5	SM	A-2-4	0,5	SP	ND	L
2	B2	0,4	Silty clayey sand	14	SC	A-2-4	4	9	20	L
3	B4	0,3	Silty clayey sand	15	SC-SM	A-4	3,5	7	17	L
4	B7	0,3	Silty clayey sand	8	SC-SM	A-2-4	2	4	16	L
5	B16	0,7	Silty clayey sand	9	SC-SM	A-2-4	2	5	16	L
6	B18	0,2	Silty clayey sand	5	SM	A-2-4	0,5	SP	ND	L
7	B21	0,2	Silty clayey sand	6	SM	A-2-4	0,5	SP	ND	L
8	B22	0,2	Silty clayey sand	10	SC-SM	A-2-4	2,5	5	15	L
9	B25	0,2	Silty clayey sand	8	SC-SM	A-2-4	2,5	4	17	L
10	B28	0,2	Silty clayey sand	12	SC-SM	A-2-4	2,5	4	15	L
11	B31	0,4	Silty clayey sand	5	SM	A-2-4	0,5	SP	ND	L
12	B32	0,5	Silty clayey sand	12	SM	A-2-4	0,5	SP	ND	L
13	B40	0.2	Sand	4	SC-SM	A-2-4	2,0	5	18	L
Material possibly expansive if value:				>12%			>8%	>12	>30	Exp?

Table A Legend

Unified

13 According to the revised ASTM-Standard on the "Unified Soil Classification System" (Weinert).

5 SM: Silty sand; poorly graded sand silt mixtures

1 SC: clayey sand, poorly graded sand clay mixtures.

7 SC-SM: silty clayey sand, poorly graded sand silt clay mixtures.

PRA

13 Public Roads Classification (Brink, Partridge & Williams).

1 A-4: Low compressibility silt.

12 A-2-4: Sand & gravel with low plasticity silt fines.

13 Expansiveness according to Van der Merwe's method (Brink, Partridge & Williams).

13 L: Low

0 L/M: Low to medium expansiveness

0 M: Medium

0 H: High

A clayey material is potentially expansive with the following properties (Kantey and Brink, 1952):

2 a clay content greater than 12 percent,

0 a linear shrinkage of more than 8 percent,

0 a plasticity index of more than 12, and

0 a liquid limit of more than 30 percent

0 NP: Not plastic: sandy material with no cohesion

5 SP: Slightly plastic with little cohesion

5 ND: not determined

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 09-Apr-20
Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	B1	B2	B4	B7	B16	B18	B21	B22
Depth (m)	0.2	0.4	0.3	0.3	0.7	0.2	0.2	0.2
Lab No	DVM-109-1034	DVM-109-1035	DVM-109-1036	DVM-109-1037	DVM-109-1038	DVM-109-1039	DVM-109-1040	DVM-109-1041
53.0	100	100	100	100	100	100	100	100
37.5	100	100	100	100	100	95	100	100
26.5	100	100	100	100	100	90	100	100
19.0	100	100	100	100	100	80	100	100
13.2	96	100	98	100	97	76	99	97
9.5	94	99	98	99	95	75	97	95
6.7	92	98	97	98	94	74	96	93
4.75	91	98	97	98	93	73	96	93
2.00	89	96	95	95	91	71	93	90
1.00	87	95	93	92	89	68	92	89
0.425	81	79	89	84	82	64	86	86
0.250	69	64	82	69	70	46	74	72
0.150	56	52	66	52	57	37	57	57
0.075	32	32	38	28	33	24	28	33
0.060	24	26	32	20	25	17	19	24
0.050	20	24	29	18	22	16	16	22
0.035	15	21	24	14	19	13	12	18
0.020	12	18	22	12	16	11	11	16
0.006	8	16	19	10	11	8	8	12
0.002	5	14	15	8	9	5	6	10
GM	0.98	0.93	0.78	0.93	0.94	1.41	0.93	0.91

Atterberg Limits

LL (%)	-	20	17	16	16	-	-	15
PI (%)	SP	9	7	4	5	SP	SP	5
LS (%)	0.5	4.0	3.5	2.0	2.0	0.5	0.5	2.5

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 09-Apr-20
Method: SANS 3001 GR1, GR3 GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	B25	B28	B31	B32	B40			
Depth (m)	0.2	0.2	0.4	0.5	0.2			
Lab No	DVM-109-1042	DVM-109-1043	DVM-109-1044	DVM-109-1045	DVM-109-1046			
53.0	100	100	100	100	100			
37.5	100	100	100	100	100			
26.5	100	100	100	100	100			
19.0	98	100	100	100	100			
13.2	97	99	100	100	98			
9.5	96	98	100	100	96			
6.7	95	96	100	100	94			
4.75	94	94	100	100	93			
2.00	93	92	100	99	90			
1.00	91	90	99	99	88			
0.425	85	79	82	76	83			
0.250	61	68	69	67	60			
0.150	49	55	54	54	44			
0.075	35	32	19	31	21			
0.060	26	24	16	23	13			
0.050	24	22	15	22	12			
0.035	20	19	12	19	9			
0.020	16	18	10	17	7			
0.006	12	14	8	15	6			
0.002	8	12	5	12	4			
GM	0.87	0.97	0.99	0.94	1.06			

Atterberg Limits

LL (%)	17	15	-	-	18			
PI (%)	4	4	SP	SP	5			
LS (%)	2.5	2.5	0.5	0.5	2.0			

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	B1	B2	B4	Sample	B1	B2	B4
Depth (m)	0.2	0.4	0.3	Depth (m)	0.2	0.4	0.3
Lab No	DVM-109-1034	DVM-109-1035	DVM-109-1036	Lab No	DVM-109-1034	DVM-109-1035	DVM-109-1036
53.0	100	100	100	Liquid Limit (%)	-	20	17
37.5	100	100	100	Plastic Limit (%)	-	11	10
26.5	100	100	100	Plasticity Index (%)	SP	9	7
19.0	100	100	100	Linear Shrinkage (%)	0.5	4.0	3.5
13.2	96	100	98	PI of whole sample	-	7	6
9.5	94	99	98				
6.7	92	98	97	% Gravel	11	4	5
4.75	91	98	97	% Sand	65	70	63
2.00	89	96	95	% Silt	19	12	17
1.00	87	95	93	% Clay	5	14	15
0.425	81	79	89	Activity	0.0	0.6	0.5
0.250	69	64	82				
0.150	56	52	66	% Soil Mortar	89	96	95
0.075	32	32	38				
0.060	24	26	32	Grading Modulus	0.98	0.93	0.78
0.050	20	24	29	Moisture Content (%)	N / T	N / T	N / T
0.035	15	21	24	Relative Density (SG)*	2.65	2.65	2.65
0.020	12	18	22				
0.006	8	16	19	Unified (ASTM D2487)	SM	SC	SC-SM
0.002	5	14	15	AASHTO (M145-91)	A - 2 - 4	A - 2 - 4	A - 4

Remarks: *: Assumed
N / T: Not Tested

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Client Name:	Geoset
Project Name:	Barkley West
Job Number:	DVM-109
Date:	2020-04-09
Method:	SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

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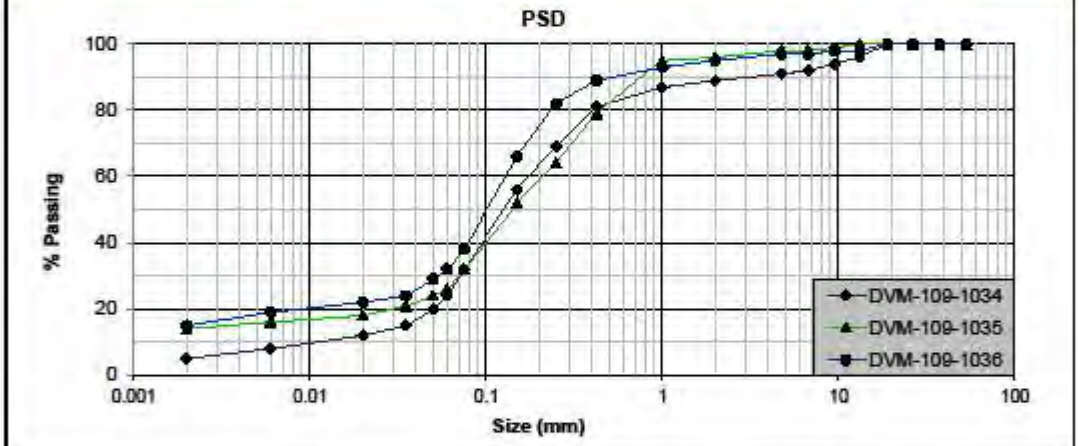

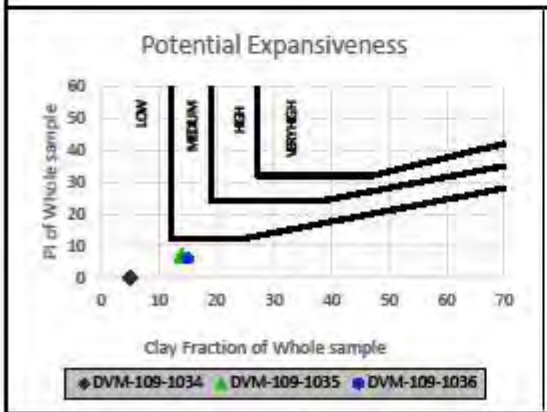

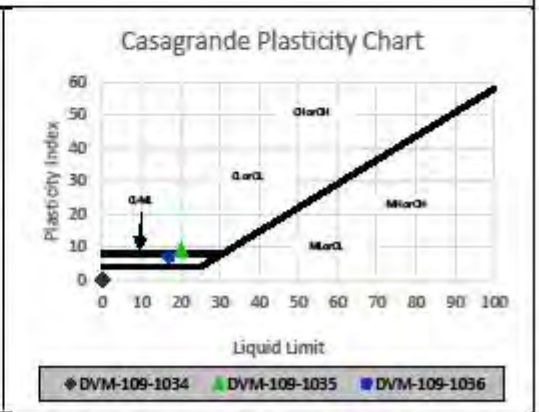

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	B7	B16	B18	Sample	B7	B16	B18
Depth (m)	0.3	0.7	0.2	Depth (m)	0.3	0.7	0.2
Lab No	DVM-109-1037	DVM-109-1038	DVM-109-1039	Lab No	DVM-109-1037	DVM-109-1038	DVM-109-1039
53.0	100	100	100	Liquid Limit (%)	16	16	-
37.5	100	100	95	Plastic Limit (%)	12	11	-
26.5	100	100	90	Plasticity Index (%)	4	5	SP
19.0	100	100	80	Linear Shrinkage (%)	2.0	2.0	0.5
13.2	100	97	76	PI of whole sample	3	4	-
9.5	99	95	75				
6.7	98	94	74	% Gravel	5	9	29
4.75	98	93	73	% Sand	75	66	54
2.00	95	91	71	% Silt	12	16	12
1.00	92	89	68	% Clay	8	9	5
0.425	84	82	64	Activity	0.5	0.6	0.0
0.250	69	70	46				
0.150	52	57	37	% Soil Mortar	95	91	71
0.075	28	33	24				
0.060	20	25	17	Grading Modulus	0.93	0.94	1.41
0.050	18	22	16	Moisture Content (%)	N / T	N / T	N / T
0.035	14	19	13	Relative Density (SG)*	2.65	2.65	2.65
0.020	12	16	11				
0.006	10	11	8	Unified (ASTM D2487)	SC-SM	SC-SM	SM
0.002	8	9	5	AASHTO (M145-91)	A - 2 - 4	A - 2 - 4	A - 2 - 4

Remarks: *: Assumed
N / T: Not Tested

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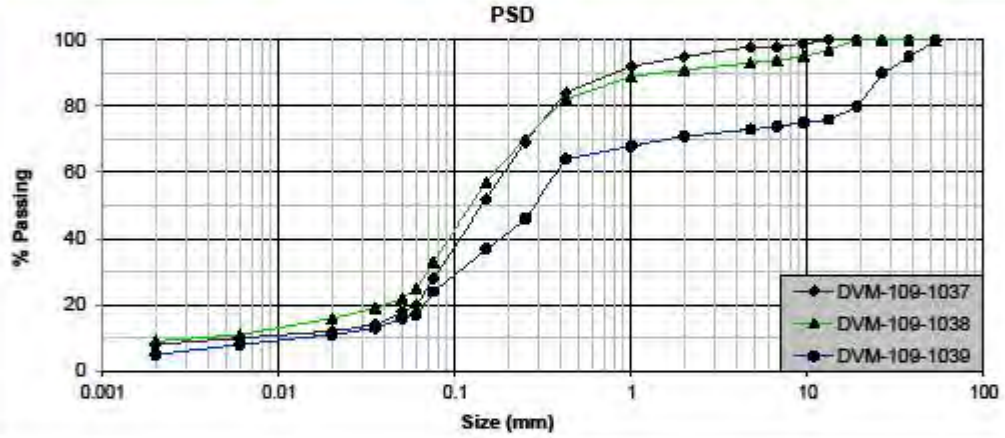
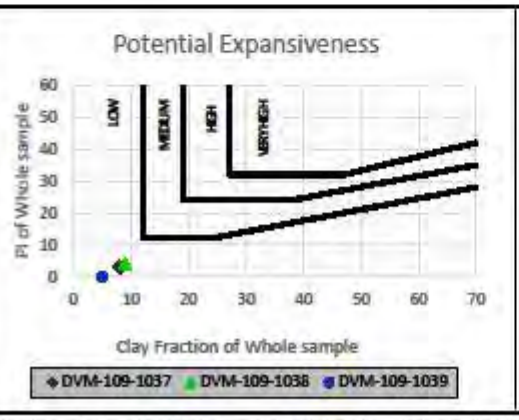
www.stlab.co.za

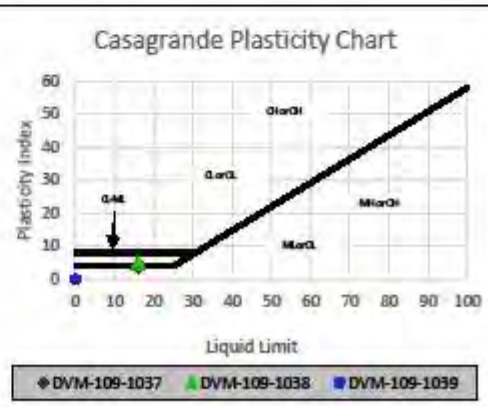
Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02







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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR							Sheet Ref: R-STL-011-Rev02
Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	B21	B22	B25	Sample	B21	B22	B25
Depth (m)	0.2	0.2	0.2	Depth (m)	0.2	0.2	0.2
Lab No	DVM-109-1040	DVM-109-1041	DVM-109-1042	Lab No	DVM-109-1040	DVM-109-1041	DVM-109-1042
53.0	100	100	100	Liquid Limit (%)	-	15	17
37.5	100	100	100	Plastic Limit (%)	-	10	13
26.5	100	100	100	Plasticity Index (%)	SP	5	4
19.0	100	100	98	Linear Shrinkage (%)	0.5	2.5	2.5
13.2	99	97	97	PI of whole sample	-	4	3
9.5	97	95	96				
6.7	96	93	95	% Gravel	7	10	7
4.75	96	93	94	% Sand	74	66	67
2.00	93	90	93	% Silt	13	14	18
1.00	92	89	91	% Clay	6	10	8
0.425	86	86	85	Activity	0.0	0.5	0.5
0.250	74	72	61				
0.150	57	57	49	% Soil Mortar	93	90	93
0.075	28	33	35				
0.060	19	24	26	Grading Modulus	0.93	0.91	0.87
0.050	16	22	24	Moisture Content (%)	N / T	N / T	N / T
0.035	12	18	20	Relative Density (SG)*	2.65	2.65	2.65
0.020	11	16	16				
0.006	8	12	12	Unified (ASTM D2487)	SM	SC-SM	SC-SM
0.002	6	10	8	AASHTO (M145-91)	A - 2 - 4	A - 2 - 4	A - 2 - 4

Remarks: *: Assumed
N / T: Not Tested

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Client Name: Geoset
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Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

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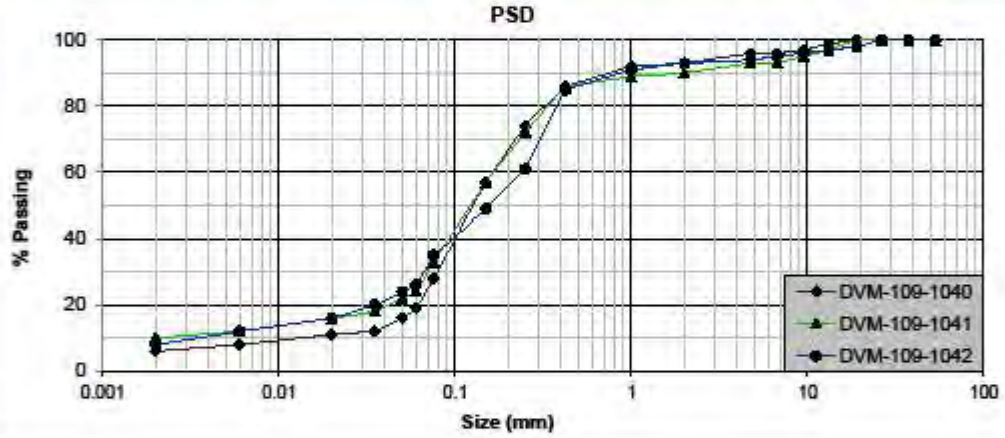

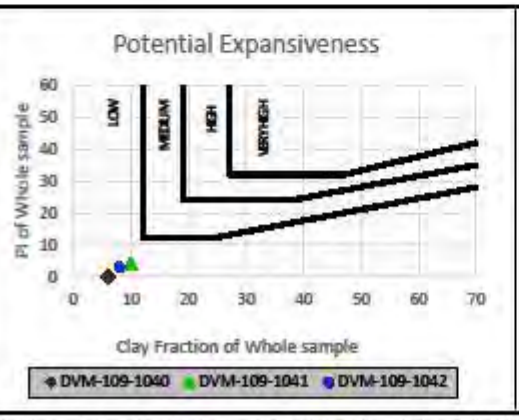

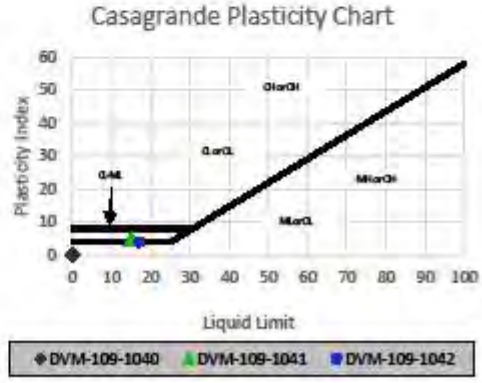

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	B28	B31	B32	Sample	B28	B31	B32
Depth (m)	0.2	0.4	0.5	Depth (m)	0.2	0.4	0.5
Lab No	DVM-109-1043	DVM-109-1044	DVM-109-1045	Lab No	DVM-109-1043	DVM-109-1044	DVM-109-1045
53.0	100	100	100	Liquid Limit (%)	15	-	-
37.5	100	100	100	Plastic Limit (%)	11	-	-
26.5	100	100	100	Plasticity Index (%)	4	SP	SP
19.0	100	100	100	Linear Shrinkage (%)	2.5	0.5	0.5
13.2	99	100	100	PI of whole sample	3	-	-
9.5	98	100	100				
6.7	96	100	100	% Gravel	8	0	1
4.75	94	100	100	% Sand	68	84	76
2.00	92	100	99	% Silt	12	11	11
1.00	90	99	99	% Clay	12	5	12
0.425	79	82	76	Activity	0.3	0.0	0.0
0.250	68	69	67				
0.150	55	54	54	% Soil Mortar	92	100	99
0.075	32	19	31				
0.060	24	16	23	Grading Modulus	0.97	0.99	0.94
0.050	22	15	22	Moisture Content (%)	N / T	N / T	N / T
0.035	19	12	19	Relative Density (SG)*	2.65	2.65	2.65
0.020	18	10	17				
0.006	14	8	15	Unified (ASTM D2487)	SC-SM	SM	SM
0.002	12	5	12	AASHTO (M145-91)	A - 2 - 4	A - 2 - 4	A - 2 - 4

Remarks: *: Assumed
N / T: Not Tested

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Client Name: Geoset
Project Name: Barkley West
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Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

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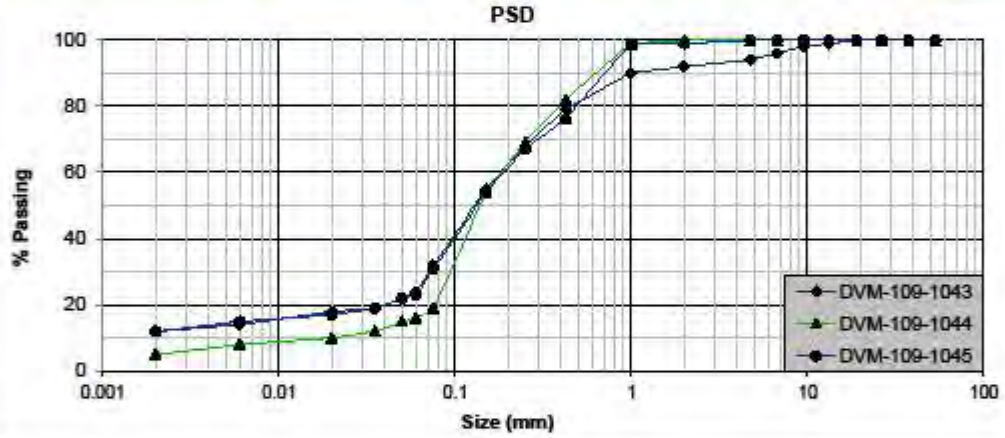

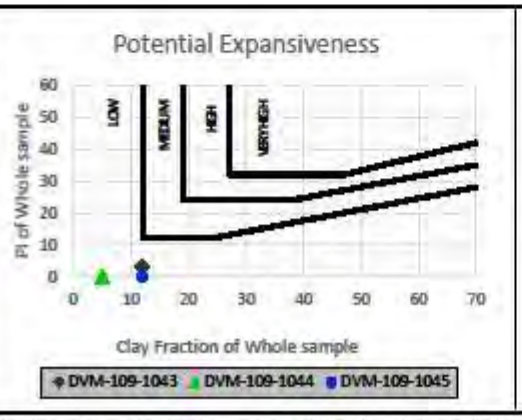

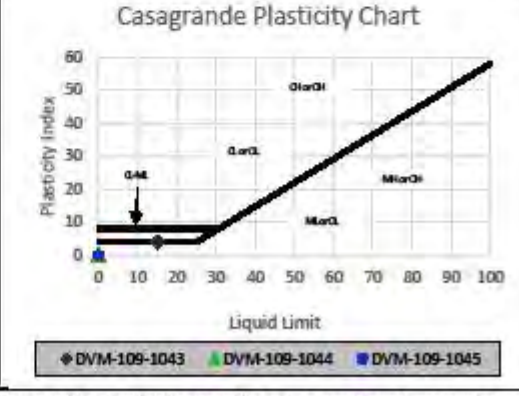

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Client Name: Geoset
Project Name: Barkley West
Job Number: DVM-109
Date: 2020-04-09
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	B40			Sample	B40		
Depth (m)	0.2			Depth (m)	0.2		
Lab No	DVM-109-1046			Lab No	DVM-109-1046		
53.0	100			Liquid Limit (%)	18		
37.5	100			Plastic Limit (%)	13		
26.5	100			Plasticity Index (%)	5		
19.0	100			Linear Shrinkage (%)	2.0		
13.2	98			PI of whole sample	4		
9.5	96						
6.7	94			% Gravel	10		
4.75	93			% Sand	77		
2.00	90			% Silt	9		
1.00	88			% Clay	4		
0.425	83			Activity	1.3		
0.250	60						
0.150	44			% Soil Mortar	90		
0.075	21						
0.060	13			Grading Modulus	1.06		
0.050	12			Moisture Content (%)	N / T		
0.035	9			Relative Density (SG)*	2.65		
0.020	7						
0.006	6			Unified (ASTM D2487)	SC-SM		
0.002	4			AASHTO (M145-91)	A - 2 - 4		

Remarks: *: Assumed
N / T: Not Tested

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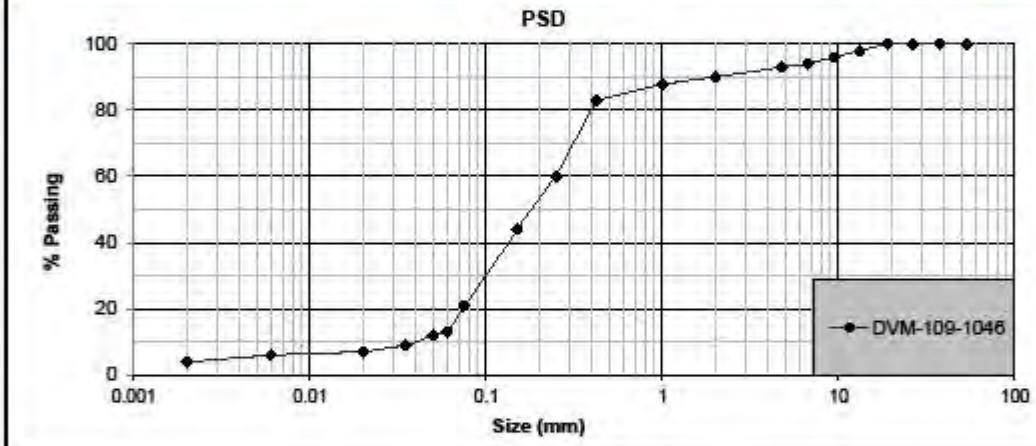

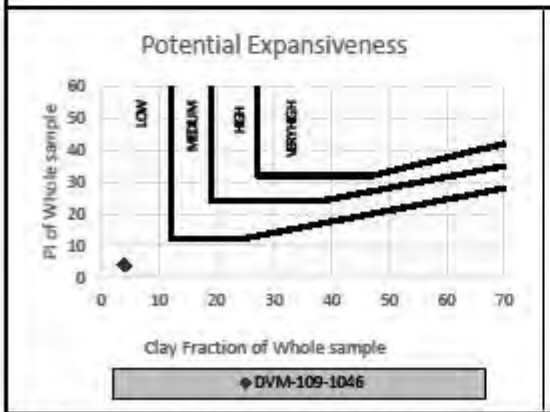

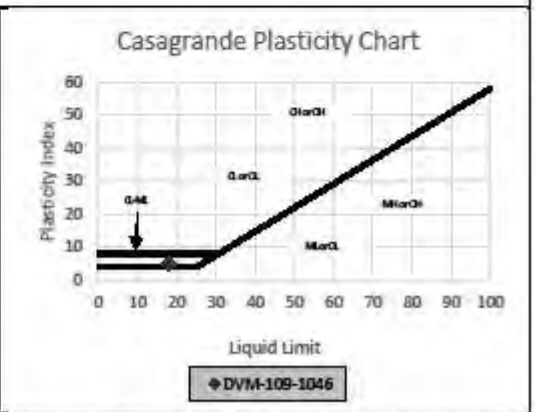

APPENDIX D: TABULAR EXPLANATION OF ZONING

Extract from: THE SOUTH AFRICAN INSTITUTE OF ENGINEERING GEOLOGISTS (SAIEG), 1997. Guidelines for Urban Engineering Geological Investigations.

Table 1. Categories of Urban Engineering Geological Investigation

Table 2. Geotechnical Classification for Urban Development: Partridge, Wood & Brink (1993)

Table 3. Residential Site Class Designations: SAICE, SAIEG & NHBRC (1995)

Table 1. CATEGORIES OF URBAN ENGINEERING GEOLOGICAL INVESTIGATION

Type	Planning Investigations		Urban Development Investigations		Specialised Investigations
Description	Regional Engineering Geological Mapping (REGM)	Mapping for Urban Planning	Urban Development Investigation	Urban Development Investigation	Specialised Geotechnical Investigation
Size of study area and field work	More than 1000 ha. Walk-over survey and limited test pits and soil sampling.	Less than 1000 ha. Walk-over survey.	Less than 10 ha. Test pits, trial holes and soil sampling.	More than 10 ha. Walk-over survey with trial pits and test holes and soil sampling.	Not relevant. Specific to type of specialised investigation.
Suggested number of test pits	A minimum of 3 test pits per land facet type.	None suggested. However, a limited number of test pits may be required at the discretion of the consultant.	Between 6 and 10 test pits.*	Between 1 and 6 test pits per 10 ha. depending on the size and variability of the area to as much as 1 test pit per hectare for highly variable sites.*	Dependent on the type of specialised investigation performed.
Mapping unit	Land systems and land facets.	Terrain types: 1 - most favourable 2 - intermediate 3 - least favourable	Soil classes: C, H, S and P and other (e.g. excavation, drainage features)	Soil classes: C, H, S and P and other (e.g. excavation, drainage features)	Not applicable.
Reference	Brink, Partridge and Williams (1982)	Partridge, Wood and Brink (1993)	SAICE Code of Practice (1995)	SAICE Code of Practice (1995)	Not relevant.
Consultants	Engineering geologists.	Engineering geologists and to a lesser extent geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Geotechnical engineers and to a lesser extent engineering geologists.

* Note that these figures are not intended to be absolute and should serve only as a guideline.

Table 2. GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

	CONSTRAINT	Most favourable (1)	Intermediate (2)	Least favourable (3)
A	Collapsible Soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness *	Any collapsible horizon or consecutive horizons with a depth of more than 750 mm in thickness.	A least favourable situation for this constraint does not occur.
B	Seepage	Permanent or perched water table more than 1,5 m below ground surface.	Permanent or perched water table less than 1,5 m below ground surface.	Swamps and marshes.
C	Active soil	Low soil-heave potential predicted. *	Moderate soil heave potential predicted.	High soil-heave potential predicted.
D	Highly compressible soil	Low soil compressibility expected.*	Moderate soil compressibility expected.	High soil compressibility expected.
E	Erodability of soil	Low.	Intermediate.	High.
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume.	Rock or hardpan pedocretes between 10 and 40 % of the total volume.	Rock or hardpan pedocretes more than 40 % of the total volume.
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred.)	Old undermined areas to a depth of 100 m below surface where stope closure has ceased.	Mining within less than 100 m of surface or where total extraction mining has taken place.
H	Instability in areas of soluble rock	Possibly unstable.	Probably unstable.	Known sinkholes and dolines.
I	Steep slopes	Between 2 and 6 degrees (all regions).	Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions).	More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions).
J	Areas of unstable natural slopes	Low risk.	Intermediate risk.	High risk (especially in areas subject to seismic activity).
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s² within 50 years.	Mining-induced seismic activity more 100 cm/s².	Natural seismic activity more than 100 cm/s².
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur.	Areas adjacent to a known drainage channel or floodplain with slope less than 1%.	Areas .within a known drainage channel or floodplain.

* These areas are designated as 1A, 1C, 1D, or 1F where localised occurrences of the constraint may arise.

Table 3. RESIDENTIAL SITE CLASS DESIGNATIONS (SAICE, 1995)

TYPICAL FOUNDATION MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENTS (mm)	ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)	SITE CLASS
Rock (excluding mud rocks which exhibit swelling to some depth)	STABLE	NEGLIGIBLE	-	R
Fine-grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	EXPANSIVE SOILS	< 7,5 7,5 - 15 15 - 30 > 30	50% 50% 50% 50%	H H1 H2 H3
Silty sands, sands, sandy and gravelly soils	COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS	< 5.0 5,0 - 10 > 10	75% 75% 75%	C C1 C2
Fine-grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	COMPRESSIBLE SOIL	< 10 10 - 20 > 20	50% 50% 50%	S S1 S2
Contaminated soils Controlled fill Dolomitic areas Land fill Marshy areas Mine waste fill Mining subsidence Reclaimed areas Very soft silt/silty clays Uncontrolled fill	VARIABLE	VARIABLE		P

NOTES:

1. The classifications C,H,R and S are not intended for dolomitic area sites unless specific investigations are carried out to assess the stability (risk of sinkholes and doline formation) of the dolomites. Where this risk is found to be acceptable, the site shall be designated as Class P (dolomitic areas).
2. Site classes are based on the assumption that differential movements, experienced by single-storey residential buildings, expressed as a percentage of the total soil movements are equal to about 50% for soils that exhibit expansive or compressive characteristics and 75% for soils that exhibit both compressible and collapse characteristics. Where this assumption is incorrect or inappropriate, the total soil movements must be adjusted so that the resultant different movement implied by the table is equal to that which is expected in the field.
3. In some instances, it may be more appropriate to use a composite description to describe a site more fully e.g. C1/H2 or S1 and/or H2. Composite Site Classes may lead to higher differential movements and result in design solutions appropriate to a higher range of differential movement e.g. a Class R/S1 site. Alternatively, a further site investigation may be necessary since the final design solution may depend on the location of the building on a particular site.
4. Where it is not possible to provide a single site designation and a composite description is inappropriate, sites may be given multiple descriptions to indicate the range of possible conditions e.g. H-H1-H2 or C1-C2.
5. Soft silts and clays usually exhibit high consolidation and low bearing characteristics. Structures founded on these horizons may experience high settlements and such sites should be designated as Class S1 or S2 a as relevant and appropriate.
6. Sites containing contaminated soils include those associated with reclaimed mine land, land down-slope of mine tailings and old land fills.
7. Where a site is designated as Class P, full particulars relating to the founding conditions on the site must be provided.
8. Where sites are designated as being Class P, the reason for such classification shall be placed in brackets immediately after the suffix - i.e. P(contaminated soils). Under certain circumstances, composite description may be more appropriate - e.g. P(dolomite areas)-C1.
9. Certain fills may contain contaminates which present a health risk. The nature of such fill should be evaluated and should be clearly demarcated as such.