WATER COMPASS

Water Compass

Geophysical site investigation report for one production borehole at Mbirizi village in Bukomasimbi District

February 2021
Project 2021-08

TGS water Ltd.

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1 General Information

1.1 Introduction

TGS Water Ltd was commissioned by Water Compass to investigate the ground water potential for one production borehole in Mbirizi village in Bukomasimbi District.

The borehole is meant to supply water to the community of Mbirizi for domestic purposes. Currently the main water source for the people of Mbirizi is a borehole which is about 600m away from the preferred site. The objective of the geophysical survey was to identify potential drill sites with high enough ground water potential to meet the client's needs.

This report presents the results of the geophysical site investigations that were carried out in the area.

1.2 Site location

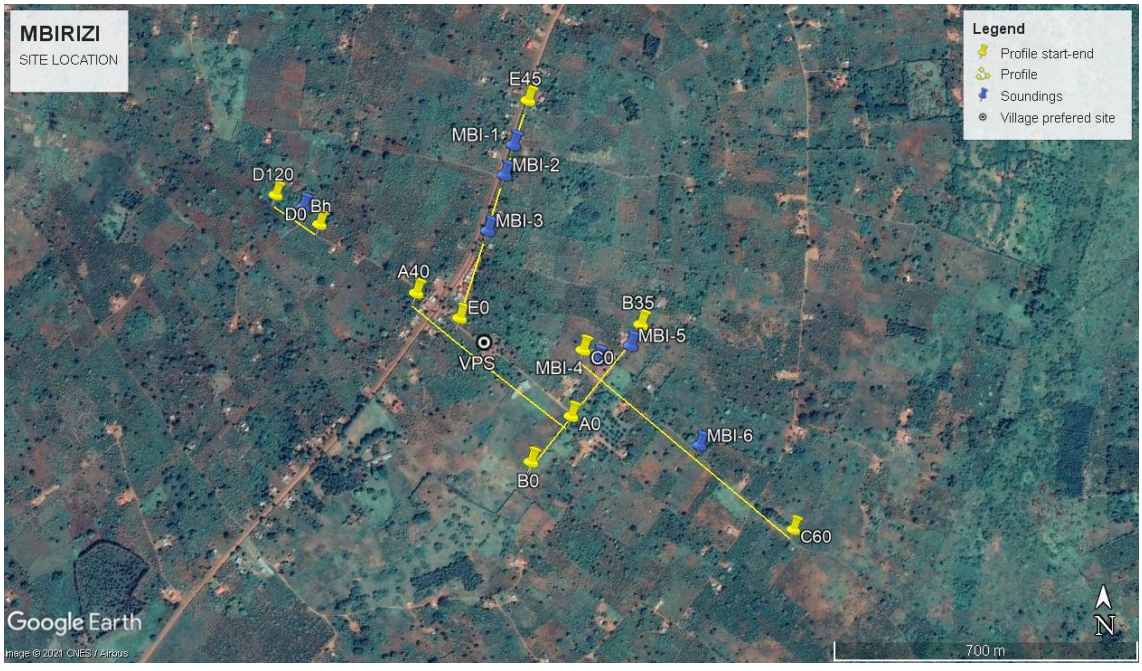
Bukomansimbi District is bordered by Gomba District to the north, Kalungu District to the east, Masaka District to the southeast, Lwengo District to the southwest and Sembabule District to the northwest.

Table 1 Site location

District	Subcounty	Parish	Village	UTM(x)	UTM(y)
Bukomansimbi	Bigasa	Kigangazi	Mbirizi	349296	9995288

UTM- Universal Transverse Mercator, X-Eastings and Y- Northings

Figure 1 Location of surveyed site



1.3 Approach

In order to assess the ground water potential of the area, the available topographical and geological maps, Google Earth images, reports and borehole data maintained by WE Consult, DWRM and TGS Water Ltd were studied.

Based on the results of the desk study and the hydrogeological information gathered, target sites for geophysical measurements were identified and measurements were carried out at those sites. The interpretation and evaluation of the results has led to the production of this report. Recommendations are presented in the recommendations section of this report.

1.4 Time frame

The time frame of the siting process is given in Table 2.

Table 2 Time frame of geophysical survey activities

Date	Activity	Staff Involved
09/02/2021-10/02/2021	Desk Study, Reconnaissance and preparation	Ron Sloots and Oyesiga Faizal
11/02/2021- 12/02/2021	Geophysical Survey	Oleja Emma and Oyesiga Faizal
14/02/2021	Evaluation and Reporting	Oyesiga Faizal
15/02/2021	Quality Control	Ron Sloots

1.5 Desk study

The main objective of the desk study is to develop an initial conceptual framework with regards to groundwater resources and how they can be best developed in the project area. The framework includes; hydrogeology of the area, concerns over water quality (if any), topography, catchment area, existing wells nearby, availability of drilling data as well as accessibility of the area.

The analysis of data on existing boreholes is crucial when gathering information on the geophysical characteristics of the surrounding area. Information obtained in this phase helps during the interpretation of the results obtained in the field and are used to make recommendations (expected Depth to Bedrock (DTB) related to ½ AB measurements, main water strike, drilling depths).

1.6 Geology and Topography

Bukomansimbi district lies in the Buganda-Toro System which is mainly composed of arenites (sand size), argillite (clay size), granites and Meta volcanic. This system is referred as a cover formation because it overlies the Basement Complex. The associated granites and gneisses are thought to be either part of Basement Complex or that granitization occurred selectively leaving the quartzite. Generally, the area surveyed areas are made up of coarse-grained granites and sandy formations.

From existing data, the overburden thickness ranges from 25.2m to 120m with an average casing depth of 67.9m, therefore the depth to bedrock is quite deep. The soils are either sandy or red lateritic, clay overlying weathered granite-gneisses or biotite granite. Sometimes quartzite boulders may

also be found in the overburden. Below the weathered zone / fractured granite is fresh massive granite- gneiss.

The landscape and topography in general are rolling and undulating with vertical gully heads and valley bottom swamps including streams flowing to lakes and rivers. Most parts of the district are dotted with the hills.

From the topographic perception the survey area is located on top of a hill, this indicates that the water level will be deep.

Figure 2 and Figure 3 show the topographic illustration of the targeted area.

Figure 2 Topographic cross-section in N-S

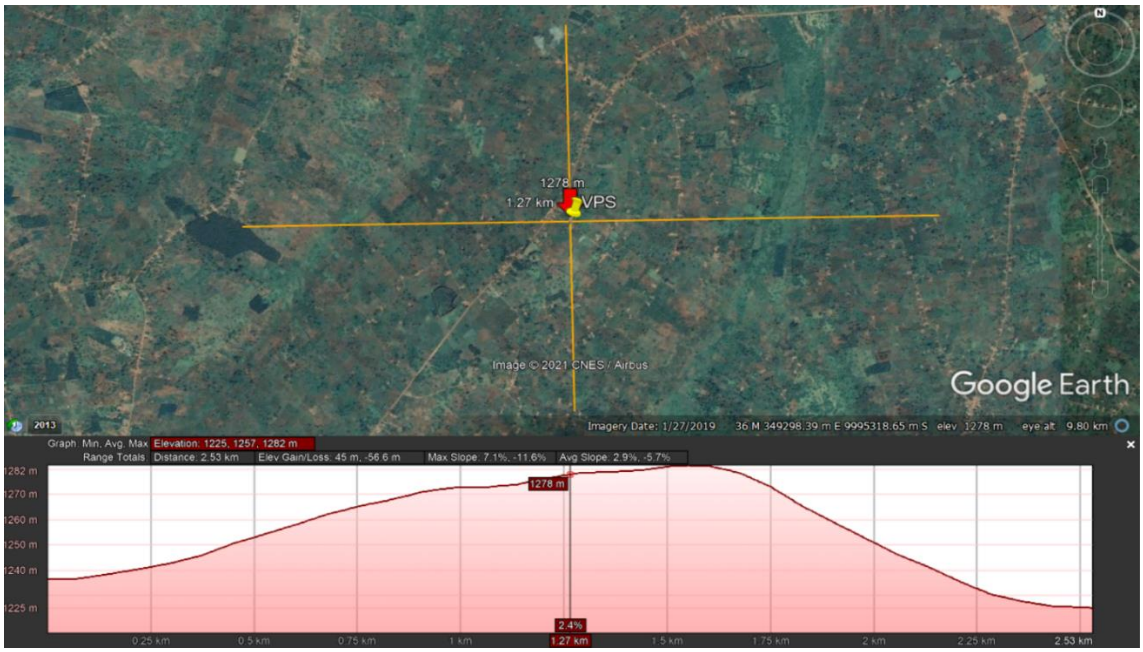
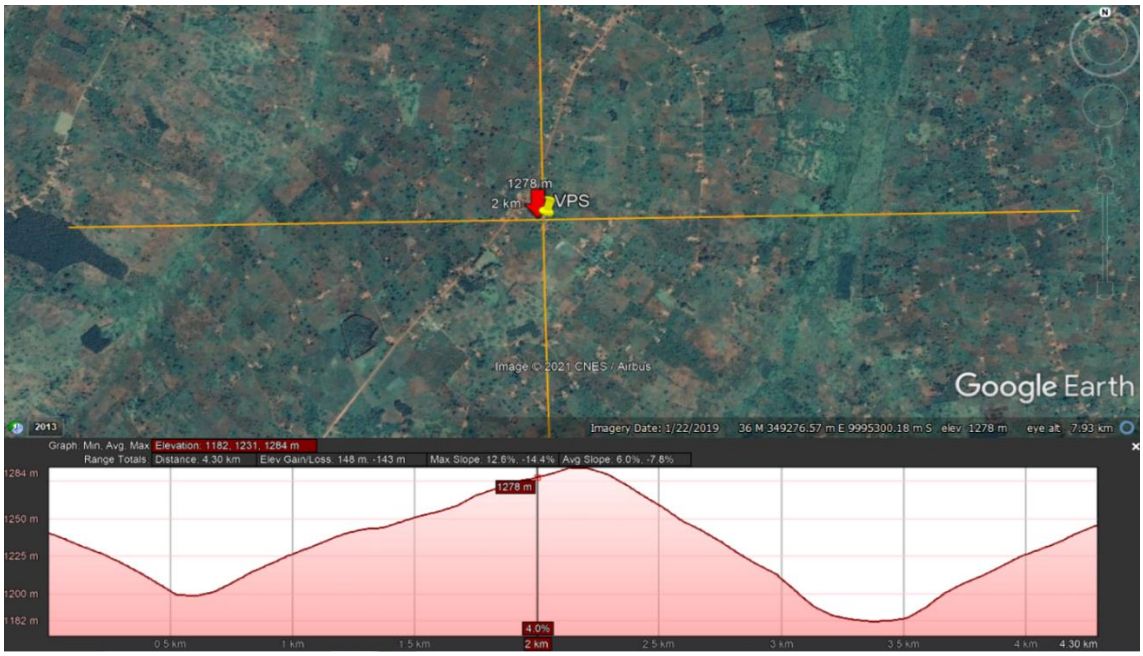


Figure 3 Topographic cross-section in t E-W



1.7 Existing boreholes

The analysis of data on existing boreholes is crucial when gathering information on the geophysical characteristics of the surrounding area. Information obtained in this phase helps during the interpretation of the results obtained in the field and are used to make recommendations (expected DTB related to ½ AB measurements, main water strike, drilling depths).

The survey area is located in Bigasa SubCounty. From the data available, the minimum yield in this sub county is 0. 8 m^3/hr and the maximum yield is 4.0 m^3/hr. The minimum drilled depth is 65.0 metres below ground level and the maximum drilled depth is 114 meters below ground level with an average drilled depth of 94.6 meters below ground level. The data was based on a sample space of nine boreholes. These nine boreholes do not lie in the same lithology and therefore the data may not be used to classify the whole subcounty as the lithology in the subcounty differs from area to area.

Table 3 Existing boreholes per Subcounty

Sub-County (2014)	Count of DTB	Min of DTB(m)	Average of DTB(m)	Max of DTB(m)	Count of yield(m^3/hr)	Min of yield(m^3/hr)	Average of yield(m^3/hr)	Max of yield(m^3/hr)	Count of Depth	Min of Depth(m)	Average of Depth(m)	Max of Depth(m)	Count of Successful2	Success Rate
BIGASA					9	0.8	1.5	4.0	9	65.0	94.6	114.0	9	100
BUKOMANSIMBI TOWN COUNCIL					1	1.6	1.6	1.6	1	86.9	86.9	86.9	1	100
BUTENGA	1	21.0	21.0	21.0	15	0.5	1.4	4.5	15	38.0	72.5	179.3	15	100
KIBINGE					8	0.8	2.1	8.5	8	60.6	83.7	114.0	8	100
KITANDA	1	19.0	19.0	19.0	11	0.3	2.0	9.5	11	72.0	95.4	151.8	11	91
Grand Total	2	19.0	20.0	21.0	44	0.3	1.7	9.5	44	38.0	85.1	179.3	44	98

DTB-Depth To bedrock (metres), m^3/hr-cubic metres per hour, depth(metres)

Table 4 Existing table per lithology

Lithology	Count of DTB	Min of DTB(m)	Average of DTB(m)	Max of DTB(m)	Count of yield	Min of yield(m^3/hr)	Average of yield(m^3/hr)	Max of yield(m^3/hr)	Min of Depth(m)	Average of Depth(m)	Max of Depth(m)	Success Rate
Alluvium; sand, silt, gravel	1	21.0	21.0	21.0	2	1.0	2.7	4.5	108.0	143.7	179.3	100
Laterite					9	0.5	1.9	8.5	38.0	80.2	114.0	100

Lithology	Count of DTB	Min of DTB(m)	Average of DTB(m)	Max of DTB(m)	Count of yield	Min of yield(m^3/hr)	Average of yield(m^3/hr)	Max of yield(m^3/hr)	Min of Depth(m)	Average of Depth(m)	Max of Depth(m)	Success Rate
Mica schist with quartzitic interbeds					13	0.3	1.1	2.0	48.0	74.4	96.0	92
Papyrus swamp, flood plain mud					1	1.7	1.7	1.7	78.9	78.9	78.9	100
Rwamasha granite (1987?5 Ma)	1	19.0	19.0	19.0	19	0.8	2.0	9.5	47.9	88.9	151.8	100
Grand Total	2	19.0	20.0	21.0	44	0.3	1.7	9.5	38.0	85.1	179.3	98

DTB-Depth To bedrock (metres), m^3/hr-cubic metres per hour, depth(metres)

The target site is found in Rwamasha granite lithology, from the data available, the minimum yield in this sub county is 0. 8 m^3/hr and the maximum yield is 9.8 m^3/hr. The minimum drilled depth is 47.9m below ground level and the maximum drilled depth is 151m below ground level with an average drilled depth of 88.9m below ground level. The data was based on a sample space of 19 boreholes.

2 Geophysical survey

2.1 Approach and methodology

The geophysical survey was done by means of resistivity measurements in the form of profiles and vertical electrical soundings (VESes) with the use of ABEM SAS 1000 terrameter. All measurements were configured to Schlumberger set up with ½ AB=90 m, ½ MN = 10 m and an interstation interval of 10 m. For VESes the maximum ½AB was 120 m while ½MN was varied from 0.5 m, 5.0 m and 20 m.

The planned resistivity profiles were marked in Google Earth in the office. In the field these locations were verified. In some places the start and end locations were adapted and, in some cases, some additional profiles were run and in other areas, the targets were not surveyed.

Normal 1D resistivity profiling was done near the targets and VESes were carried out at promising anomalies identified on the profiles. Coordinates and altitudes of the VES locations were recorded. The orientations of the soundings were noted using a compass.

The software used for processing and interpreting the 1D survey data is MS Excel.

Calibration measurements

Calibration measurements were done on the existing borehole. The calibration measurements were compared with the results of selected sites to confirm the results and interpretation.

2.2 Results of the geophysical measurements

A combined total of 2000m profiling at 10 m interval station spacing was done in the different areas of interest, combined with a total of 6 VESes. Table 5 shows the quantity of measurements carried out at Mbirizi village.

Table 5 Quantity of measurements carried out

S/County	Parish	Village	No. of profiles	No. of VESes	Profiling distance (m)
Bigasa	Kigangazi	Mbirizi	4	6	2000

2.3 1 D profiles and Vertical Electrical Soundings

Most of the profiles were carried out as planned during the desk study. However, some target valleys could not be surveyed as they were; not accessible and the rock exposures could make it impossible for the electrodes to be hammered into the ground.

Table 6 Overview of Soundings made at Mbirizi Village

VES	Profile	Elevation(m)	UTM X	UTM Y	LRA	LRVES
MBI-1	E	1276	349344	9995655	34	41
MBI-2	E	1275	349326	9995595	57	52
MBI-3	E	1274	349292	9995484	27	79
MBI-4	C	1276	349513	9995225	178	104
MBI-5	B	1276	349581	9995253	171	114
MBI-6	A	1249	349730	9995045	171	111

UTM-Universal Transverse Mercator, X-Eastings and Y- Northings, LRA-lowest restivity anomaly, LRVES-Lowest restivity VES

3 Conclusions and recommendations

3.1 Conclusions

Based on the results of the desk study, combined with target sites selected in the field, a geophysical survey was carried out. The interpretation and evaluation of the results has led to the identification of potential drill sites, which are presented below.

Table 7 gives a summary of the recommended and alternative drill sites.

Table 7 Summary of potential drill sites and comments

VES	UTM (X)	UTM (Y)	RDS	ADS	RDD	REMARKS
MBI-1	284394	163196	YES		80	MBI-1 because it has wide anomaly and the lowest LRA and scored highest on scoring table
MBI-4	284485	163120		YES	80	MBI-4 because it has a confirmed anomaly and its sounding has kinks.

RDD: Recommended drill depth, RDS: Recommended drill site, ADS: Alternative drill site

3.2 Recommendations

The two recommended drill points are MBI-1 and MBI-4.

Drilling should only be done on the recommended sites or alternative site. The outcome and progress of drilling should be followed carefully during the project execution. These results should be analysed in relation to the geophysical results and decisions on drill sites should be adapted if necessary. The recommended drill depth is based on the data of existing boreholes and the geophysical measurements carried out.

It should be noted that the interpretations are a simplification of the collected data. The actual depth to bedrock and final decision on when to stop drilling has to be made on site by the supervisor in consultation with the driller.

ANNEX 1 Occurrence of groundwater

The occurrence of aquifers in different parts of Uganda is related to the respective geological characteristics of the areas. The productive aquifers are mainly found in in-situ weathered bedrock, the regolith overlying the bedrock and in faults and fractures in the basement. The highest yielding wells are found in the weathered- fractured bedrock where the permeability is rather high and where the storage can be provided by the overlying regolith. The number and distribution of fractures, and the effective porosity in each geological material control aquifer characteristics respectively. However, in our present survey particularly in Bukomansimbi the granitic area reveals there is deep weathering zone and the expected ground water occurrence is from the deep seated granitic rock.

In most of the study area the potential for shallow aquifers is high because of either high effective rainfall or favorable geomorphologic and geological conditions. This is confirmed by high spring frequency and swampy valley bottoms in most of the study area. Previous experience reveals the depth of aquifer in the area of investigation is up to 114 meters and the present survey area also shows that the deep fracturing related to groundwater occurrences is starting from 40 to 180m. Borehole yields may vary from 0.1 – 9.5m^3/hr.

The Bukomansimbi district has a deeply weathered crystalline rock. Much of it is underlain by Precambrian crystalline rock. These formations have been subjected to long term weathering which is evident from thick mantles of weathered rock that overlie bedrock.

Aquifers occur in the fractured bedrock and at the base of the unconsolidated overburden where coarser bedrock fragments predominate.

Occurrence of aquifers in Bukomansimbi district is related to respective geological characteristics of the areas.

Productive aquifers mainly found in in-situ weathered bedrock, regolith overlying the bedrock.

Moderate amount of water was obtained in the contact between the regolith and bed rock.

Highest yielding wells are found in faults and fractures in the basement. Here the permeability is high and storage can be provided by the overlying regolith.

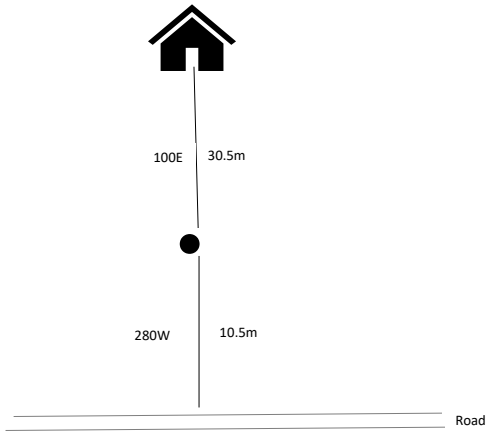
The number and distribution of fractures, and the effective porosity in each geological material control aquifer characteristics.

ANNEX 2 Results of geophysical measurements

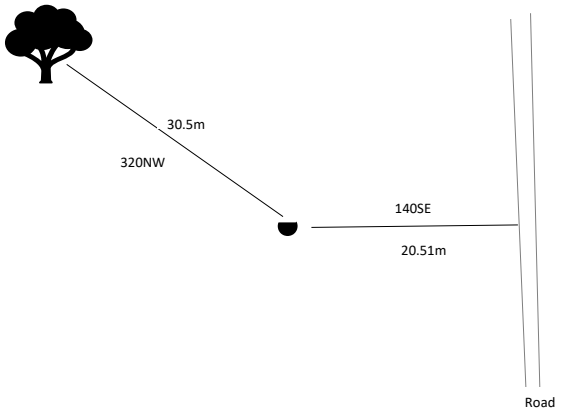
Location:	**Mbirizi**				
Recommended Site:	MBI-1	UTM (E)	349344	UTM (N)	9995655
Expected DTB (m):		Altitude (amsl	1276.00		
Recommended Depth (m):	80	Accessibility Site:		Accessible	
Alternative Site:	MBI-4	UTM (E)	349513	UTM (N)	9995225
Expected DTB (m):		Altitude (amsl)		1276	
Recommended Depth (m):	80	Accessibility Site:			
Expected Formation:	Granites	Accessibility Village:		Accessible	
Contact number:		Contact person:			

Remarks:	MBI-1 because its anomaly has wide anomaly and the lowest LRA. MBI-1 also scored the highest on the table of scores

Recommended Site Sketch:

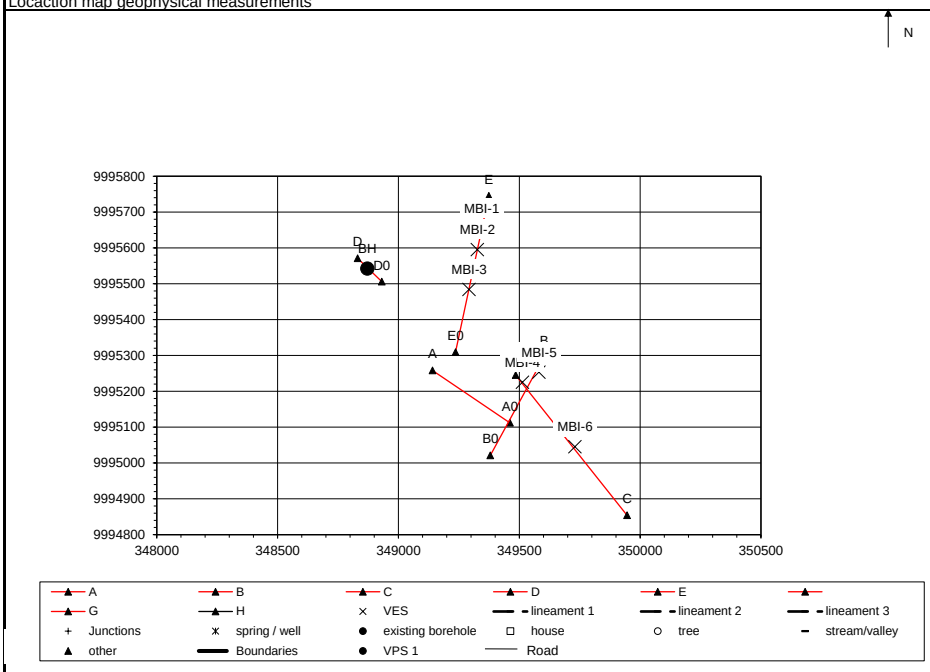


Alternative Site Sketch:



Site	Mbirizi		Village	Mbirizi			
Parish			Sub- County	Bigasa			
County	Bigasa		District	Bukomasimbi			
Rating per site (max. 100 points):							
	1	2	3	4	5	6	7
Local topography (0-20 points)	6.00	6.00	6.00	6.00	6.00	8.00	
Lineament (0-20 points)	5	5	5	5	5	5	
Anomaly (0-30 points)	17.00	7.00	7.00	26.00	22.00	12.00	
VES (0 -15 points)							
Earlier results (0 - 15)	10.00	10.00	10.00				
Total	38.00	28.00	28.00	37.00	33.00	25.00	
Remarks	MBI-1 scored the highest followed by MBI-4 therefore our recommended drill site is MBI-1 and its alternative is MBI-4						

Locaction map geophysical measurements



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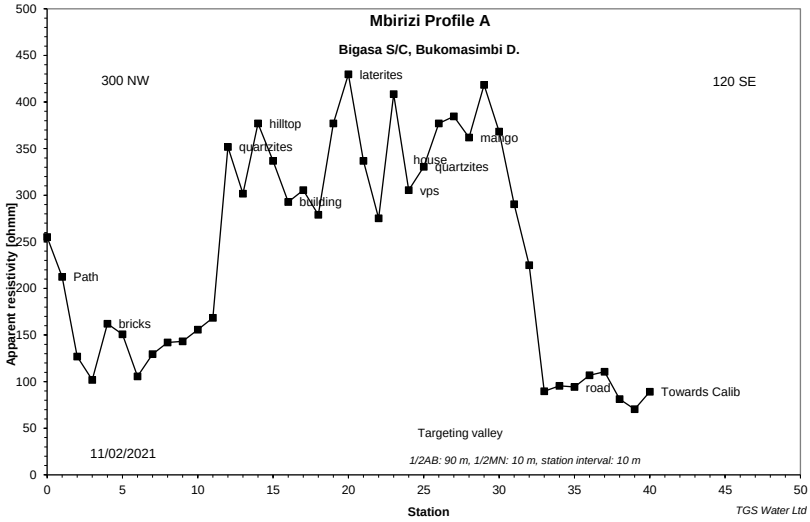
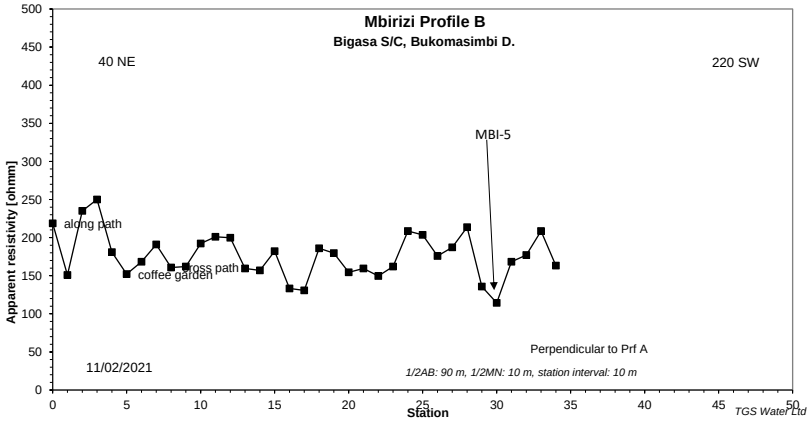
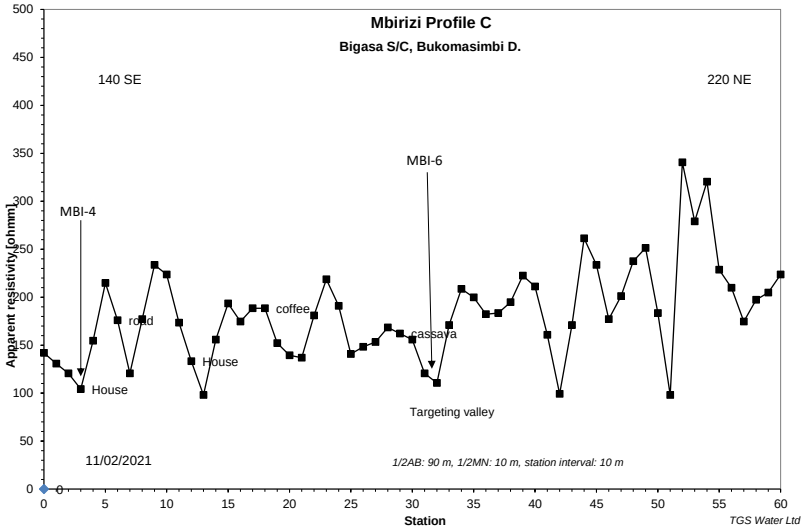
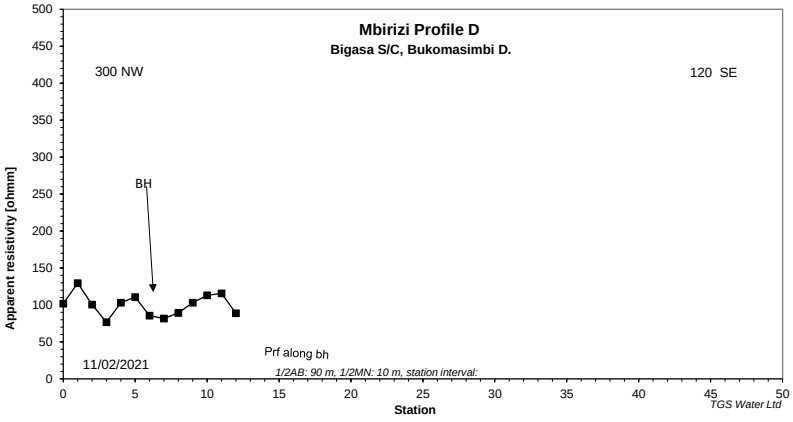
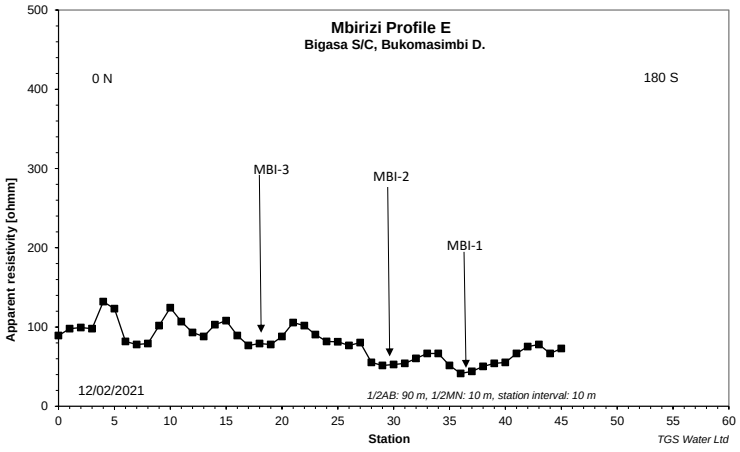
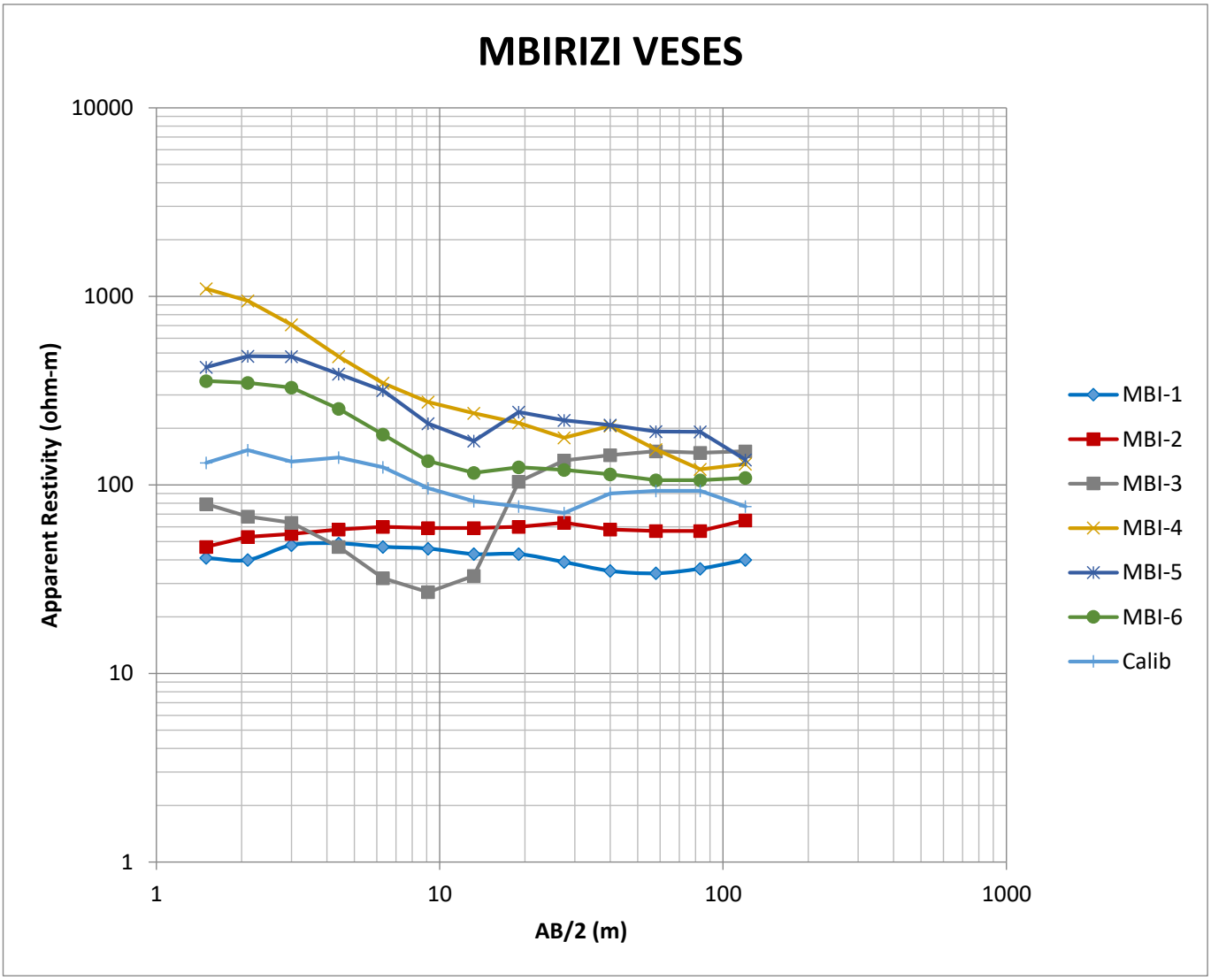

Mbirizi Profile A
Bigasa S/C, Bukomasimbi D.
300 NW
120 SE
laterites
hilltop
quartzites
mango
house
quartzites
vps
building
Path
bricks
road
Towards Calib
Targeting valley
11/02/2021
1/2AB: 90 m, 1/2MN: 10 m, station interval: 10 m
Apparent resistivity [ohmm]
Station
TGS Water Ltd


Mbirizi Profile B
Bigasa S/C, Bukomasimbi D.
40 NE
220 SW
MBI-5
along path
coffee garden
cross path
Perpendicular to Prf A
11/02/2021
1/2AB: 90 m, 1/2MN: 10 m, station interval: 10 m
Apparent resistivity [ohmm]
Station
TGS Water Ltd


Mbirizi Profile C
Bigasa S/C, Bukomasimbi D.
140 SE
220 NE
MBI-4
MBI-6
road
coffee
cassava
House
House
Targeting valley
11/02/2021
1/2AB: 90 m, 1/2MN: 10 m, station interval: 10 m
Apparent resistivity [ohmm]
Station
TGS Water Ltd


Mbirizi Profile D
Bigasa S/C, Bukomasimbi D.
300 NW
120 SE
BH
Apparent resistivity [ohmm]
Prf along bh
11/02/2021
1/2AB: 90 m, 1/2MN: 10 m, station interval:
Station
TGS Water Ltd


Mbirizi Profile E
Bigasa S/C, Bukomasimbi D.
0 N
180 S
MBI-3
MBI-2
MBI-1
Apparent resistivity [ohmm]
12/02/2021
1/2AB: 90 m, 1/2MN: 10 m, station interval: 10 m
Station
TGS Water Ltd


MBIRIZI VESES
10000
1000
100
10
1
Apparent Restivity (ohm-m)
1
10
100
1000
AB/2 (m)
MBI-1
MBI-2
MBI-3
MBI-4
MBI-5
MBI-6
Calib