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COMMISSION OF THE EUROPEAN COMMUNITIES BRUSSELS

FEDERAL DEPARTMENT OF WATER RESOURCES LAGOS

FDWR / EDF WATER RESOURCES PROJECT

GROUNDWATER RESEARCH DEPARTMENT

National Water Resources Institute Kaduna

FINAL REPORT

Volume II

Borehole Completion Reports

July 1986

MRT CONSULTING ENGINEERS (NIGERIA) LTD

20 JOHNSON STREET ILUPEJU LAGOS

This report consists of three volumes:

Volume I Text and Appendices

Volume II Borehole Completion Reports

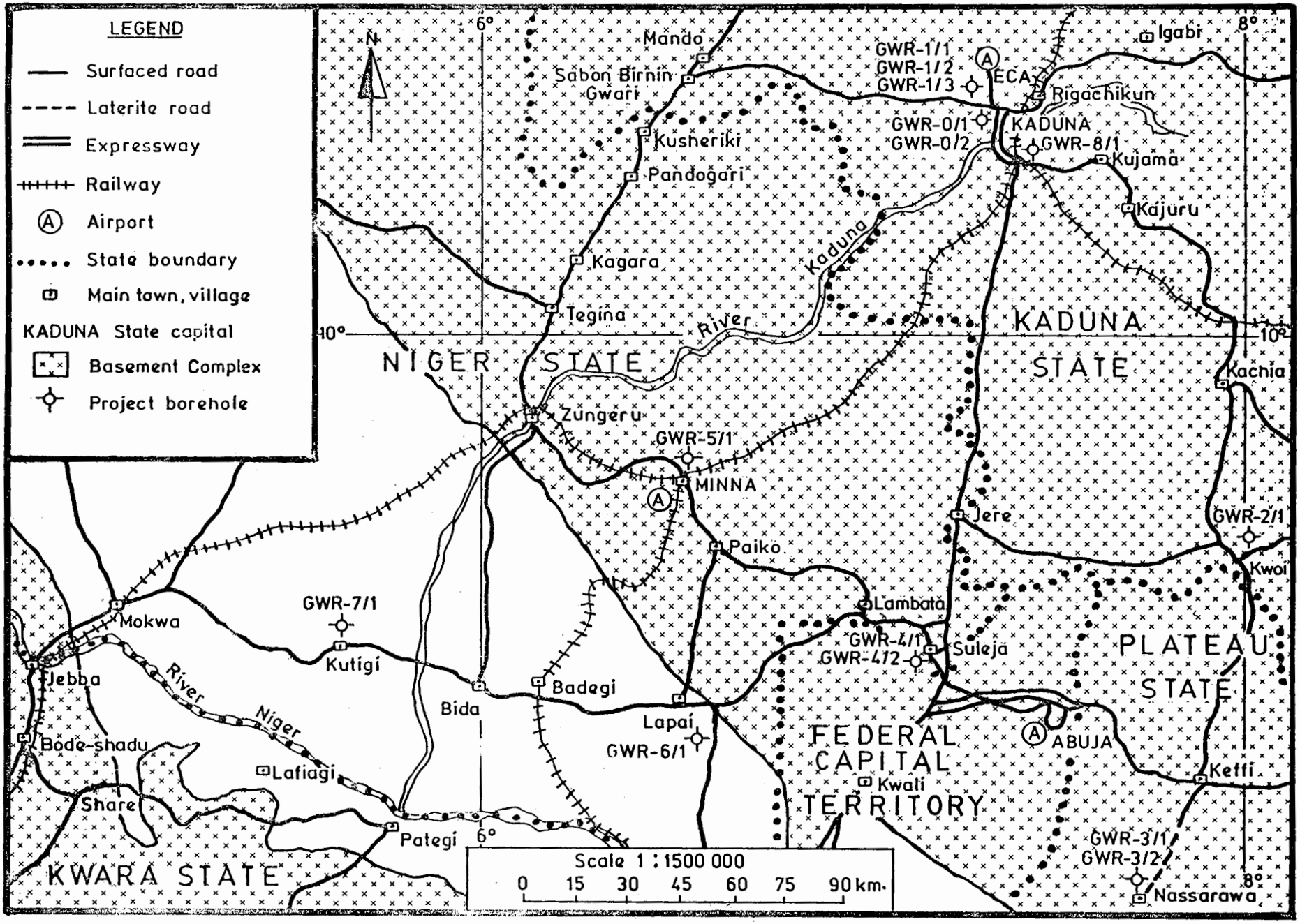
Volume III Geophysical Data

VOLUME II

BOREHOLE COMPLETION REPORTS

CONTENTS

FIGURE 11-1 GROUNDWATER RESEARCH DEPARTMENT-LOCATION OF BOREHOLES



COMPLETION REPORT-BOREHOLE NR.GWR-0/1

1. GENERAL/SUMMARY

Research Project	: -		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Kaduna	River Basin	:
Location	: National Water Resources Institute Compound		
Map Sheet Nr.	: 123 (1:50 000)	Sector	: SE
Longitude	: 7° 25' 18" E	Latitude	: 10° 34' 55" N
Rig	: Halco V866	Rig on site	: 17/11-18/12/84
Depth drilled	: 92m	Drilling method	: 0-36m foam 36-42 Mudflush 42-92m DHH
Screen installed	: -		
Reference Point	: Ground level	Open hole	: 40.8 - 92m
Elevation Ref. Pt.	: 625m	Source elev. data	: 1:50 000 map
SWL (date)	: 6.79m (31/1/85)	EC (date)	: 280 u.S/cm (21/5/85)

2. OBJECTIVES

The aims of the borehole, the first to be drilled by the Groundwater Research Department of the NWRI, were as follows:-

(a) to test the drill rig and the full range of ancilliary equipment under working conditions;

(b) to provide training for the drilling crew;

(c) to provide a borehole which could be used as a piezometer hole, for training purposes, and for testing equipment;

(d) to provide an alternative water supply for the Institute if the yield was sufficient.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-0/1

Nr.	Operation(s)	Date
1	Drilled with $9\frac{7}{8}$" drag bit by air flush to 13.2m (rock encountered)	8/11/84
2	Drilled with $9\frac{5}{8}$" soft formation tricone bit by foam flush from 13.2 to 30.3m while 10" steel casing pushed down to 30.3m	9 - 28/11
3	At 30.3m loose sand with mica encountered, foam could not keep hole open and casing could not be pushed down deeper. Changed to mudflush, added two 7" stabilisers to tricone bit and drilled from 30.3 to 41.3m into rock	7/12
4	Installed 42m of 8" steel casing and withdrew 20" casing. (base of casing 40.8m, geophys. logs)	12/12
5	Drilled with $7\frac{7}{8}$" down-the-hole hammer from 41.3 to 92m (total depth). WL varied between 8.22 and 16.22m at borehole depth 92m	12 - 13?/12
6	Geophysical logging - caliper, SP/PR and gamma	?14/12
7	Well development by airlift	17 - 18/12
8	Installation and testing of small Monolift test pump. Foot valve had to be fabricated before pump worked	10 - 21/5/85
9	Geophysical logging (gamma only)	11/6

Depth (m) From	Depth (m) To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - Approx. 9m (approx. 9m)				
0	5	5	No samples collected	
5	9	4	Bright reddish brown, clayey soil	
Weathered Basement Complex Approx. 9 - 23m (approx. 39m)				
9	13	4	Brown, medium sand	
13	14	1	Brown, micaceous, pebbly sand	
14	17	3	Brown, micaceous, medium sand	
17	18	1	Brown grey, micaceous, silty fine sand with gravels	
18	21	3	Gravelly, coarse sand	
21	24	3	Grey, micaceous, silty, med-cse sand	
24	25	1	Greyish brown, medium-coarse sand	Probably low permeability aquifer between depth water struck (16m) and top of fresh basement ccmplex at 38m. Aquifer thickness about 22
25	32	7	Greyish brown, medium-coarse sand, micaceous, with frag(s) qtz and felsp	
32	35	3	Quartz and feldspar gravel with mica flakes, med-cse sd below 33m	
35	38	3	Dark grey, clayey sand with quartz and feldspar fragments	
Fresh Basement Complex 38 - 92m (54m)				
38	92 (TD)	54	Fresh crystalline rock (? granite)	Water limited to cracks, yields probably very low

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

BOREHOLE NR: GWR-0/1

None

6. WELL DESIGN

8 inch diameter steel casing was landed on sound rock (Basement Complex) at 40.8m, to prevent the inflow of loose sand encountered at 30.3m. The hole is open from 40.8m to total depth (length open hole 51.2m)

7. WELL DEVELOPMENT

The well was cleaned out by airlift pumping and surging using $3\frac{1}{4}$" eductor pipe and 1" airpipe. The discharge was about 2.5 m^3/h, measured by timing the filling up of a 2.3 m^3 tank.

8. PUMPING TESTS

BOREHOLE NR: GWR-0/1

A pumping test was attempted on 21 May with the small Monolift test pump. However, the water level fell to the pump intake at 50m after 7 minutes pumping at a discharge of about 2.9 m^3/h - drawdown was in excess of 43m.

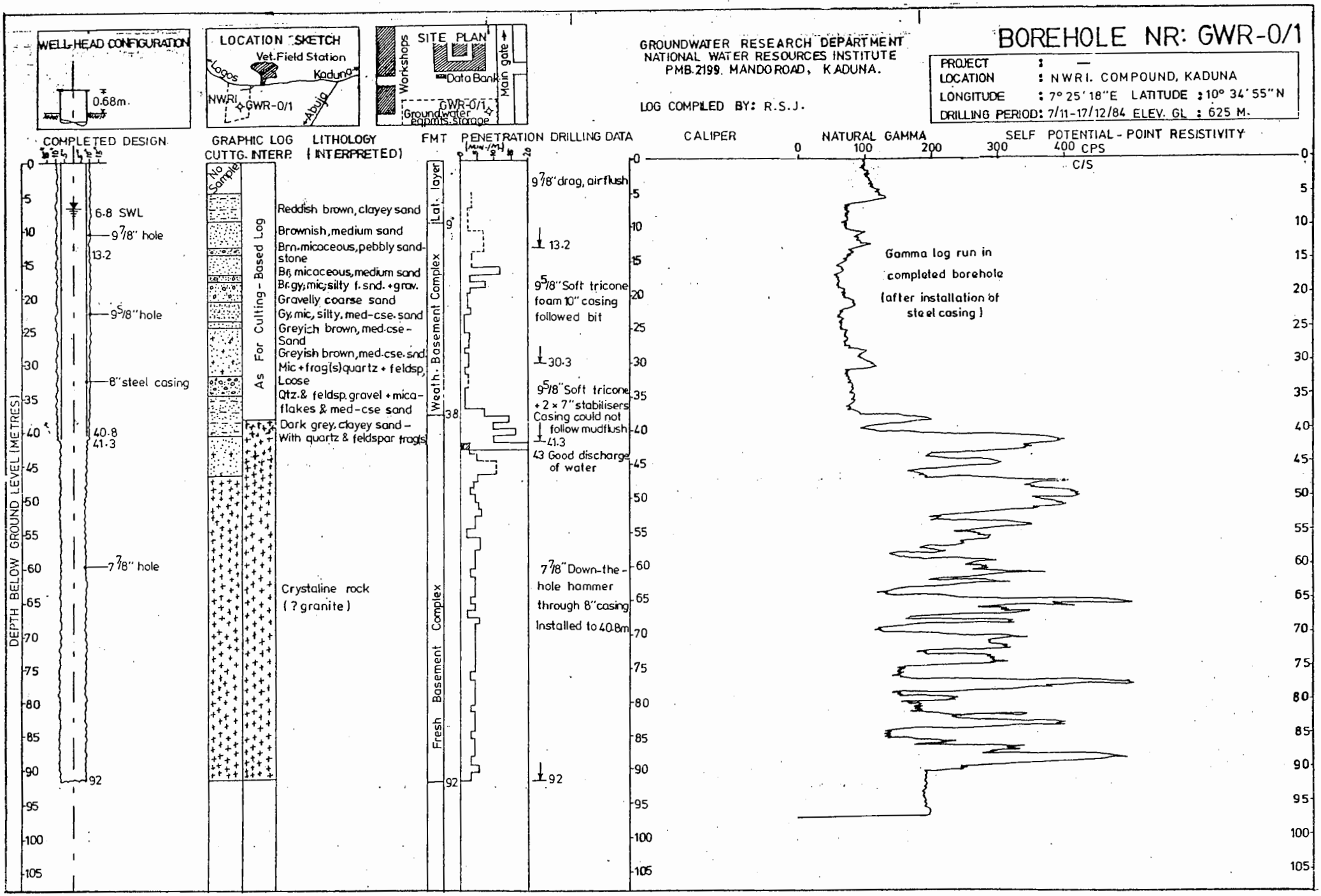
9. WATER QUALITY

Results of chemical analyses with a Hach DR-EL/4 portable laboratory on a sample collected on 21 May are given below:

Ca^{++}	1.16	meq/L
Mg^{++}	0.66	"
CL^{-}	0.82	"
EC	280	u.S/cm (temperature compensated)
pH	7.21	

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps the fresh Basement Complex and its yield is probably too low for water supply use. It should be used for water level monitoring purposes only.


WELL HEAD CONFIGURATION
0.68m.
LOCATION SKETCH
Vet. Field Station
Kaduna
Lagos
NWRI
GWR-0/1
Abuja
SITE PLAN
Workshops
Data Bank
Main gate
GWR-0/1
Groundwater Exploration Storage
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB. 2199, MANDO ROAD, KADUNA.
LOG COMPILED BY: R.S.J.
BOREHOLE NR: GWR-0/1
PROJECT : —
LOCATION : NWRI. COMPOUND, KADUNA
LONGITUDE : 7° 25' 18"E LATITUDE : 10° 34' 55"N
DRILLING PERIOD: 7/11-17/12/84 ELEV. GL : 625 M.
COMPLETED DESIGN
GRAPHIC LOG
CUTTG. INTERP.
LITHOLOGY (INTERPRETED)
FMT
PENETRATION
DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
0 100 200 300 400 CPS
C/S
DEPTH BELOW GROUND LEVEL (METRES)
6·8 SWL
9 7/8" hole
13·2
9 5/8" hole
8" steel casing
40·8
41·3
7 7/8" hole
92
No Sample
As For Culting - Based Log
Reddish brown, clayey sand
Brownish, medium sand
Brn. micaceous, pebbly sand-stone
Br. micaceous, medium sand
Br. gy; mic; silty f. snd. + grav.
Gravelly coarse sand
Gy, mic, silty, med-cse. sand
Greyish brown, med-cse - Sand
Greyish brown, med-cse. snd
Mic + frag(s) quartz + feldsp, Loose
Qtz. & feldsp. gravel + mica-flakes & med-cse sand
Dark grey, clayey sand - With quartz & feldspar frags
Crystaline rock (? granite)
Lat. layer
Weath. Basement Complex
38
Fresh Basement Complex
92
9 7/8" drag, airflush
13·2
9 5/8" Soft tricone foam 10" casing followed bit
30·3
9 5/8" Soft tricone + 2 × 7" stabilisers Casing could not follow mudflush
41·3
43 Good discharge of water
7 7/8" Down-the-hole hammer through 8" casing Installed to 40·8m
92
Gamma log run in completed borehole (after installation of steel casing)

8-II

COMPLETION REPORT-BOREHOLE NR.GWR-0/2

1. GENERAL/SUMMARY

Research Project	: -		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Kaduna	River Basin	: Kaduna
Location	: National Water Resources Institute		
Map Sheet Nr.	: 123 (1:50 000)	Sector	: SE
Longitude	: 07° 25' 18" E	Latitude	: 10°34' 55" N
Rig	: Halco V866	Rig on site	: 23/5 - 4/6/85
Depth drilled	: 29.0m	Drilling method	: Water Flush
Screen installed	: 13.1 - 26.5m (backfilled 23.7-26.5m)		
Reference Point	: Ground Surface	Open hole	: -
Elevation Ref. Pt.	: 625 m	Source elev. data	: 1:50 000 map
SWL (date)	: 6.77m gL (3/6/85)	EC (date)	: 200 u.S/cm (3/6/85)

2. OBJECTIVES

To supply water for the proposed calibration tank for the hydraulics laboratory of the NWRI. The requirement was stated to be 1 L/min (0.06 m^3/h).

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-0/2

Nr.	Operation(s)	Date
1	Drilled with 4⅞" tricone bit by direct circulation water flush to 29.0m	24/5/85
2	Geophysical logging (E-log, gamma and caliper)	"
3	Reamed with 12¼" tricone bit to 27m; 15m of drill collars used	27-28/5
4	Installed 6" PVC casing and screen with bottom plug to 25.5m. Annular space infilled with sand to act as a filter	26/5
5	Well development by air jetting; sand entered well through break in screen	30/5
6	Drilled out sand in bottom of well and backfilled with gravel and cement to 23.7m	31/5
7	Well development by air jetting, followed by airlift pumping test/recovery. Chemical analysis of water sample	3/6

4. LITHOLOGY AND AQUIFERS

BOREHOLE NR: GWR-0/2

Depth (m) From	Depth (m) To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 10.4m (10.4m)				
0	4	4	Reddish brown, silty clay with reddish brown ferruginous concretions	Lateritic layer is largely above saturated zone
4	10.4	6	Reddish brown, sandy clay with ferruginous concretions	Water table about 7.0m
Weathered Basement 10.4 - 27.1m (16.7m)				
10.4	12.8	2.4	Mottled reddish brown/grey, micaceous clay, sandy	Weathered Basement is main aquifer, highest permeability likely to be below 17.0m. Aquifer thickness about 20m
12.8	14.4	2.6	Brownish grey, clayey sand, pebbly	
14.4	17.0	2.6	Grey, sandy clay, micaceous	
17.0	24.2	7.2	Sandstone (decomposed gneiss), with fragments of hard, fresh rock towards base	
24.2	25.3	1.1	Grey, silty clay	
25.3	26.1	0.8	Sandstone (decomposed gneiss) with fragments (probably blocks) of hard, fresh rock	
26.1	27.1	1.0	Brownish grey, clayey sand	
Fresh Basement 27.1 - 29.0m (2.1m)				
27.1	29.0 (TD)	1.9	Gneiss, hard	Impermeable

5. SAMPLING /AIRLIFT TESTS DURING DRILLING

BOREHOLE NR: GWR-0/2

None

6. WELL DESIGN

The following lengths of 150mm (6") n.d. PVC casing and screen were installed:-

- 0.4 - 1.1m	1 x 1.5m	length casing
1.1 - 13.1m	2 x 6m	lengths casing
13.1 - 25.1m	2 x 6m	lengths screen 1.0mm slots
25.1 - 26.5m	1 x 1.5m	length screen 1.0mm slots

The annular space was infilled with medium-coarse sand to act as a filter - a particle size analysis showed the following results:

D_{10} = 0.24mm, D_{50} = 0.66mm D_{60} = 0.80mm, UC = 3.3

Unfortunately a break occurred in the bottom length of screen which allowed sand to flow into the well during development. Sand filled the bottom 2m of screen but was drilled out and replaced by a gravel/cement backfill which stopped any further sand inflow. The top of the backfill lies at 23.7m; thus, the effective screen length is 10.6m.

7. WELL DEVELOPMENT

Air jetting was carried out for 1.9 hours before sand started flowing into the well. After the emplacement of a gravel and cement backfill further air jetting was carried out for 2.3 hours. Some foam was added down the drill pipes during both development phases.

8. PUMPING TESTS

BOREHOLE NR: GWR-0/2

A 2.1 hour long airlift test was carried out after the completion of well development. The discharge was 1.0 m^3/h (+/- 6%) and the drawdown about 5.0m (SWL 6.77m gl), indicating a specific capacity of 0.2 $m^3/h/m$ and a Logan transmissivity of 5.9 m^2/day.

9. WATER QUALITY

The results of analyses by a Hach DR-EL/4 portable laboratory are summarised below:

Ca^{++}	0.64	meq/L
Mg^{++}	0.18	"
$SO_4^{=}$	0.19	"
CL^{-}	0.79	"
EC	200	u.S/cm (temperature compensated)
T_Q	19°C	
pH	9.46	
Total iron	0.05	mg/L
$NO_3^{=}$	11	"

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps the lower part of the Basement weathered zone consisting mostly of sandstone (decomposed gneiss). It was tested by airlift at a discharge of 1.0 m^3/h, and is thus easily able to satisfy the requirement of 0.05 m^3/h. Its specific capacity was determined as 0.2 $m^3/h/m$ drawdown, indicating a Logan transmissivity of 5.9 m^2/day and permeability of 0.56 m/day (effective screen length 10.6m). Water quality is good, with an EC of 200 u.S/cm.

GWR/HG-01

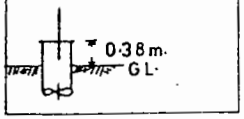
BOREHOLE NR:GWR-0/2

GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199. MANDO ROAD, KADUNA.

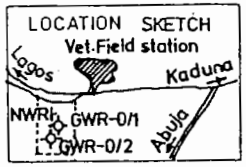
LOG COMPILED BY: R.S.Jackson

PROJECT	: -
LOCATION	: National Water Resources Institute
LONGITUDE	: 07°25'18"E LATITUDE : 10°34'55" N
DRILLING PERIOD	: 24/5/85 ELEV. GL : 625 m.

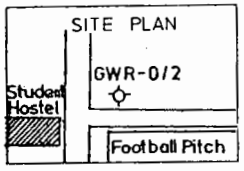
WELL-HEAD CONFIGURATION



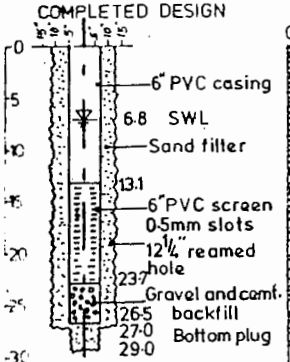
LOCATION SKETCH



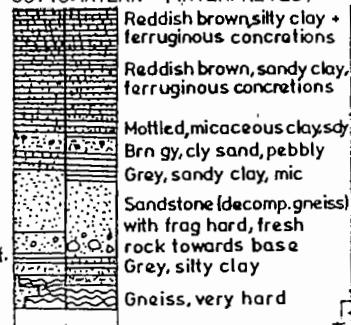
SITE PLAN



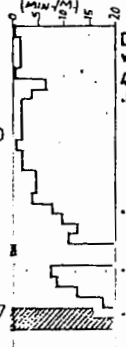
COMPLETED DESIGN



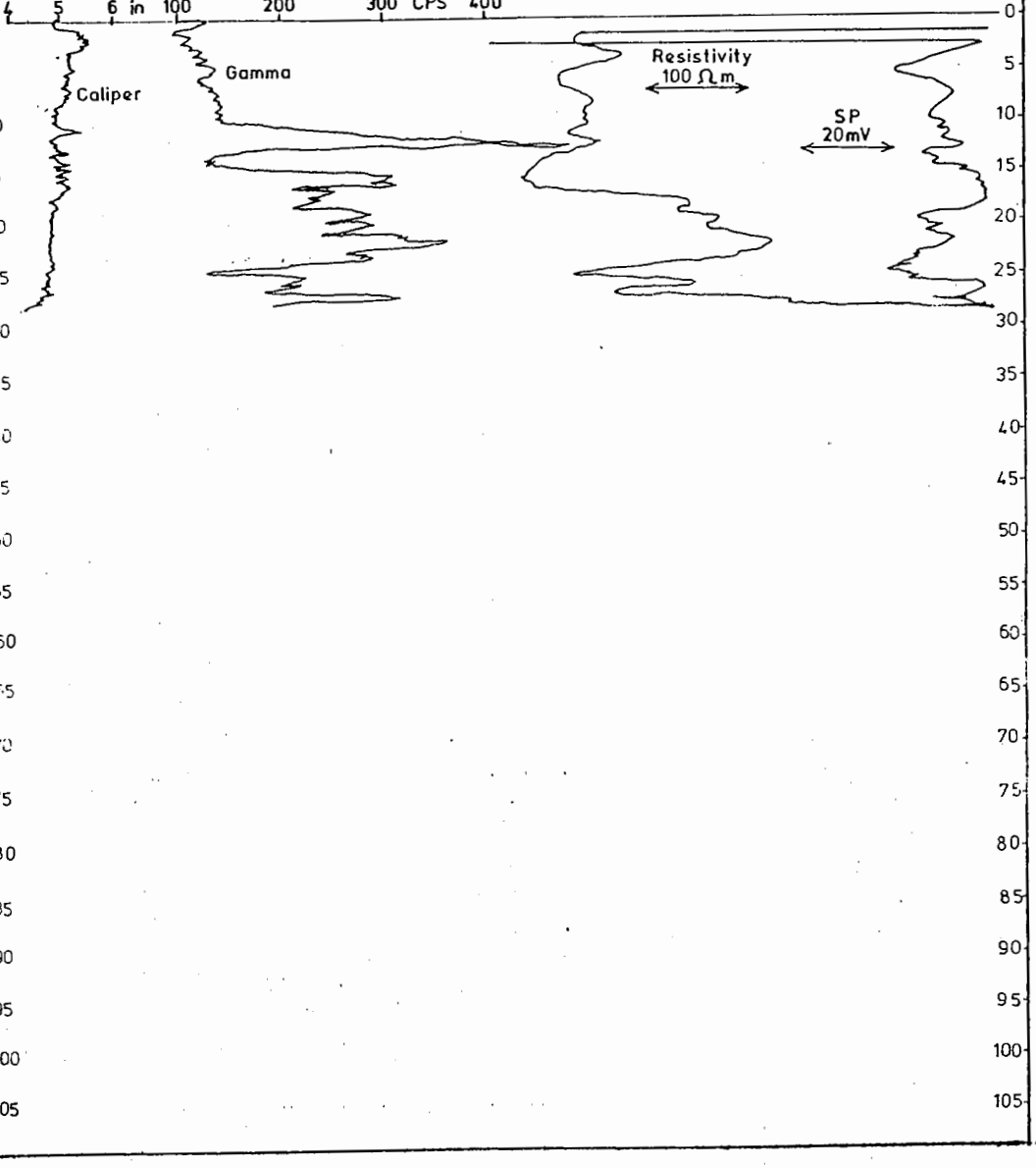
GRAPHIC LOG LITHOLOGY CUTTG. INTERP. (INTERPRETED)



FMT PENETRATION DRILLING DATA



CALIPER NATURAL GAMMA SELF POTENTIAL - POINT RESISTIVITY



COMPLETION REPORT-BOREHOLE NR.GWR-1/1

1. GENERAL/SUMMARY

Research Project	: Experimental Catchment Area		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Zaria	River Basin	:
Location	: 1.6km NE of Nagijmbe Hill, near Buruku		
Map Sheet Nr.	: 123	Sector	: SE
Longitude	: 07° 16' 21" E	Latitude	: 10° 38' 27" N
Rig	: Halco V866	Rig on site	: 4 - 19/2/85
Depth drilled	: 102.0m	Drilling method	: Mudflush 0-19m DHH 19-102m
Screen installed	: None		
Reference Point	: Ground level	Open hole	: 18.0 - 102.0m
Elevation Ref. Pt.	: 575.1m	Source elev. data	: National bench-marks
SWL (date)	: 1.90m (18/2/85)	EC (date)	: 410 u.S/cm (19/2/85)

2. OBJECTIVES

The original objective was to investigate the hydrogeological properties of the alluvial/weathered basement zone. This was later changed to testing the fresh Basement beneath since it was felt that the first borehole in the catchment area study should be the deepest and penetrate all the formations of interest before deciding on the roles for subsequent boreholes.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-1/1

Nr.	Operation(s)	Date
1	Drilled with 5⅛" drag bit by airflush to 12.7m after installing 3m of 6" conductor casing. Drilling could not continue because of inflow of sand encountered below 5m and instability of hole. Hole abandoned (designated GWR-1/1X) and rig moved 6m to N to start new hole (GWR-1/1)	4/2/85
2	Drilled with 5⅞" drag bit by mudflush to 16.9m after installing 1.5m of 8" conductor casing	5 - 6/2
3	Drilled with 4⅛" tricone rock bit by mudflush from 16.9 to 18m	6/2
4	Drilled with 7⅞" tricone rock bit by mudflush from 18 to 19m	7/2
5	Geophysical logging (E log, gamma and caliper)	8/2
6	Installed 6" steel casing to 18.0m	8, 11/2
7	Drilled with 5⅞" DHH bit from 19 to 102m; foam frequently used since there was not enough water in the formation to clean the hole of cuttings	11 - 15/2
8	Geophysical logging (E log, gamma and caliper). E log not effective since water level was at 79.7m (still recovering from drilling operation)	15/2
9	Geophysical logging (E log only); water level fully recovered (1.90m)	18/2
10	Sampling test by airlift	19/2

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Alluvium 0 - 9.8m (9.8m)				
0	1	1	Brown, silty clay, with small dark brown ferruginous concretions	
1	3	2	Mottled brown and grey, micaceous, silty clay, with sporadic, small dark brown ferruginous concretions	
3	6.3	3.3	As above, but with sporadic stalks of vegetation matter	
6.3	9.8	3.5	Sand and gravel, angular to sub-angular, micaceous, containing zones of vegetation matter	Aquifer
Weathered Basement Complex 9.8 - 16.0m (6.2m)				
9.8	16.0	6.2	Greenish black, micaceous, clayey silt containing gravels and pebbles	Poor aquifer
Fresh Basement Complex 16.0 - 102.0m (86.0m)				
16.0	63	47	Banded gneiss, abundant dark coloured minerals	Resistivity log indicates lows at 24.0, 50.1 and 58.0m; these may represent cracks containing water
63	84	21	Quartzite, largely rose-coloured, probably also occuring with gneiss, abundance of light-coloured minerals	Resistivity low occurs at 73.9m
84	102 (TD)	18	Banded gneiss, abundant dark coloured minerals	Resistivity low occurs at 95.7m

5. SAMPLING /AIRLIFT TESTS DURING DRILLING

None

6. WELL DESIGN

6 inch diameter steel casing installed to 18.0m well below the top of the fresh Basement Complex. The casing fits tightly into the hole and it was not considered necessary to cement the casing in. The hole is open below the casing and taps 84 metres of the fresh Basement Complex.

7. WELL DEVELOPMENT

The well was airlifted for about one hour to clean the hole and collect a water sample. Eductor pipe and airline were installed to about 87m. Discharging water was slightly foamy, otherwise clean. Discharge was very low, estimated at 0.6 m^3/h.

8 . PUMPING TESTS

BOREHOLE NR: GWR-1/1

None

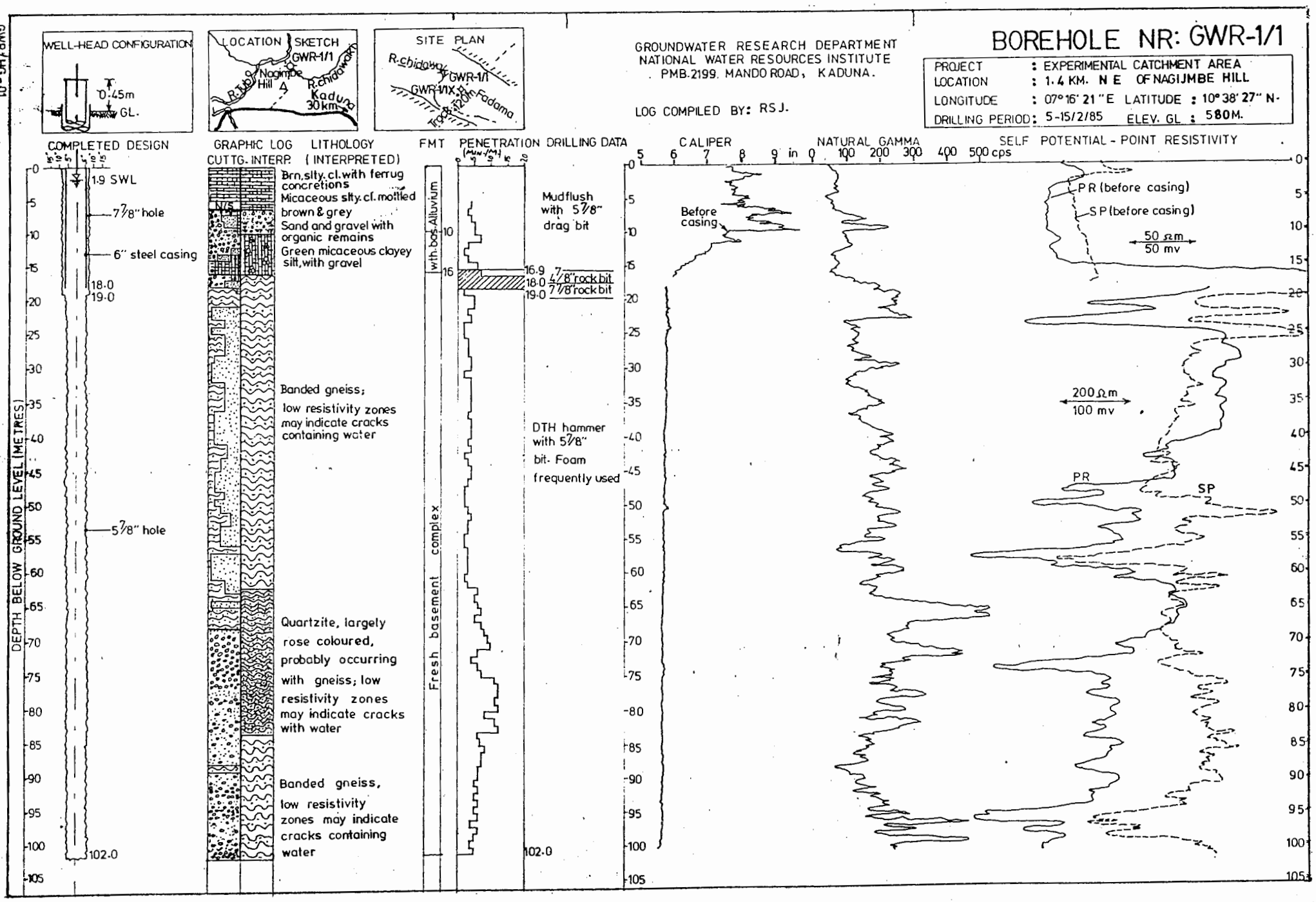
9. WATER QUALITY

The following tests were carried out with a Hach DR-EL/4 portable laboratory:-

EC	410 u.S/cm	(compensated for temperature)
Iron	0.16	mg/L
Copper	0.07	"
Sulphate	5.3	" (0.1 mec/L)
CO_2	19	"
H_2S	Nil	

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps the fresh Basement Complex, which is virtually impermeable. It is recommended that water level monitoring, which began on 4 March, continues.


WELL-HEAD CONFIGURATION
0.45m
GL.
LOCATION SKETCH
GWR-1/1
Nagimbe Hill
R.Chidawak
Kaduna 30km
SITE PLAN
R.Chidawak
GWR-1/1
GWR-1/1X
120m
Fadama
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199, MANDO ROAD, KADUNA.
LOG COMPILED BY: RSJ.
BOREHOLE NR: GWR-1/1
PROJECT : EXPERIMENTAL CATCHMENT AREA
LOCATION : 1.4 KM. N E OF NAGIJMBE HILL
LONGITUDE : 07°16' 21 "E LATITUDE : 10°38' 27" N.
DRILLING PERIOD: 5-15/2/85 ELEV. GL : 580M.
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY CUTTG. INTERP. (INTERPRETED)
FMT PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
DEPTH BELOW GROUND LEVEL (METRES)
1.9 SWL
7⅞" hole
6" steel casing
18.0
19.0
5⅞" hole
102.0
Brn.silty.cl.with ferrug concretions
Micaceous slty.cl.mottled brown & grey
Sand and gravel with organic remains
Green micaceous clayey silt,with gravel
Banded gneiss; low resistivity zones may indicate cracks containing water
Quartzite, largely rose coloured, probably occurring with gneiss; low resistivity zones may indicate cracks with water
Banded gneiss, low resistivity zones may indicate cracks containing water
wth.bas.Alluvium
Fresh basement complex
Mudflush with 5⅞" drag bit
16.9 7⅞" rock bit
18.0 4⅞" rock bit
19.0 7⅞" rock bit
DTH hammer with 5⅞" bit. Foam frequently used
102.0
Before casing
PR (before casing)
SP (before casing)
50 Ωm
50 mv
200 Ωm
100 mv
PR
SP

COMPLETION REPORT-BOREHOLE NR.GWR-1/2

1. GENERAL/SUMMARY

Research Project	: Experimental Catchment Area		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Zaria	River Basin	:
Location	: 1.6 km NE of Nagijmbe Hill, near Buruku		
Map Sheel Nr.	: 123	Sector	: SE
Longitude	: 07° 16' 21" E	Latitude	: 10° 38' 27" N
Rig	: Halco V866.	Rig on site	: 20/2 - 5/3/85
Depth drilled	: 15.0m	Drilling method	: Water flush
Screen installed	: 6.8 - 13.9m		
Reference Point	: Ground level	Open hole	: Nil
Elevation Ref. Pt.	: 574.8m	Source elev. data	: National bench-marks
SWL (date)	: 1.70m (4/3/85)	EC (date)	: 140 u.S/cm (1/3/85)

2. OBJECTIVES

The objective of the borehole was to test the alluvium / weathered Basement aquifer.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-1/2

Nr.	Operation(s)	Date
1	Installed 1.5m of 14" conductor casing	20/2/85
2	Drilled with 12¼" drag bit to 13m by water flush, 10" steel casing followed drilling	20 - 21/2
3	Drilled with 9⅞" tricone bit from 13 to 15m, 10" steel casing installed to 13.7m	21/2
4	Installed 6" PVC casing and screen, and gravel pack, and pulled out 10" steel casing	28/2
5	Well development by airlifting with drill pipe for 2 hours, and by pumping with eductor/air pipes for 1½ hours	1/3
6	Pumping test by airlift	4/3

4. LITHOLOGY AND AQUIFERS

BOREHOLE NR: GWR-1/2

Depth (m) From	Depth (m) To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Alluvium 0 - 10m (10m)				
0	5	5	Brown, grading down to greyish brown, silty clay with ferruginous concretions and plant remains	
5	10	5	Wood and plant remains, with greyish brown and brown sand	Aquifer
Weathered Basement 10 - 15m (5m)				
10	12.5	2.5	Greyish brown, medium coarse sand, micaceous with possibly some pyrite	Aquifer
12.5	15 (TD)	2.5	Light brown sandstone, abundant mica and pyrite	Aquifer

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

None

6. WELL DESIGN

A particle size analysis was carried out on a sand sample from 11.3m; the composition was 15% fine sand and silt, 45% medium sand and 40% coarse sand; D_{10} = 0.21mm, D_{50} = 0.45mm, D_{60} = 0.50mm and UC = 2.38. The most suitable gravel pack composition would have been 60% gravel (2-4mm) and 40% coarse sand (0.5 - 2.0mm) with a 1.0mm screen slot size. However, such a composition could not be found locally, and a pebble - sized pack had to be used instead.

7. WELL DEVELOPMENT

The well was developed by airlift surging with the drill pipes for about 2 hours. The airlift pipes were then installed and the well pumped for about 1½ hours. The discharging water was initially slightly cloudy, with negligable sand, but became discoloured after about one hour pumping. SWL was 2.00m (below toc), and DWL 5.15m (s = 3.15m). Q was measured by timing the filling up of a 219 litre drum - 6.7 m^3/h.

8. PUMPING TESTS

The results of a short pumping test by airlift on 4/3/85 are given below:

Type of test	(1) SWL (m)	(1) DWL (m)	s (m)	Q (m^3/h)	Duration (min)	T (m^2/day)	Method
Constant discharge	2.02	(2) 5.72	(2) 3.70	7.4 (± 16%)	240	34 59	Jacob Logan
Recovery	-	-	-	-	120	29	Theis recovery

Notes: (1) below top casing, height above ground level 0.32m

(2) extrapolated to t = 240 min.

Normally Logan is an underestimate of T since well losses are included in the drawdown component. However, drawdown was fluctuating in the second half of the test, reaching a maximum of 4.7m, so not much credence can be given to Logan in this case. There is fairly close agreement between Jacob T and Theis Recovery T; if T is assumed to be 30 m^2/day, a permeability of about 4 m/day is indicated.

9. WATER QUALITY

Results of analyses carried out by a Hach DR-EL/4 portable laboratory during the well development pumping on 1/3/85 are given below:

Ca^{++}	24.4	mg/L	1.22	meq/L	) Colour did not change to blue;
Mg^{++}	2.19	"	0.18	"	) end point taken when colour changed
Cl^{-}	92	"	2.59	"	) from pink to colourless.
CO_2	25	"	)		
H_2S	nil		) affected by airlift action.		

The water sample was colourless when collected but turned greenish yellow with storage. This may be indicative of a significant iron content, with the ferric state precipitating in respone to changes in pH and Eh. Iron staining was noticed on the ground around the well casing where water had splashed during airlifting.

Further analyses, carried out on the sample on 13/3/85 gave the followinn results:

EC	140	Micromhos/cm (temperature compensated)
Iron	0.55	mg/L
Copper	0.14	mg/L

10. CONCLUSIONS AND RECOMENDATIONS

The well taps part of the thin alluvium and weathered basement aquifer occupying the fadama; the aquifer consisting of medium-coarse sand, sandstone and wood remains. The aquifer permeability is estimated to be about 4 m/day from the results of a short airlift test, but this needs to be verified by longer and more accurate pumping tests once the proper equipment is available. The water appears to have a significant iron content.

The well is able to produce about 180 m^3/day or 2.1 l/s, sufficient to irrigate about 2 ha of dryfoot crops. However, further tests are required on the water quality (once the equipment is available) to determine the suitability of the water for irrigation.

GWR/HG-01

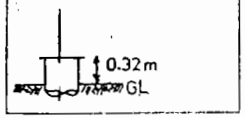
BOREHOLE NR: GWR-1/2

GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB. 2199. MANDO ROAD, KADUNA.

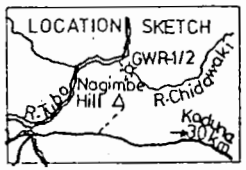
LOG COMPILED BY: R.S.J.

PROJECT	: Experimental Catchment Area		
LOCATION	: 1.4Km NE of Nagijmba Hill		
LONGITUDE	:7°16'21" E	LATITUDE	: 10°38'27" N
DRILLING PERIOD	: 20-21/2/85	ELEV. GL	: 580 M.

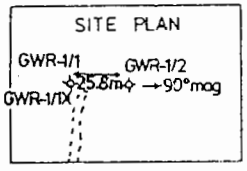
WELL-HEAD CONFIGURATION



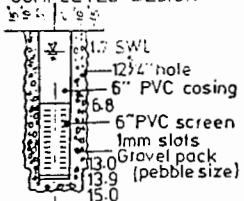
LOCATION SKETCH



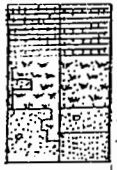
SITE PLAN



COMPLETED DESIGN



GRAPHIC LOG CUTTG. INTERP. LITHOLOGY (INTERPRETED)



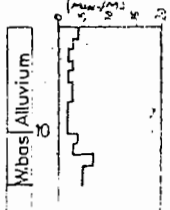
Brn. to greyish brn. silty clay + ferrug concret & plant remains

Wood & plant remains with some sand

Gysh. brn. sd, micaceous

Brn. sandstone, micaceous

FMT



PENETRATION DRILLING DATA

12¼" drag bit water flush

11.5 water loss

13.7

9⅞" tricone bit 10" steel casing installed to 13.7 m

CALIPER

NATURAL GAMMA

SELF POTENTIAL - POINT RESISTIVITY

No logs run

DEPTH BELOW GROUND LEVEL (METRES)

COMPLETION REPORT-BOREHOLE NR.GWR-1/3

1. GENERAL/SUMMARY

Research Project	: Experimental Catchment Area		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Zaria	River Basin	:
Location	: 1.6km NE of Nagijmbe Hill, near Buruku		
Map Sheet Nr.	: 123	Sector	: SE
Longitude	: 07° 16' 21" E	Latitude	: 10° 38' 27" N
Rig	: Halco V866	Rig on site	: 6/3 - 3/4/85
Depth drilled	: 40.1m	Drilling method	: DC with bentonite and Drill-Aid Custom Mud
Screen installed	: 5.3 - 11.3m 26.3 - 32.3m		
Reference Point	: Ground level	Open hole	: Nil
Elevation Ref. Pt.	: 574.1m	Source elev. data	: National bench-marks
SWL (date)	: 1.06m gL (11/4/85)	EC (date)	:

2. OBJECTIVES

The borehole was drilled to discover whether the alluvium and weathered zone thickens towards the southern edge of the fadama where the River Chidawaki occurs.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-1/3

Nr.	Operation(s)	Date
1	Drilled with 4⅛" rock bit to 8m using Drill-Aid (Custom Mud). Drilling stopped by breakdwon to variable displacement hydraulic pump on rig. Borehole abandoned, designated GWR-1/3X	7/3/85
2	Hydraulic pump repaired	9/3
3	Drilled with 4⅞" rock bit to 40.1m using bentonite and Drill-Aid Custom Mud on new site a few metres away	18-19/3
4	Geophysical logging (E log, gamma and caliper from 38m)	19/3
5	Reamed with 7⅞" rock bit to 23.6m and installed 6" PVC casing (1 x 6m length) and screen (3 x 6m lengths). However, well design changed following inspection of geophysical logs, and casing/screen removed	20/3
6	Handing-over ceremony EEC/FDWR - NWRI	25/3
7	Reamed with 10⅝" rock bit to 35.3m	26-27/3
8	Installed 6" PVC screen and casing	27/3
9	Well development by jetting and airlifting	27-28/3
10	Drilling equipment removed from site because of flooding from heavy rain which fell on 29 - 31/3/85	1 - 3/4

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Alluvium 0 - 8.2m (8.2m)				
0	3.4	3.4	Greyish brown and brown clay, micaceous	
3.4	4.4	1.0	Ferruginous, pebbly sand, brownish	Aquifer
4.4	4.8	0.4	Sandy clay	
4.8	6.4	1.6	Whitish, coarse sand	Aquifer
6.4	6.8	0.4	Sandy clay	
6.8	7.7	0.9	Whitish, medium-coarse sand with some vegetation remains	Aquifer
7.7	7.9	0.2	Sandy clay	
7.9	8.2	0.3	Sand	Aquifer
Weathered Basement 8.2 - 28.0m (19.8m)				
8.2	8.7	0.5	Micaceous clay	Weathered basement probably acts as an aquitard
8.7	9.6	0.9	Sandstone, with significant feldspars	
9.6	18.9	9.3	Brownish, clayey sandstone, ferruginous and feldspathic	
18.9	19.5	0.6	Loose sandstone, poorly cemented	
19.5	25.5	6.0	Sandy and gravelly clay or shale, brownish and greyish	
25.5	28.0	2.5	Black gneiss, with green clay inclusions (weathering products)	
Fresh Basement 28.0 - 40.1m (12.1m)				
28.0	29.7	1.7	Black gneiss	
29.7	33.9	4.2	Hard gneiss, feldspathic, possibly fractured	Low resistivity may indicate water occurrence
33.9	40.1 (TD)	6.2	Gneiss	

None

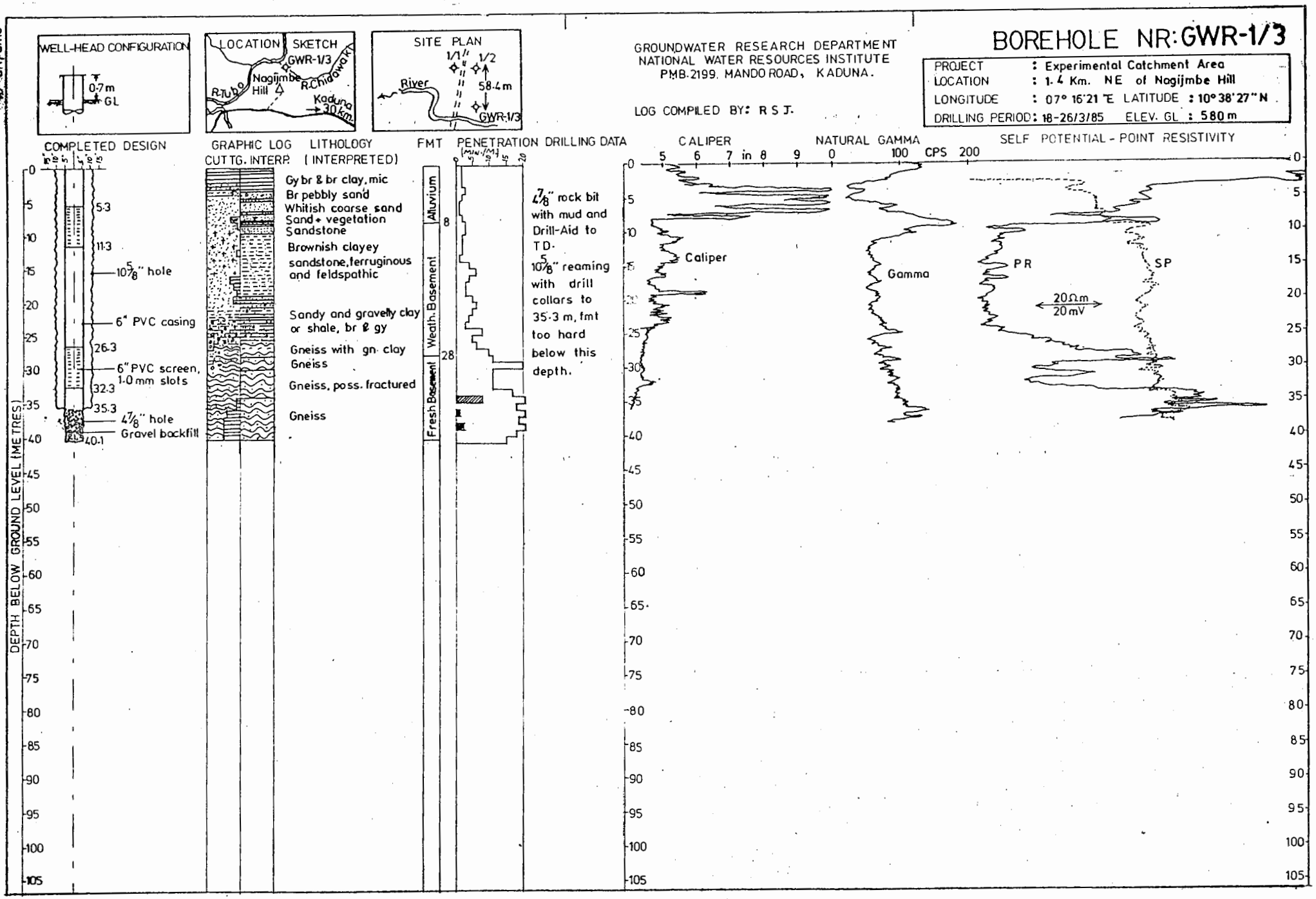
6. WELL DESIGN

Particle size analyses were carried out on sand samples from 5-7m and 8-11m, although the latter sample is considered unrepresentative of the formation since it consists of cavings. The sample from 5-7m consisted of about 80% coarse sand with D_{10} = 0.45mm, D_{50} = 0.74mm, D_{60} = 0.83mm anc UC = 1.8.

It was decided to install 6" PVC casing and screen without a gravel pack. Screen (1.0 mm slots) was installed at 5.3 - 11.3 m and 26.3 - 32.3 m. No plug was placed at the bottom of the casing - instead gravel was poured down the casing to backfill the hole below and effect a seal.

7. WELL DEVELOPMENT

Well development consisted of 12 min jetting and 3½ hours airlifting. The water became clear and the discharge increased during airlifting. Unfortunately, further development could not be carried out because of the heavy rain which fell on 29 - 31/3/85 and the subsequent flooding of the site.


WELL-HEAD CONFIGURATION
0.7m
GL
LOCATION SKETCH
GWR-1/3
Nagijmbe Hill
R.Tubo
R.Chiadawaki
Kaduna 30km
SITE PLAN
1/1
1/2
58.4m
River
GWR-1/3
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: R S J.
BOREHOLE NR: GWR-1/3
PROJECT : Experimental Catchment Area
LOCATION : 1.4 Km. NE of Nagijmbe Hill
LONGITUDE : 07° 16'21 "E LATITUDE : 10° 38'27 "N
DRILLING PERIOD: 18-26/3/85 ELEV. GL : 580 m
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY CUTTG. INTERP. (INTERPRETED)
FMT PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
5.3
11.3
10 5/8" hole
6" PVC casing
26.3
6" PVC screen, 1.0 mm slots
32.3
35.3
4 7/8" hole
Gravel backfill
40.1
Gy br & br clay, mic
Br pebbly sand
Whitish coarse sand
Sand + vegetation
Sandstone
Brownish clayey sandstone, ferruginous and feldspathic
Sandy and gravelly clay or shale, br & gy
Gneiss with gn. clay
Gneiss
Gneiss, poss. fractured
Gneiss
Alluvium
Weath. Basement
Fresh Basement
8
28
4 7/8" rock bit with mud and Drill-Aid to T.D.
10 5/8" reaming with drill collars to 35.3 m, fmt too hard below this depth.
Caliper
Gamma
PR
SP
20Ωm
20mV
DEPTH BELOW GROUND LEVEL (METRES)

COMPLETION REPORT-BOREHOLE NR.GWR-2/1

1. GENERAL/SUMMARY

Research Project	:		
State	: Kaduna	National Data Bank Nr.	:
Local Govt. Area	: Jema'a	River Basin	:
Location	: Government Girls Secondary School, Kwoi		
Map Sheet Nr.	: 188	Sector	: NW
Longitude	: 08° 00' 16" E	Latitude	: 09° 26' 46" N
Rig	: Halco V866	Rig on site	: 12/6-15/7/85
Depth drilled	: 61.3m	Drilling method	: 0-7m water flush 7-61m DHH
Screen installed	: None		
Reference Point	: Ground Level	Open hole	: 13.1 - 61.3m
Elevation Ref. Pt.	: 777m	Source elev. data	: 1:50 000 map
SWL (date)	: 10.05m gL (3/7/85)	EC (date)	: 95 u.S/cm (3/7/85)

2. OBJECTIVES

To provide an additional water source for the school.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-2/1

Nr.	Operation(s)	Date
1	Drilled with $4\frac{3}{4}$" tricone bit to 7m by direct circulation water flush. Encountered hard rock (boulder)	13/6/85
2	Drilled with $5\frac{7}{8}$" DHH from 7 to 19m, foam added at intervals	14/6
3	Geophysical logging from 16m (E-log, gamma, and caliper)	"
4	Reamed with $12\frac{1}{4}$" tricone bit to boulder at 6m	17/6
5	Reamed with $9\frac{5}{8}$" DHH from 6 to 13m. Boulder deflected drill string	"
6	Reamed with $12\frac{1}{4}$" tricone bit to 6.2m, no further penetration possible	19/6
7	Installed 10" steel casing to boulder at 6m	20/6
8	Reamed with $9\frac{5}{8}$" tricone to 12.4m, no further penetration possible. Casing withdrawn	"
9	Installed 8" steel casing but only 6.6m, could be reached. Casing withdrawn	22/6
10	Reamed again with $9\frac{5}{8}$" tricone bit but only 11.7m could be reached. Installed 8" casing but it would not go beyond 7m	24/6
11	Attempted to drill with 8" casing but only 10m could be reached. Withdrew casing	25 - 26/6
12	Installed 6" steel casing to 13.1m	26/6
13	Drilled with $5\frac{7}{8}$" DHH from 19 to 61.3m	26 - 28/6
14	Geophysical logging from 60m (E-log, gamma, and caliper)	29/6
15	Well development / cleaning by airlift	1/7
16	Pumping tests	2 - 3/7

Depth (m) From	Depth (m) To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 5.4m (5.4m)				
0	5.4	5.4	Reddish brown, sandy clay with some fragments of decomposed rock and quartz	
Weathered Basement 5.4 - 11.4m (6.0m)				
5.4	7.0	1.6	Boulder of hard granite	
7.0	11.4	4.4	Brown, grey, micaceous, sandy clay	WL 10.05m gL
Fresh Basement 11.4 - 61.3m (49.9m)				
11.4	61.3 (TD)	49.9	Hard granite. Fracture at 13.4 - 14.0m, and cracks at 16.8, 20.4, 24.8 - 26.0, 32.8, 35.4 - 36.0, 38.8m and below 42.0m	Virtually impermeable but some water in fracture and cracks, particularly between 32 and 38m

None

6. WELL DESIGN

Many attempts were made to install steel casing past the boulder at 5.4 - 7.0m, starting with 10" size and finally succeeding with 6" size. The flush- jointed casing was landed at 13.1m, just below the top of the fresh Basement. The hole is open below (length of open hole = 48.2m).

7. WELL DEVELOPMENT

The borehole was cleaned out by airlift surging and pumping for one working day. The water became clear and free of any sediment.

8. PUMPING TESTS

BOREHOLE NR: GWR-2/1

The borehole was tested on 3/7/85 by the P631CE Monolift pump, installed to 50m. Discharge was measured by timing the filling up of 25 litre buckets, and water level by an Ott KL 50 electric contact gauge. Test data and results are summarised below:

Type of test	SWL (m) (1)	DWL (m) (1)	s (m)	Q (m^3/h)	Duration (min)	T (m^2/day)	Method
Constant water level	10.55	43 (2)	32 (2)	0.56 (2) (± 34%)	330	0.5	Logan
Recovery	-	-	-	-	450	0.1	Theis recovery

Notes: (1) below top of casing (0.50m)

(2) representative of last 4½ hours pumping

During the pumping test the discharge was adjusted in an attempt to maintain the water level a few metres above the pump. Because of the extremely low permeability of the rock, the water level was very sensitive to even the smallest adjustment of discharge and fluctuated within an 8m range (28 to 36m drawdown) throughout most of the test.

The representative values of discharge and drawdown indicate a specific capacity of about 0.02 m^3/h/m.

9. WATER QUALITY

BOREHOLE NR: GWR-2/1

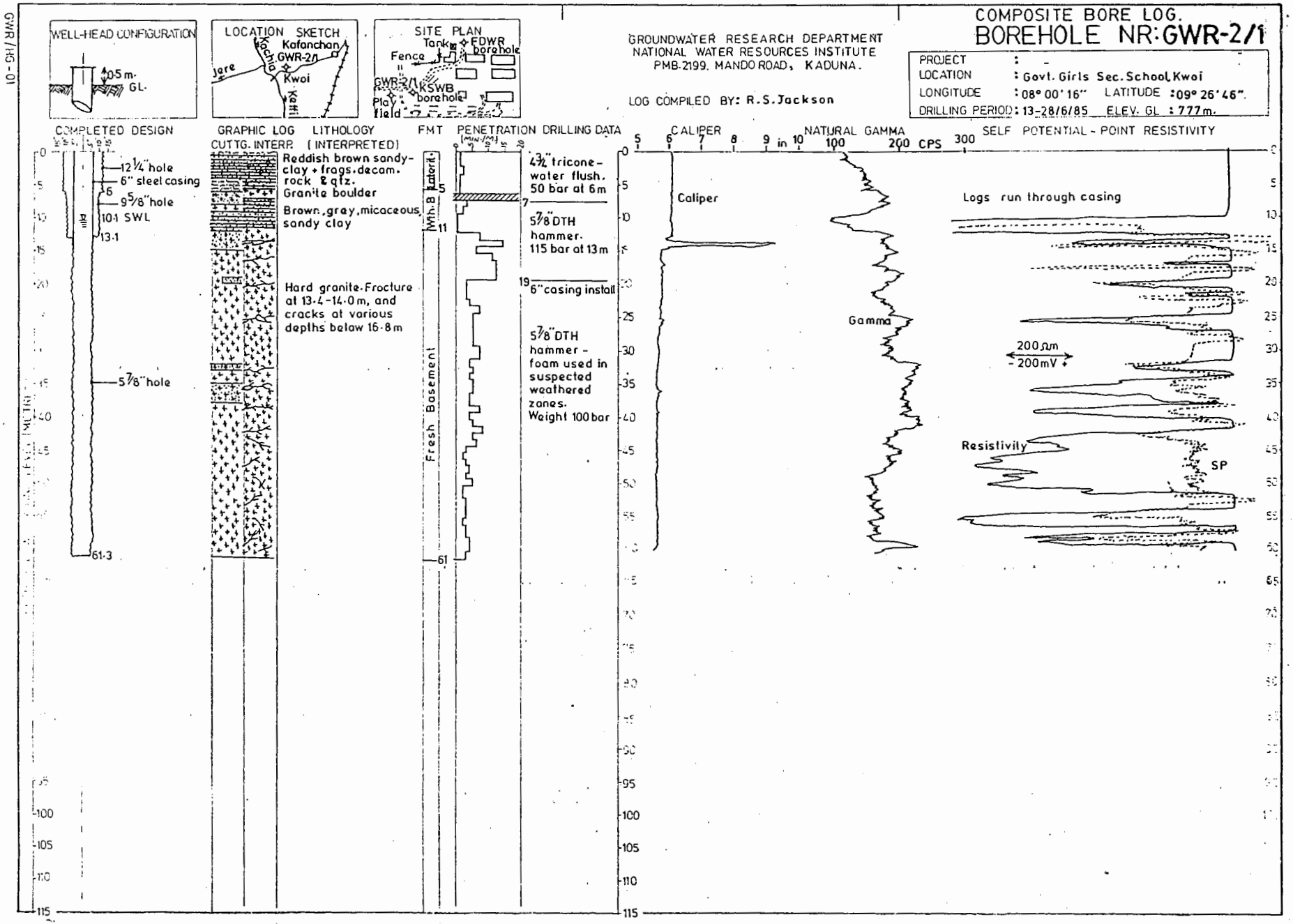
Results of chemical analyses carried out with a Hach DR-EL/4 portable laboratory on samples collected during the pumping test are given below:

Ca^{++}	0.10	meq/L
Mg^{++}	0.48	"
$SO_4^{=}$	0.84	"
CL^{-}	0.11	"
EC	95	u.S/cm (temperature compensated)
T_Q	20°C	
pH	6.25	
SiO_2	32	mg/L
Fe total	0.35	"
NO_4^{-}	18	"
F^{-}	trace	

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps the fresh Basement (granite), which only contains water in small fractures and cracks. The water producing capacity is too low for the efficient operation of a mechanically - driven pump. However, the water quality is excellent for drinking purposes and it is recommended that a hand-pump be installed to serve the needs of the nearby houses and school buildings.

The static water level is 10.1m below ground surface. It is understood that hand-pumps are available in Kaduna for installation to depths of up to 40m (the depth of the borehole is 61.3m).


WELL-HEAD CONFIGURATION
+0.5 m.
GL.
LOCATION SKETCH
Kafanchan
Kacha
GWR-2/1
Jere
Kwoi
Keffi
SITE PLAN
Tank
EDWR borehole
Fence
GWR-2/1
KSWB borehole
Play field
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199, MANDO ROAD, KADUNA.
LOG COMPILED BY: R.S.Jackson
COMPOSITE BORE LOG.
BOREHOLE NR: GWR-2/1
PROJECT : -
LOCATION : Govt. Girls Sec. School, Kwoi
LONGITUDE : 08° 00' 16" LATITUDE : 09° 26' 46".
DRILLING PERIOD: 13-28/6/85 ELEV. GL : 777m.
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY
CUTTG. INTERP. (INTERPRETED)
FMT
PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
12¼" hole
6" steel casing
5
9⅝" hole
10.1 SWL
13.1
5⅞" hole
61.3
Reddish brown sandy-clay + frags. decam. rock & qtz. Granite boulder
Brown, gray, micaceous sandy clay
Hard granite. Fracture at 13.4-14.0m, and cracks at various depths below 16.8m
Mth. B Laterite
Fresh Basement
5
11
61
4¾" tricone-water flush. 50 bar at 6m
7
5⅞" DTH hammer. 115 bar at 13m
19
6" casing install
5⅞" DTH hammer - foam used in suspected weathered zones. Weight 100 bar
Caliper
Gamma
Logs run through casing
200 Ωm
-200 mV
Resistivity
SP

COMPLETION REPORT-BOREHOLE NR.GWR-3/1

1. GENERAL/SUMMARY

Research Project	:		
State	: Plateau	National Data Bank Nr.	:
Local Govt. Area	: Nassarawa	River Basin	:
Location	: Mar Farms, 9.1 km. north of Nassarawa		
Map Sheet Nr.	:	Sector	:
Longitude	: 07°43' E	Latitude	: 08° 34' N
Rig	: Halco V866	Rig on site	: 15 - 24/7/85
Depth drilled	: 43.5m	Drilling method	: 0-29m water flush 29-43m DHH
Screen installed	: 6.0 - 30m		
Reference Point	:	Open hole	: 30 - 43.5m
Elevation Ref. Pt.	:	Source elev. data	:
SWL (date)	: 3.28 m gL (22/7/85)	EC (date)	: 400 u.S/cm (22/7/85)

2. OBJECTIVES

The borehole was drilled to supply water for the houses on the farm.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-3/1

Nr.	Operation(s)	Date
1	Drilled with 4¾" tricone bit by water flush to 18m (0.5m 6" steel casing installed as conductor)	15 -16/7/85
2	Geophysical logging from 17m (E - log, gamma and caliper)	16/7
3	Reamed with 9⅝" tricone bit to 14.5m (start of hard rock) and installed 15m of 8" steel casing (flush-jointed)	"
4	Reamed with 7⅞" tricone bit from 14.5 to 18m, and drilled on to 29m	17/7
5	Drilled with 7" DHH from 29 to 43.5m	"
6	Plug, consisting of sack containing sawdust, inserted to 15m and 6" PVC casing and screen, with rubber packer on bottom, landed on top. Steel casing withdrawn and annular space filled with gravel. Unfortunately, after drilling through the plug gravel found its way into the hole below the screen. The casing and screen were removed and the drill string inserted to flush out the accumulated gravel. 8" steel casing again inserted to 14.5m	18 - 19/7
7	Geophysical logging from 42m (E - log, gamma and caliper)	19/7
8	6" PVC casing and screen inserted to 30m with rubber pack at base to make a tight fit with the 7" hole. Steel casing removed and gravel inserted into annular space	20/7
9	Well development by airlift jetting for 1½ hours. Borehole depth checked after development - no accumulated sediment	"
10	Pumping tests and field chemical analysis	22 - 24/7

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 5m			(5m)	
0	1.5	1.5	Reddish brown laterite	
1.5	2.5	1.0	Reddish sand, loosely cemented	
2.5	5	2.5	Reddish brown, lateritic sandy clay	WL 3.3m gL
Weathered Basament 5 -			14.9m (9.9m)	
5	13.0	8	Grey and brown sandy clay	Aquifer consists largely of weathered Basement, with maybe some contribution from the upper part of the fresh rock However, permeability is likely to be very low
13.0	14.4	1.4	Dark coloured weathered rock	
14.4	14.9	0.5	Weathered product, probably clayey sand	
Fresh Basement		14.9 - 43.5m (28.6m)		
14.9	43.5 (TD)	28.6	Dark coloured rock, probably granodiorite. Fractured/broken 14.9 - 17.0m. Possible cracks at 18.8 and 30.5 - 30.8m	

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

BOREHOLE NR: GWR-3/1

NONE

6. WELL DESIGN

6" PVC string, consisting of 1 x 6m length casing and 4 x 6m lengths screen (1.0 mm slots), installed to 30m. Rubber packer placed around screen base to ensure a tight fit in the 7" hole. Screen open at base. Gravel filter installed in annular space. Hole is open below screen (from 30 to 43.5 m).

7. WELL DEVELOPMENT

Airlift jetting for 1½ hours down to 30m. Borehole plumbed after development, and depth found to equal that drilled.

8 , PUMPING TESTS

BOREHOLE NR: GWR-3/1

The borehole was tested from 22 to 24/7/85 by the P 631 CE Monolift pump, installed to 31.5m. Discharge was measured by timing the filling up of a 25 litre bucket, and water level by an Ott KL 50 electric contact gauge.

Test data and results are summarised below:

Test Nr.	SWL (1) (m)	DWL (1) (m)	$\bar{s}$ (m)	$Q^{(2)}$ (m^3/h)	Duration (min)	T (m^2/day)	Method
1	3.28	11.41	8.13	0.89	80	3.2	Logan
						3.3?	Jacob
Recovery		-	-	-	160	0.9	Theis recovery
2		24.10	20.82	1.64	77	2.1	Logan
						0.5?	Jacob
Recovery		-	-	-	140	0.8?	Theis recovery
3	3.27	25.52	22.25	1.65	89	2.2	Logan
						0.4	Jacob
Recovery		-	-	-	220	0.8?	Theis recovery
4		27.65	24.38	1.22	196	1.5	Logan
Recovery		-	-	-	60	1.5?	Theis recovery

(1) below casing top at ground level

(2) weighted average.

Steady state was not approached in any of the tests - the water level fell steadily during pumping. The tests could not be run long enough to produce data plots of sufficient consistency for meaningful analysis. However, from the observations made, the transmissivity is likely to be of the order of 1.0 m^2/day.

The water was slightly discoloured / cloudy during the tests.

9. WATER QUALITY

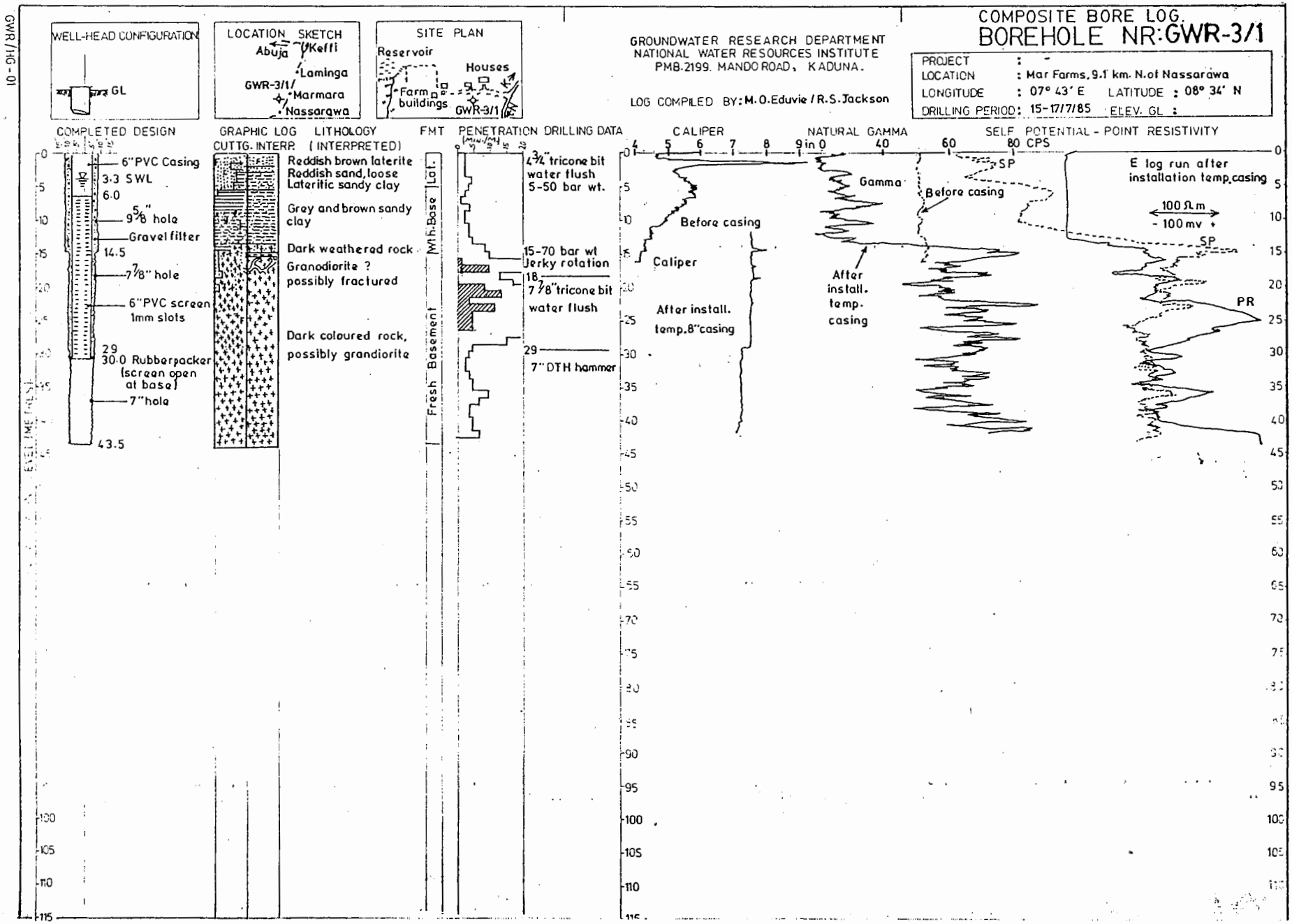
The following results were obtained from an analysis of a sample collected on 22/7/85, using a Hach DR-EL/4 portable laboratory:

Ca^{++}	3.10	meq/L
Mg^{++}	0.48	"
$SO_4^{=}$	0.31	"
CL^{-}	0.71	"
EC	400	u.S/cm (temperature compensated)
T_Q	19	^{o}C
pH	6.86	
SiO_2	32	mg/L
Fe total	0.15	"
NO_4^{-}	16.7	"
F^{-}	1.2	"

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps relatively thin weathered Basement, consisting mainly of sandy clay, and 28m of the fresh rock. Although some fractures appear to be present near the top of the rock the water producing capacity of the Basement as a whole at this site is very low.

The maximum practical yield is about 1.2 m^3/h but this will only be sustainable for 3 to 4 hours at a time depending on the pump setting. However, the volume of water produced should be sufficient to meet the daily needs of the nearby farm houses providing a suitable storage tank is provided. The water quality is good for drinking/ domestic purposes.


WELL-HEAD CONFIGURATION
GL
LOCATION SKETCH
Abuja
Keffi
Laminga
GWR-3/1/
Marmara
Nassarawa
SITE PLAN
Reservoir
Houses
Farm buildings
GWR-3/1
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB-2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: M.O.Eduvie / R.S.Jackson
COMPOSITE BORE LOG.
BOREHOLE NR: GWR-3/1
PROJECT :
LOCATION : Mar Farms, 9.1 km. N.of Nassarawa
LONGITUDE : 07° 43' E LATITUDE : 08° 34' N
DRILLING PERIOD: 15-17/7/85 ELEV. GL :
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY
CUTTG. INTERP. (INTERPRETED)
FMT
PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
ELEVATION (METRES)
6" PVC Casing
3.3 SWL
6.0
5 5/8" hole
Gravel filter
14.5
7 7/8" hole
6" PVC screen 1mm slots
29
30.0 Rubberpacker (screen open at base)
7" hole
43.5
Reddish brown laterite
Reddish sand, loose
Lateritic sandy clay
Grey and brown sandy clay
Dark weathered rock
Granodiorite ?
possibly fractured
Dark coloured rock, possibly grandiorite
Lat.
Mth.Base
Fresh Basement
4 3/4" tricone bit water flush 5-50 bar wt.
15-70 bar wt Jerky rotation
18
7 7/8" tricone bit water flush
29
7" DTH hammer
Caliper
Before casing
After install. temp.8" casing
Gamma
Before casing
After install. temp. casing
SP
E log run after installation temp.casing
100 Ω m
- 100 mv +
SP
PR

COMPLETION REPORT-BOREHOLE NR.GWR-3/2

1. GENERAL/SUMMARY

Research Project	:		
State	: Plateau	National Data Bank Nr.	:
Local Govt. Area	: Nassarawa	River Basin	:
Location	: Mar Farms, 9.1 km north of Nassarawa		
Map Sheet Nr.	:	Sector	:
Longitude	: 07° 43' E	Latitude	: 08° 34' N
Rig	: Halco V866	Rig on site	: 24/7-9/8/85
Depth drilled	: 61.4m	Drilling method	: 0-14m water flush 14-61.4m DHH
Screen installed	: 5.3 - 14.3m		
Reference Point	:	Open hole	: 14.3 - 61.4m
Elevation Ref. Pt.	:	Source elev. data	:
SWL (date)	: 2.20m gL (2/8/85)	EC (date)	: 350 u.S/cm (2/8/85)

2. OBJECTIVES

To supply irrigation water for the farm.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-3/2

Nr.	Operation(s)	Date
1	Drilled with $4\frac{3}{4}$" tricone bit to 14m by water flush	14/7/85
2	Geophysical logging from 13m (caliper and gamma) and 14m (E - log)	25/7
3	Reamed with $9\frac{5}{8}$" tricone bit to 13.9m	"
4	Installed 14.5m of 8" flush - jointed, steel casing to 13.8m	26/7
5	Drilled with $5\frac{7}{8}$" DHH from 13.9 to 61.4m (TD)	26 & 29/7
6	Geophysical logging from 60m (caliper, gamma and E - log). Unfortunately, no point resistivity response	30/7
7	Installed 6" PVC casing and screen to 14.5m, pulled out 8" steel casing and infilled annular space with gravel. Unfortunately, seating of PVC screen was not tight and gravel entered borehole during subsequent airlift development PVC string removed, steel casing reinstalled and gravel flushed out of borehole by water circulation After the borehole had been cleared of gravel the PVC string was reinstalled with a packer, made of sacking, at the bottom to ensure a good fit with the sides of the borehole. The steel casing was then removed and the annular space infilled with gravel	30/7 - 1/8
8	Geophysical logging from 40m (E - log only). Point resistivity responded OK	1/8
9	Well development by airlift jetting for 4 hours. No gravel entered the borehole	"
10	Pumping test and field chemical analysis	2 - 3/8

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 1.8m (1.8m)				
0	0.8	0.8	Laterite, crumbly and easily broken, reddish brown	
0.8	1.3	0.5	Reddish brown sandy clay	
1.3	1.8	0.5	Reddish brown, clayey laterite	
Weathered Basement 1.8 - 12.8m (11.0m)				
1.8	2.4	0.6	Greyish brown sand, micaceous	SWL 2.2m gL
2.4	2.8	0.4	Greyish brown clay, micaceous	
2.8	5.0	2.2	Greyish brown, micaceous sandy clay	
5.0	9.7	4.7	Dark coloured, micaceous sandy clay with fragments of quartz and Basement material	
9.7	12.8	3.1	Dark grey, clayey, micaceous sandstone (decomposed Basement) grading down to blocks of broken Basement set in clayey material	Aquifer consists of weathered Basement, with a significant contribution from the fracture zone at 38.4m in the fresh Basement
Fresh Basement 12.8 - 61.4m (48.6m)				
12.8	61.4 (TD)	48.6	Dark grey to black, laminated Basement rock (largely tabular cuttings), probably schist. Fracture zone at 38.4m	

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

BOREHOLE NR: GWR-3/2

None

6. WELL DESIGN

6" PVC casing (1 x 6m length) and screen (1 x 3m length plus 1 x 6m length) was finally installed to 14.3m. A packer, made of sacking wound round the base of the screen, ensured a tight fit with the top of the $5\frac{7}{8}$" hole. Screen slot size 1.0mm. Screen open at base. Open hole from 14.3 to 61.4m (47.1m). The filter in the annular space consists of coarse material (pebbles/cobbles) at the base and finer material above. A particle size analysis was carried out on the material above the coarse layer:

pebble 72%
gravel 15% and sand 13%
D_{10} 1.5mm, D_{50} 7.4mm, D_{60} 9.0mm, and UC 6.0

7. WELL DEVELOPMENT

Consisted of airlift jetting to 54m for 4 hours. The water became relatively clear and sediment-free.

8 , PUMPING TESTS

BOREHOLE NR: GWR-3/2

The borehole was tested from 2 to 3 August 1985 by the P 631 Monolift pump, installed to 50m. Discharge was measured by timing the filling up of a 25 litre bucket, and water level by an Ott KL 50 electric contact gauge.

Test data and results are summarised below:

Test Nr.	SWL (1) (m)	DWL (1) (m)	s (m)	$Q^{(2)}$ (m^3/h)	Duration (min)	T (m^2/day)	Method
1	2.20	34.15	31.95	1.64	1445	1.5	Logan
Recovery	-	-	-	-	600	1.3?	Theis recovery

(1) below casing top at ground level

(2) weighted average

The water level fluctuated too much during pumping for a meaningful time drawdown plot since it was very sensitive to adjustments in the discharge rate. However, approximate steady state conditions were attained and the Logan estimate of 1.5 m^2/day for transmissivity is thought to be plausible.

9. WATER QUALITY

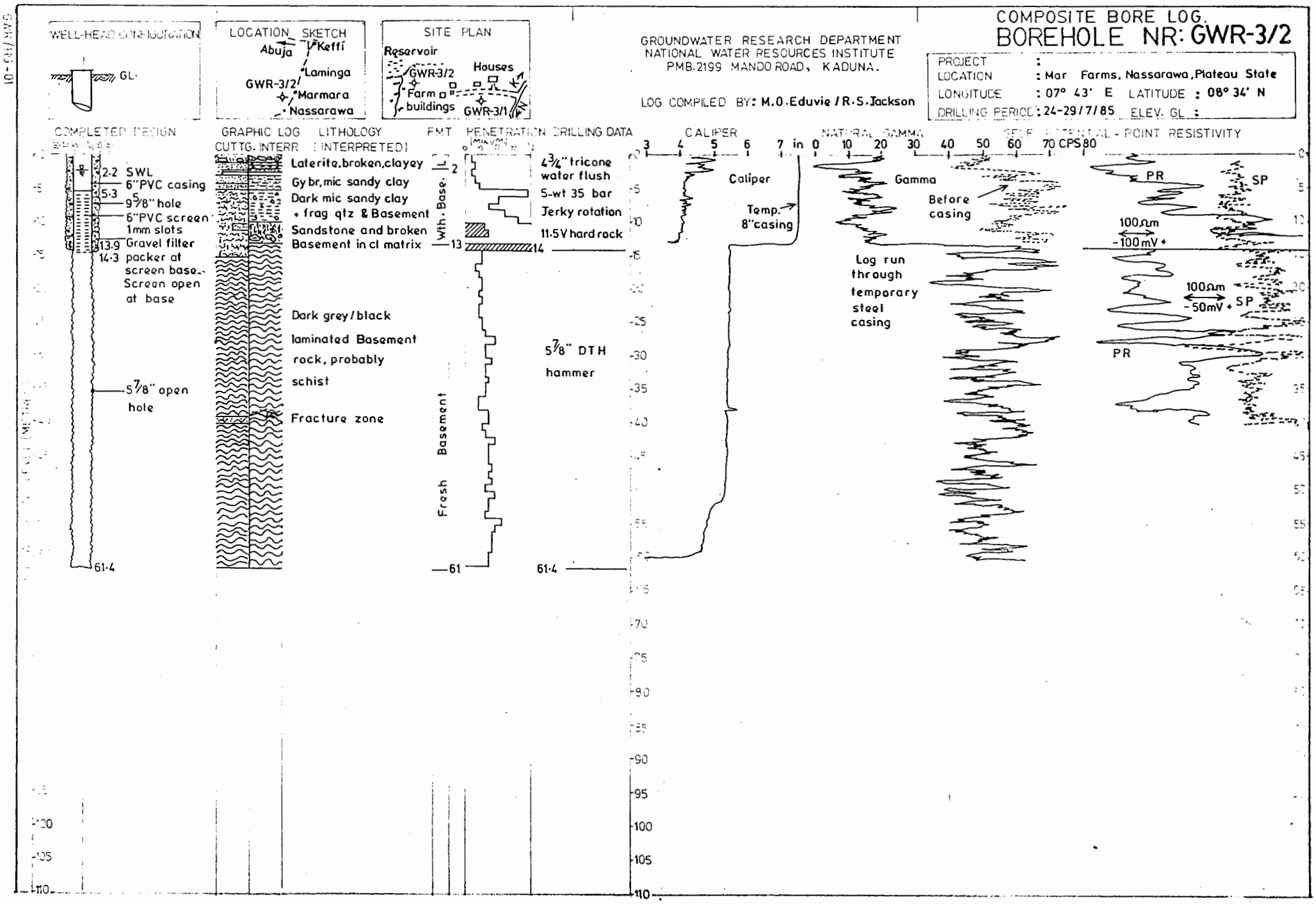
Results of chemical analyses using a Hach DR-EL/4 portable laboratory are summarised below:

Ca^{++}	1.62	meq/L
Mg^{++}	0.92	"
$SO_4^{=}$	0.08	"
CL^{-}	0.42	"
EC	350	u.S/cm (temperature compensated)
T_Q	18 ^{o}C	
pH	7.4	
SiO_2	28	mg/L
Fe total	0.05	"
NO_4^{-}	7.9	"
F^{-}	0.2	"

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps relatively thin weathered Basement, consisting of sandy clay and decomposed rock (sandstone), and 47m of the fresh rock. A significant fracture zone occurs at about 38m.

A pumping test was carried out for 24 hours, at a discharge of about 1.6 m^3/h - this effectively is the maximum sustainable yield and should be used as a guide for choosing a suitable permanent pump.


WELL-HEAD CONFIGURATION
GL
LOCATION SKETCH
Abuja
Keffi
Laminga
GWR-3/2
Marmara
Nassarawa
SITE PLAN
Reservoir
GWR-3/2
Houses
Farm buildings
GWR-3/1
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199 MANDO ROAD, KADUNA.
LOG COMPILED BY: M.O.Eduvie / R.S.Jackson
COMPOSITE BORE LOG.
BOREHOLE NR: GWR-3/2
PROJECT :
LOCATION : Mar Farms, Nassarawa, Plateau State
LONGITUDE : 07° 43' E LATITUDE : 08° 34' N
DRILLING PERIOD: 24-29/7/85 ELEV. GL :
COMPLETED DESIGN
GRAPHIC LOG
LITHOLOGY
CUTTG. INTERR (INTERPRETED)
FMT PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
2.2 SWL
6"PVC casing
5.3
9 7/8" hole
6"PVC screen
1mm slots
13.9 Gravel filter
14.3 packer at screen base. Screen open at base
5 7/8" open hole
61.4
Laterite, broken, clayey
Gy br, mic sandy clay
Dark mic sandy clay
+ frag qtz & Basement
Sandstone and broken
Basement in cl matrix
Dark grey/black laminated Basement rock, probably schist
Fracture zone
Weath. Base.
Fresh Basement
2
13
14
61
4 3/4" tricone water flush
5-wt 35 bar
Jerky rotation
11.5V hard rock
5 7/8" DTH hammer
61.4
3 4 5 6 7 in
Caliper
Temp. 8"casing
0 10 20 30 40 50 60 70 CPS 80
Gamma
Before casing
Log run through temporary steel casing
PR
SP
100Ωm
-100mV +
100Ωm
-50mV +
SP
PR

COMPLETION REPORT-BOREHOLE NR.GWR-4/1

1. GENERAL/SUMMARY

Research Project	: Niger State Water Board		
State	: Niger	National Data Bank Nr.	:
Local Govt. Area	: Suleja	River Basin	:
Location	: Southern end of Hassan Dallatu Road, Suleja		
Map Sheet Nr.	: 186	Sector	: SW
Longitude	: 07° 10' 21" E	Latitude	: 09° 10' 22" N
Rig	: Halco V866	Rig on site	: 9 - 21/8/85
Depth drilled	: 40.0m	Drilling method	: 0-9m water flush 9-40m DHH
Screen installed	: None		
Reference Point	: Ground level	Open hole	: 9.0 - 40.0m
Elevation Ref. Pt.	: 410m	Source elev. data	: 1:50 000 map
SWL (date)	: 4.00m (19/8/85)	EC (date)	: 140 u.S/cm (19/8/85)

2. OBJECTIVES

The objective was to determine the water producing capacity of the Basement at a site selected by geophysics as part of the research project proposed for the Niger State Water Board. The borehole was drilled at seismic refraction point 4S5 which indicated rock at about 7.5m.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-4/1

Nr.	Operation(s)	Date
1	Installed 0.8m 10" steel conductor casing and drilled with $7\frac{7}{8}$" tricone bit by water flush to 9.0m	12/8/85
2	Geophysical logging from 9.0m (E log, gamma and caliper)	13/8
3	Installed 6" collar-jointed, steel casing to 9.0m	"
4	Drilled with $5\frac{7}{8}$" DTH hammer from 9.0 to 40.0m. At 24m air leaked through annular space around casing resulting in slumping and caving. Area around casing excavated (about 0.5 m^3) and back-filled with a dry mixture of sand and bentonite - this was effective in sealing the annulus. At 40m hammer removed to inspect bit - 8 buttons were found to be missing. However, drilling could not continue because replacement bit, although of the same diameter gauge, could not enter previously drilled hole - obviously the old bit was worn and its diameter was less than $5\frac{7}{8}$"	13 - 15/8
5	Well development by airlift jetting to the bottom of the hole for about $2\frac{1}{2}$ hours	16/8
6	Geophysical logging from 40.0m (E-log, gamma and caliper). Resistivity did not respond well	17/8
7	Pumping test and chemical analysis	19 - 20/8

4. LITHOLOGY AND AQUIFERS

BOREHOLE NR: GWR-4/1

Depth (m) From	Depth (m) To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 4.0m (4.0m)				
0	4.0	4.0	Reddish brown, clayey sand with ferruginous concretions (Laterite)	
Weathered Basement 4.0 - 5.2m (1.2m)				
4.0	5.2	1.2	Light brown, off-white, coarse sand consisting of quartz, feldspars and micas	SWL gL 4.0m Aquifer
Fresh Basement 5.2 - 40.0m (34.8m)				
5.2	40.0 (TD)	34.8	Coarsely - crystallins granite containing some pyrites at places. Small crack at 13.9m	Virtually impermeable

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

None

6. WELL DESIGN

6" collar-jointed, steel casing installed to 9.0m with top of casing 0.45m above ground level. Annular space back-filled with sand and bentonite. Open hole below casing, from 9.0 to 40.0m (31.0m). Concrete base constructed around borehole head.

7. WELL DEVELOPMENT

Airlift jetting and surge pumping for about $2\frac{1}{4}$ hours down to the bottom of the hole.

8. PUMPING TESTS

BOREHOLE NR: GWR-4/1

The borehole was tested from 19 to 20 August 1985 by the P 631 Monolift pump, installed to 31.8m. Discharge was measured by timing the filling up of a 23 litre bucket, and water level by an Ott KL 50 electric contact gauge. However, after 600 minutes pumping the gauge only made contact when an exposed part of the wire in the tape was submerged - an appropriate correction had to be made to the water level readings after this time.

Test data and results are summarised below:

Test nr.	SWL (1) (m)	DWL (1) (m)	s (m)	Q (2) (m^3/h)	Duration (min)	T (m^2/Day)	Method
1	4.20	7.6 (3)	3.4	0.36	1440	3.1 ?	Logan
Recovery					4 (4)		

(1) below casing top, 0.20m above ground level

(2) value for last 480 minutes of test

(3) value for last 480 minutes of test

(4) no water level readings possible after 4 minutes recovery because of malfunctioning instrument.

The water level fluctuated widely during the early part of the test, in response to adjustments of the discharge rate, and only settled down in the last 480 minutes when the discharge was maintained at a constant 0.36 m^3/h. Even so, the water level was still fluctuating within a 3.5 m range and, because of the very low discharge, not much credence can be placed on the Logan estimate of T. All that can be concluded is that the permeability of the Basement rock is extremely low.

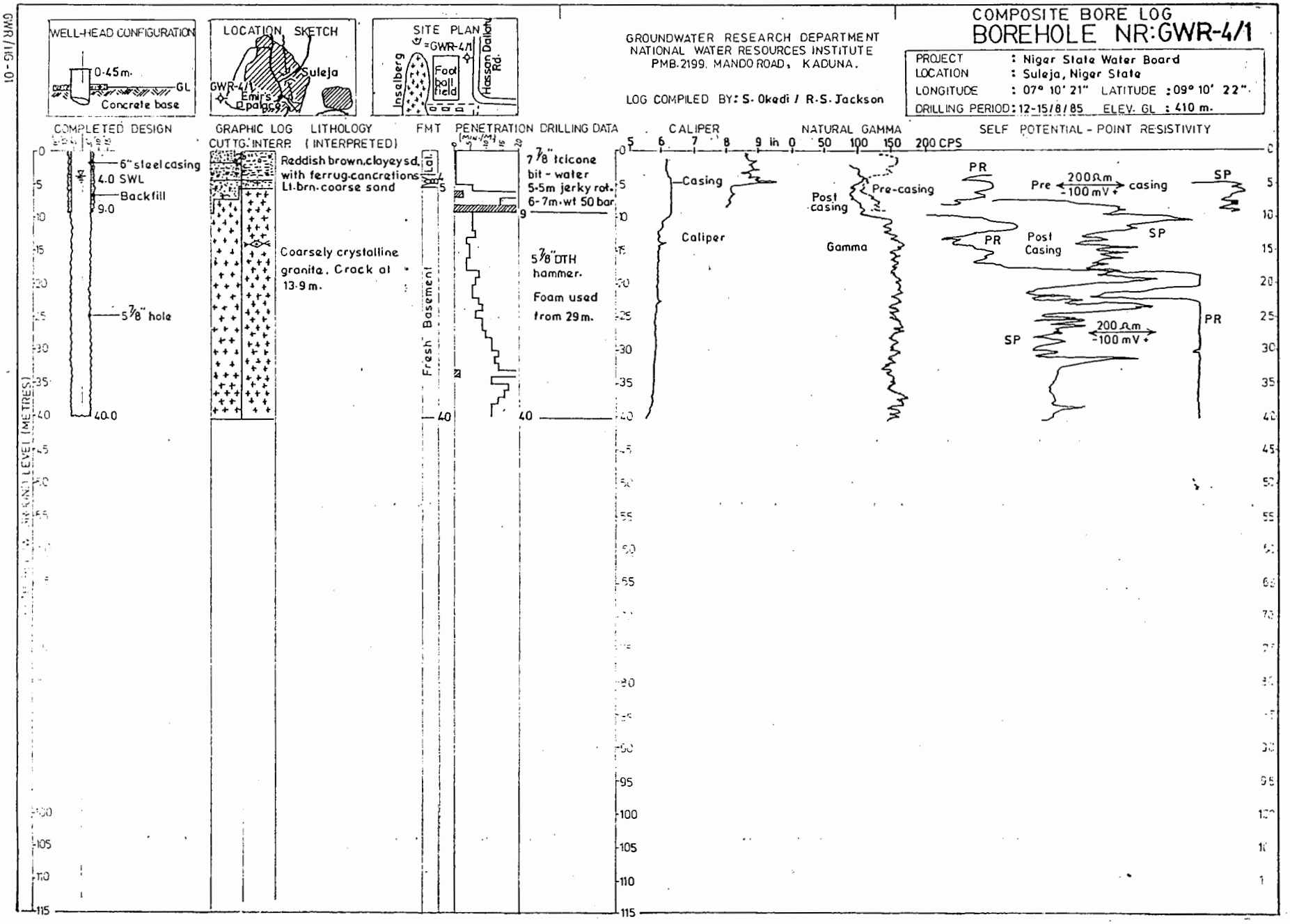
9. WATER QUALITY

The results of a chemical analysis using a Hach DR-EL/4 portable laboratory are summarised below:

Ca^{++}	0.30	meq/L
Mg^{++}	0.58	"
$SO_4^{=}$	0.06	"
Cl^{-}	1.9	"
EC	140	u.S/cm (temperature compensated)
T_Q	19.0	^{o}C
pH	6.3	
SiO_2	16	mg/l
Fe	0.3	"
NO_3^{-}	24	"
F^{-}	1.1	"

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps 31m of fresh Basement rock (granite) which appears not to have any significant fractures. Accordingly, the water producing capacity is very low. However, the water is chemically of good quality and suitable for domestic purposes, and it is recommended that a hand-pump be installed to serve the needs of the nearby school.


WELL-HEAD CONFIGURATION
0·45m.
GL
Concrete base
LOCATION SKETCH
Suleja
GWR-4/1
Emir's Palace
SITE PLAN
=GWR-4/1
Insalberg
Foot Ball Field
Hassan Dallow Rd.
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199, MANDO ROAD, KADUNA.
LOG COMPILED BY: S. Okedi / R.S. Jackson
COMPOSITE BORE LOG
BOREHOLE NR:GWR-4/1
PROJECT : Niger State Water Board
LOCATION : Suleja, Niger State
LONGITUDE : 07° 10' 21" LATITUDE : 09° 10' 22"
DRILLING PERIOD: 12-15/8/85 ELEV. GL : 410 m.
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY CUTTG. INTERP. (INTERPRETED)
FMT
PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
6" steel casing
4.0 SWL
Backfill
9.0
5⅞" hole
40.0
Reddish brown, clayey sd. with ferrug. cancretions
Lt. brn. coarse sand
Coarsely crystalline granite. Crack at 13·9 m.
Fresh Basement
7⅞" tcicone bit - water
5-5m jerky rot.
6-7m. wt 50 bar
5⅞" DTH hammer.
Foam used from 29m.
Casing
Caliper
Post casing
Pre-casing
Gamma
PR
Pre
200Ωm
-100 mV+
casing
SP
Post Casing
SP
PR
200 Ωm
-100 mV+
SP
PR
STATIC WATER LEVEL (METRES)

COMPLETION REPORT-BOREHOLE NR.GWR-4/2

1. GENERAL/SUMMARY

Research Project	: Niger State Water Board		
State	: Niger	National Data Bank Nr.	:
Local Govt. Area	: Suleja	River Basin	:
Location	: Northern end of Hassan Dellatu Road, Suleja		
Map Sheet Nr.	: 186	Sector	: SW
Longitude	: 07° 10' 35" E	Latitude	: 09° 10' 49" N
Rig	: Halco V866	Rig on site	: 4 - 12/9/85
Depth drilled	: 60.0m	Drilling method	: 0-8m water flush 8-60m DHH
Screen installed	: None		
Reference Point	: Ground level	Open hole	: 8.9 - 60.0m
Elevation Ref. Pt.	: 415m	Source elev. data	: 1:50 000 map
SWL (date)	: 4.60m gL (11/9/85)	EC (date)	: 150 u.S/cm (11/9/85)

2. OBJECTIVES

To determine the water producing capacity of the Basement at a site selected by a geophysical survey carried out at Suleja as part of the research project proposed for the Niger State Water Board. The borehole was drilled near seismic refraction point 4S2 which indicated rock at about 6m.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-4/2

Nr.	Operation(s)	Date
1	Installed 0.8m 12" conductor casing and drilled with $7\frac{7}{8}$" tricone bit by water flush to 9.0m	5/9/85
2	Geophysical logging from 8m (E-log, gamma and caliper) Resistivity did not respond	6/9
3	Installed 2" collar-jointed, steel casing to 8.9m (top casing 0.15m above ground level)	"
4	Drilled with $5\frac{7}{8}$" DTH hammer from 9.0 to 60.0m	7, 9/9
5	Well development by airlift jetting for $1\frac{1}{2}$ hours	9/9
6	Geophysical logging from 59m (E-log, gamma and caliper) Resistivity only partially responded	"
7	Pumping test and chemical analysis	11 - 12/9

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 2.0m (2.0m)				
0	0.8	0.8	Dark brown, fine-medium, feldspathic quartz sand	
0.8	1.4	0.6	Reddish brown, sandy clayey sand	
1.4	2.0	0.6	Reddish brown, angular, feldspathic quartz sand, compact	
Weathered Basement 2.0 - 8.0m (6.0m)				
2.0	3.6	1.6	Sandy and gravelly, light brown and grey clay, micaceous	
3.6	4.6	1.0	Sand and gravel	
4.6	5.8	1.2	Greyish clay	SWL gL 4.6m
5.8	8.0	2.2	Sand, gravel and rock fragments in clayey matrix (decomposed Basement rock)	Poorly permeable aquifer
Fresh Basement 8.0 - 60.0m (52.0m)				
8.0	10.8	2.8	Variegated rock (granite/granodiorite)	
10.8	14.8	4.0	Fracture zone	Aquifer
14.8	17.0	2.2	Granite / granodiorite	
17.0	21.2	4.2	Dark coloured rock (Granodiorite/ diorite)	
21.2	22.4	1.2	Fracture zone	Aquifer
22.4	60.0 (TD)	37.6	Granite / Granodiorite	

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

BOREHOLE NR: GWR-4/2

None

6. WELL DESIGN

6" (150mm) n.d. steel casing, collar-jointed, installed in 7⅝" drilled hole to 8.9m, with top of casing 0.15m above ground level.

Open hole below, from 8.9 to 60.0m (51.1m)

7. WELL DEVELOPMENT

1½ hours of airlift surging/pumping, with jetting tool at end of drill pipes, down to 48m.

8. PUMPING TESTS

BOREHOLE NR: GWR-4/2

The borehole was tested from 11 to 12 September 1995 by the P 631 Monolift pump which was installed to 49.8m. Discharge was measured by timing the filling up of a 23 litre bucket (a 30° V-notch weir was also tried, but the discharge was below the level of accuracy) and water level by an Ott KL 50 electric contact gauge.

Test data and results are summarised below:

Test nr.	SWL (1) (m)	DWL (1) (m)	s (m)	Q (m^3/h)	Duration (min)	T (m^2/day)	Method
1	4.75	26.1 (2)	21.3 (2)	2.8 (3)	1440	1.1 ?	Jecob
						3.8 (4)	Logan
Recovery	-	-	-	(2.9) (5)	240	3.8 ?	Theis recovery

(1) below toc at 0.15m above ground level

(2) representative value for last 600 min.

(3) value for last 600 min.

(4) from data for last 600 min.

(5) weighted average.

The water level declined steadily for the first 100 minutes of the test when the discharge was constant at 3.8 m^3/h; the data for the period 20 to 100 minutes were analysed by the Jacob method for T but because of the short time interval the result has to be treated with some caution. After 100 minutes the discharge declined to a constant value of 2.8 m^3/h for the last 600 minutes; however, the water level fluctuated within an 11 metre range. Recovery measurements were hampered by problems to the water level measuring gauge, and not enough readings were obtained for a plausible analysis of the data plot.

9. WATER QUALITY

The results of a chemical analysis using a Hach DR-EL/4 portable laboratory are summarised below:

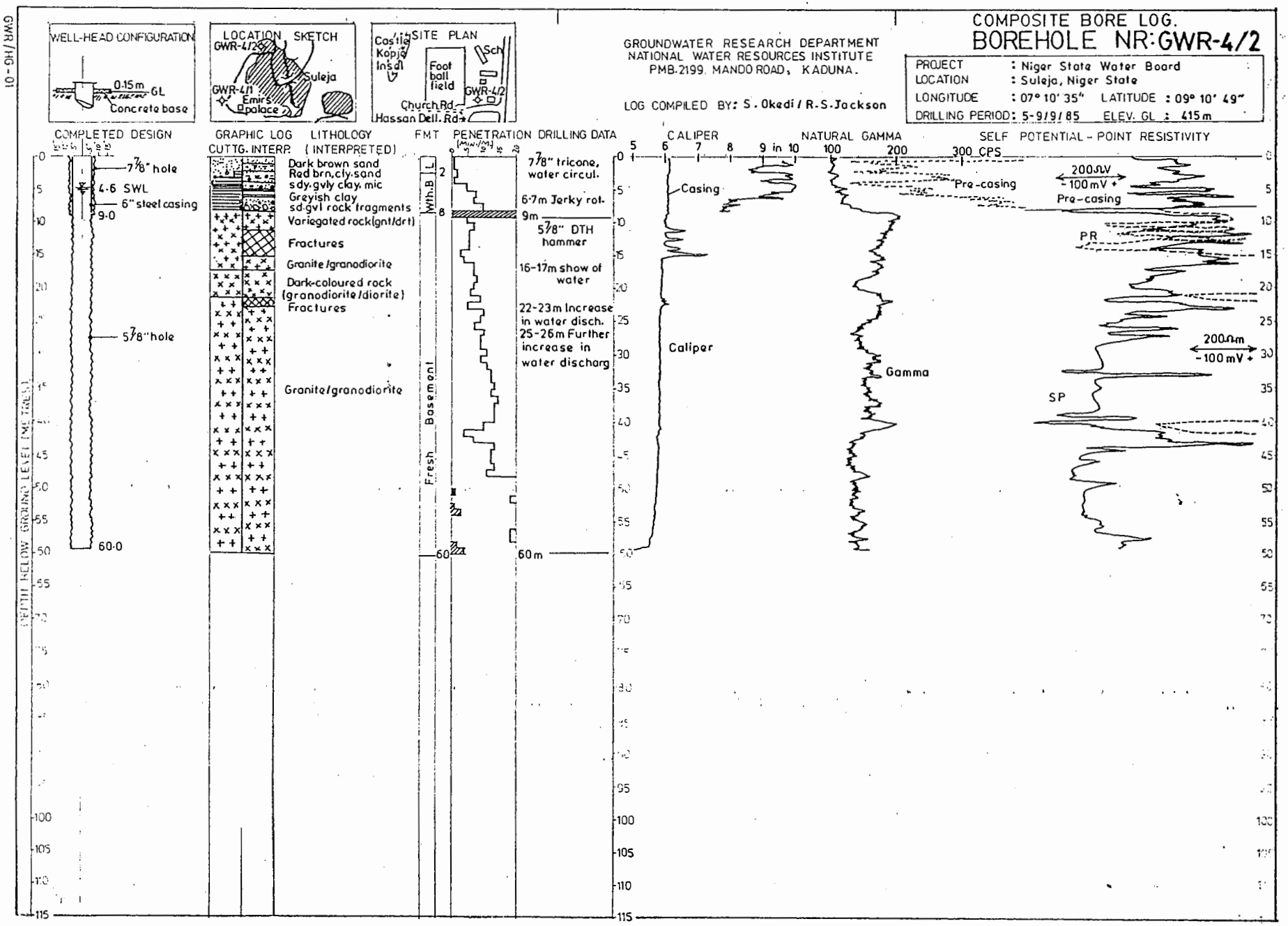
Ca^{++}	0.52	meq/l
Mg^{++}	0.32	"
$SO_4^{=}$	0.04	"
Cl^{-}	1.6	"
EC	150	u.S/cm (temperature compensated)
T_Q	16°C	
pH	6.1	
SiO_2	160	mg/l
Fe	< 0.05	"
NO_3^{-}	24	"
F^{-}	0.55	"
Turbidity	10	FTU
Colour	25	APHA

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps 51.1m of the fresh Basement rock (granite and granodiorite) which has significant fracture zones at 10.8 - 14.8m and 21.2 - 22.4m. These render the borehole relatively productive - the terminal yield after 24 hours pumping was 2.8 m^3/h.

The chemical quality of the water is good for drinking and domestic use; however, the shallow water table (at 4.6m) could easily be affected by nearby latrines and care should be taken to boil the water before drinking.

The borehole is suitable for equipping with a mechanically-driven or electric submersible pump.


GWR-HO-01
WELL-HEAD CONFIGURATION
0.15m
GL
Concrete base
LOCATION SKETCH
GWR-4/2
Suleja
GWR-4/1
Emirs Palace
SITE PLAN
Castle
Kopje
Insel
Foot ball field
Sch
GWR-4/2
Church Rd.
Hassan Dell. Rd.
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: S. Okedi / R.S. Jackson
COMPOSITE BORE LOG.
BOREHOLE NR: GWR-4/2
PROJECT : Niger State Water Board
LOCATION : Suleja, Niger State
LONGITUDE : 07° 10' 35" LATITUDE : 09° 10' 49"
DRILLING PERIOD: 5-9/9/85 ELEV. GL : 415m
COMPLETED DESIGN
GRAPHIC LOG
LITHOLOGY CUTTG. INTERP. (INTERPRETED)
FMT
PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
DEPTH BELOW GROUND LEVEL (METRES)
7⅞" hole
4.6 SWL
6" steel casing
9.0
5⅞" hole
60.0
Dark brown sand
Red brn, cly. sand
sdy. gvly clay, mic
Greyish clay
sd. gvl rock fragments
Variegated rock (gnt/drt)
Fractures
Granite/granodiorite
Dark-coloured rock (granodiorite/diorite)
Fractures
Granite/granodiorite
Fresh Basement
7⅞" tricone, water circul.
6-7m Jerky rot.
9m
5⅞" DTH hammer
16-17m show of water
22-23m Increase in water disch.
25-26m Further increase in water discharg
60m
Casing
Caliper
Pre-casing
Gamma
200Ω.V
-100 mV +
Pre-casing
PR
200Ω.m
-100 mV +
SP

COMPLETION REPORT-BOREHOLE NR.GWR-5/1

1. GENERAL/SUMMARY

Research Project	: -		
State	: Niger	National Data Bank Nr.	:
Local Govt. Area	: Minna	River Basin	:
Location	: Upper Niger RBRDA Compound, Minna		
Map Sheet Nr.	: 164	Sector	: SW
Longitude	: 06° 28' E	Latitude	: 09° 41' N
Rig	: Halco V866	Rig on site	: 31/10-19/11/85
Depth drilled	: 70.0m	Drilling method	: Air, DHH 5.4-70.0m
Screen installed	: None		
Reference Point	: Ground level	Open hole	: 5.4 - 70.0m
Elevation Ref. Pt.	: ?	Source elev. data	: -
SWL (date)	: 4.7m gL (14/11/85).	EC (date)	: 240 u.S/cm (14/11/85)

2. OBJECTIVES

The borehole was drilled at the request of the Upper Niger River Basin and Rural Development Authority to supply water for their compound at Minna. It was drilled near to the site recommended by a resistivity survey conducted by ABU in 1983 - the actual site, at VES 9, was inaccessible.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-5/1

Nr.	Operation(s)	Date
1	Drilled with 4⅝" tricone bit to 6m by air flush, and reamed out with 7⅝" bit	31/10/85
2	Installed 6m of 6" steel casing to 5.4m and sealed annular space with cement grout	1/11
3	Drilled with 5⅝" DHH bit to 70.0m	4 - 7/11
4	Well development by airlift	7/11
5	Geophysical logging from 69m (E-log, gamma and caliper)	8/11
6	Pumping and bailing tests, and chemical analysis	14/11

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer		0 - 2.5m	(2.5m)	
0	2.5	2.5	Dark brown, poorly sorted sand with clayey concretions	
Weathered Basement Complex		2.5 - 4.7m	(2.2m)	
2.5	4.7	2.2	Dark brown, grading down to light brown and off-white, micaceous sand; clayey with some quartz gravel	Show of water at 2.7m
Fresh Basement Complex		4.7 - 70.0m	(65.3m)	
4.7	70.0 (TD)	65.3	Granite. Fracture zones to 13.2m, at 23.5m, from 36.0 to 46.4m and at 67m	SWL 4.8m Water occurrence restricted to fracture zones

5. SAMPLING / AIRLIFT TESTS DURING DRILLING

None

6. WELL DESIGN

6" steel casing to 5.4m. Annular space between casing and $7\frac{7}{8}$" hole infilled with cement grout. Open hole 5.4 to 70.0m (64.6m)

7. WELL DEVELOPMENT

2 hours of airlifting

8 , PUMPING TESTS

BOREHOLE NR: GWR-5/1

An attempt was made to carry out a pumping test with the Monolift P 631 test pump installed to 50m. However, the discharge - measured as 0.9 m^3/h by timing the filling up a 25 litre bucket - was surging and, because of concern over the build-up of back pressure on the pump when the valve was closed on the discharge line to try to create a smoother flow, the test was abandoned.

A test by bailer was then carried out. The volume of the bailer was about 38 litres but because it was about half empty by the time it was removed from the borehole the net withdrawal of water was assumed to be about 15 litres per stroke.

The test was run for 45 minutes, during which time the bailer was pulled 70 times from the borehole - this indicates a discharge of about 1.4 m^3/h. The drawdown after 40 minutes was 10.4m (SWL 5.9m toc)

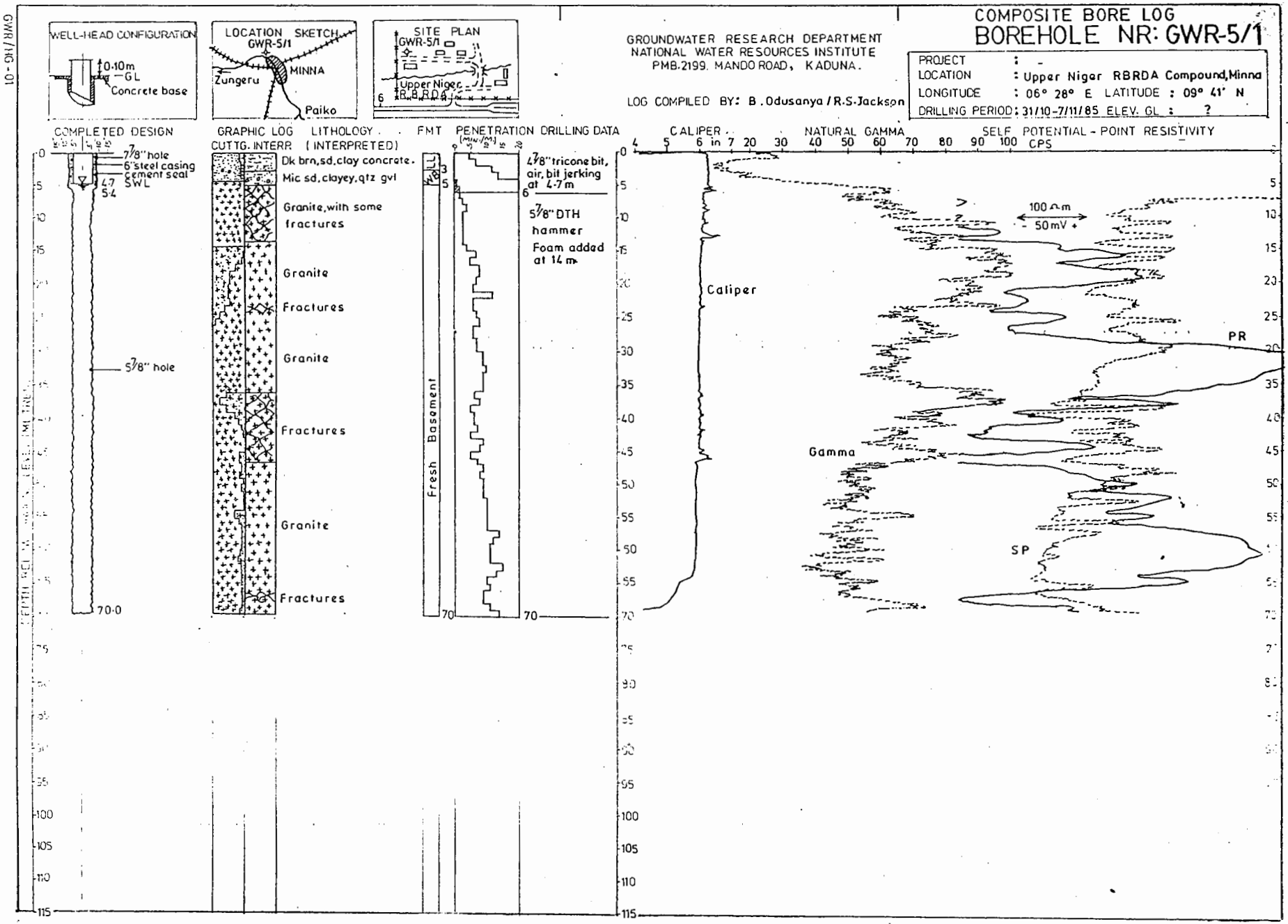
Results of chemical analysis with Hach DR-EL/4 portable laboratory:

Ca^{++}	1.32	meq/L
Mg^{++}	1.34	"
$SO_4^{=}$	0.25	"
CL^{-}	2.68	"
EC	420	u.S/cm (temperature compensated)
T_Q	14.5	^{o}C
pH	6.82	

10. CONCLUSIONS AND RECOMENDATIONS

The borehole taps about 65m of fresh Basement rock (granite) which is fractured to 13.2m, at 23.5m, from 36.0 to 46.4m and at 67m.

Unfortunately, it could not be adequately tested because of limitations to the test pump. However, a yield of about 1.4 m^3/h was obtained by bailing which indicates that the borehole has some potential as a water supply source. It is recommended that a proper test be carried out using a small electrical submersible pump to enable a permanent pump to be specified.


GWR/HG-01
WELL-HEAD CONFIGURATION
0·10m
GL
Concrete base
LOCATION SKETCH
GWR-5/1
MINNA
Zungeru
Paiko
SITE PLAN
GWR-5/1
Upper Niger
R.B.R.D.A.
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB.2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: B.Odusanya / R.S.Jackson
COMPOSITE BORE LOG
BOREHOLE NR: GWR-5/1
PROJECT :
LOCATION : Upper Niger RBRDA Compound, Minna
LONGITUDE : 06° 28° E LATITUDE : 09° 41' N
DRILLING PERIOD: 31/10-7/11/85 ELEV. GL : ?
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY
CUTTG. INTERR (INTERPRETED)
FMT PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
7⅞" hole
6" steel casing
cement seal
SWL
4·7
5·4
5⅞" hole
70·0
Dk brn,sd,clay concrete.
Mic sd,clayey,qtz gvl
Granite,with some fractures
Granite
Fractures
Granite
Fractures
Granite
Fractures
Fresh Basement
4⅞" tricone bit, air, bit jerking at 4·7m
5⅞" DTH hammer
Foam added at 14 m
Caliper
100 Ω m
50 mV
PR
Gamma
SP
DEPTH BELOW MEAN SEA LEVEL (M)

COMPLETION REPORT-BOREHOLE NR.GWR-6/1

1. GENERAL/SUMMARY

Research Project	: -		
State	: Niger	National Data Bank Nr.	:
Local Govt. Area	: Lapai	River Basin	: Upper Niger
Location	: Malle Farms (Nig) Ltd., 4.8km SW of Lapai		
Map Sheet Nr.	: 185	Sector	: SW
Longitude	: 06° 36' 13" E	Latitude	: 09° 00' 47" N
Rig	: Halco V866	Rig on site	: 3-17/12/85
Depth drilled	: 61.3m	Drilling method	: 0-17.4m airflush 17.4-24.5m mudflush 24.5-61.3m DHH
Screen installed	: 13.0-24.4m		
Reference Point	: Ground level	Open hole	: 24.6 - 61.3m
Elevation Ref. Pt.	: 145m	Source elev. data	: 1:50 000 map
SWL (date)	: 13.8m (15/12/85)	EC (date)	: 250 u.S/cm (15/12/85)

2. OBJECTIVES

To supply water for the Malle Farms (Nig) Ltd. farm near Lapai.

3. PROGRAMME OF OPERATIONS

BOREHOLE NR: GWR-6/1

Nr.	Operation(s)	Date
1	Installed 0.74m of 6" conductor casing to 0.32m and drilled with $4\frac{3}{4}$" tricone bit by air flush to 17.4m	3/12/85
2	Because of caving changed to mud flush and continued drilling to 24.5m	4/12
3	Geophysical logging from 24m (E-log, gamma and caliper)	5/12
4	Reamed with $9\frac{5}{8}$" tricone bit by mud flush to 24.4m through 0.8m of 10" steel conductor casing	5 - 6/12
5	Installed 8" steel casing to 24.4m through 10" conductor casing	6/12
6	Drilled with $5\frac{7}{8}$" DHH from 24.4m to 61.3m (TD)	10 - 11/12
7	Geophysical logging from 60m (gamma and caliper only - E-log not working)	11/12
8	Drilled with $7\frac{7}{8}$" tricone bit from 24.4 to 24.6m to provide a seat for 6" PVC casing / screen string	12/12
9	Installed 6" PVC casing and screen to 24.6m and gravel pack in annular space after 8" steel casing withdrawn	12 - 13/12
10	Well development by bailing and airlift pumping	13 - 14/12
11	Pumping test by airlift, and chemical analysis	15/12

Depth (m) From	To	Thickness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer	0 - 2.0m		(2.0m)	
0	2.0	2.0	Reddish brown, loosely-cemented lateritic sand	
Weathered Basement	2.0 -	22.8m	(20.8m)	
2.0	6.0	4.0	Brownish clay	
6.0	7.8	1.8	Greyish brown, sandy clay	
7.8	9.6	1.8	Greyish brown clayey sand, with some quartz fragments	
9.6	13.0	3.4	Greyish brown, sandy and silty clay	
13.0	14.2	1.2	Loose sand, coarse	SWL gL 13.8m
14.2	15.6	1.4	Black, sandy, silty clay	
15.6	18.0	2.4	Brown sand with thin clayey layers	
18.0	20.8	2.8	Gritty clay with quartz and rock fragments	Aquifer (thickness 9.0m)
20.8	22.5	1.7	Large rock fragments / boulders, blocky, in weathered matrix	
22.5	22.8	0.3	Greyish clayey sand	
Fresh Basement	22.8 - 61.3m		(38.5m)	
22.8	61.3 (TD)	38.5	Basement Complex rock, solid, no discernable fractures. Appears to consist of dark granite gneiss /migmatite	Impermeable

None

6. WELL DESIGN

Particle size analysis of formation sample from 17 - 18m gave following results: D_{10} 0.55mm, D_{50} 1.22mm, D_{60} 1.36mm, UC 2.5; mostly coarse sand, much of the fines having been lost in the sampling process.

A 6" string of PVC casing and screen was installed to 24.6m - casing to 13.0m, screen (1.0mm slots) 13.0 - 24.4m and a short length of casing wrapped with inner tubes to form a seat from 24.4 to 24.6m. String was not plugged, hole open below.

Gravel pack was installed around the casing/screen string; a particle size analysis gave the following results: D_{10} 1.2mm, D_{50} 8.7m, D_{60} 11.4mm, UC 9.5.

7. WELL DEVELOPMENT

Consisted of bailing with a 4" bailer for 1½ hours to clear the hole of mud and mudcake, and airlift pumping (eductor 54m, airline 60m) for 3¼ hours. The water was very clear after 2 hours of pumping.

8. PUMPING TESTS

BOREHOLE NR: GWR-6/1

A pumping test was carried out by airlift - 4" eductor pipes were installed to 54m, and 1¼" airline to 50m. Discharge was measured by timing the filling up of the 2.87 m^3 weir tank, and 16 and 23 litre buckets from the overflow (measurements of the head over the 30° V-notch weir were also taken but were too low for reliable discharge calculations). Drawdown was measured by a Waidart electric sounding tape which unfortunately was only 30.5m long - water levels below this depth could not be measured.

Test data and results are summarised below:

Test nr.	SWL (1) (m)	DWL (1) (m)	s (m)	Q (m^3/h)	Duration (min)	T (m^2/day)	Method
1(P)	13.8	33.4 (2)	19.6 (2)	2.5	420	1.7 3.7	Jacob Logan
1(R)	-	-	-	(2.5)	140	?	

Notes: (1) below top of casing at ground level
(2) extrapolated to time 420 min

After the cessation of pumping the water level recovered in 80 minutes.

The water was clear and sand-free after 40 minutes of pumping, and good tasting.

9. WATER QUALITY

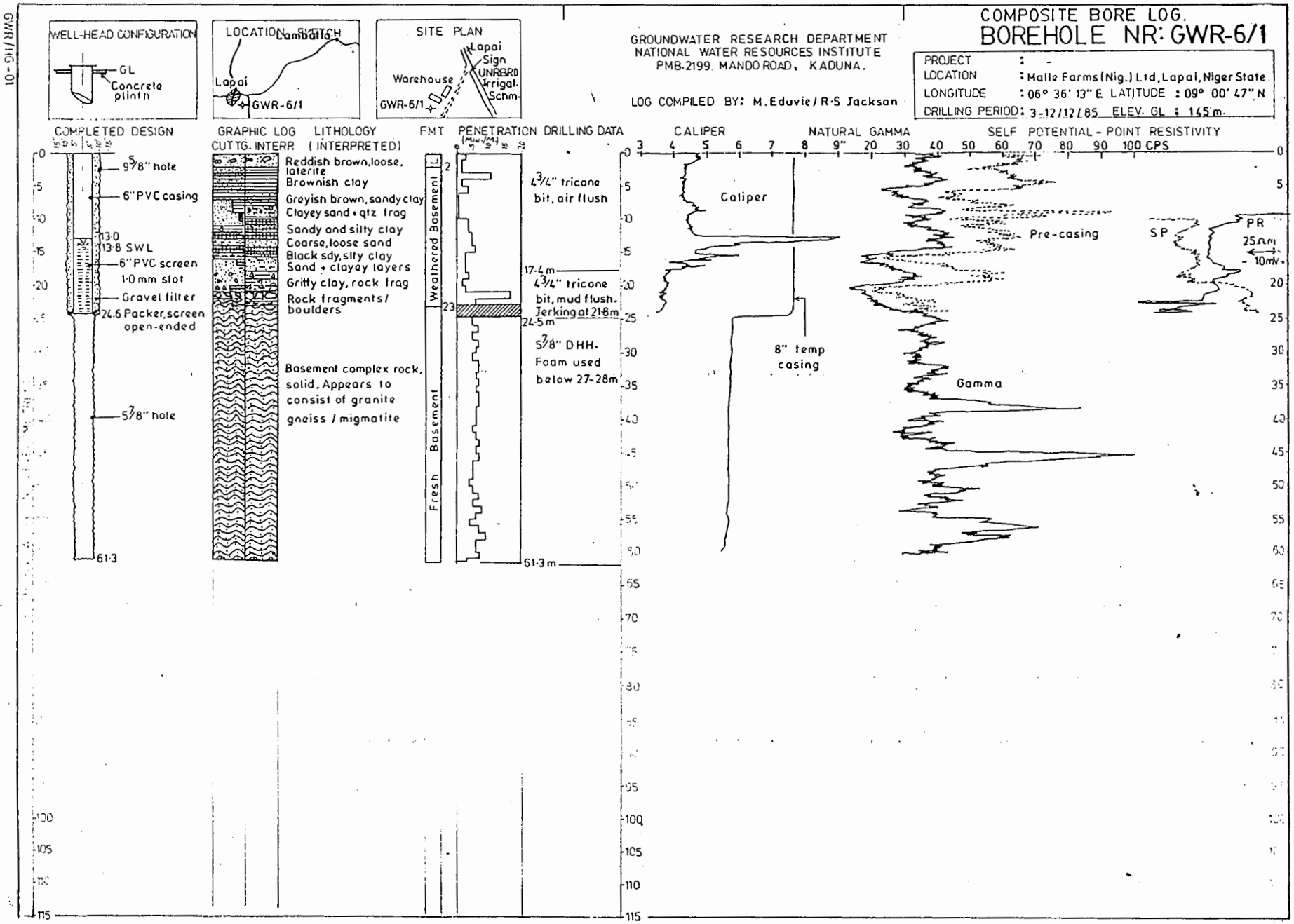
A chemical analysis using a Hach DR-EL/4 portable laboratory gave the following results:

Ca^{++}	1.22	meq/L
Mg^{++}	0.72	"
$SO_4^{=}$	0.20	"
Cl^{-}	0.01	"
EC	250	u.S/cm (temperature compensated)
T_Q	15°C	
pH	7.7	
SiO_2	75	mg/L
Fe (total)	0.02	"
NO_3	7.9	"
F^{-}	0.4	"

10. CONCLUSIONS AND RECOMENDATIONS

The only aquifer occurs in the lower part of the weathered Basement (aquifer thickness about 9m); the fresh Basement rock below is largely impermeable.

A yield of 2.5 m^3/h was obtained during a 7 - hour pumping test, and the water quality is good for domestic purposes. The borehole is suitable for supplying the domestic needs of the farm - it is suggested that a permanent pump be installed to about 40m.


GWR/HG-01
WELL-HEAD CONFIGURATION
GL
Concrete plinth
LOCATION SKETCH
Lambatta
Lapai
GWR-6/1
SITE PLAN
Lapai Sign
UNRBRD Irrigat. Schm.
Warehouse
GWR-6/1
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB-2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: M.Eduvie / R.S Jackson
COMPOSITE BORE LOG.
BOREHOLE NR: GWR-6/1
PROJECT : -
LOCATION : Malle Farms (Nig.) Ltd, Lapai, Niger State.
LONGITUDE : 06° 36' 13" E LATITUDE : 09° 00' 47" N
DRILLING PERIOD: 3-12/12/85 ELEV. GL : 145 m.
COMPLETED DESIGN
GRAPHIC LOG LITHOLOGY CUTTG. INTERP. (INTERPRETED)
FMT PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
9 5/8" hole
6" PVC casing
13·0
13·8 SWL
6" PVC screen
1·0 mm slot
Gravel filter
24·6 Packer, screen open-ended
5 7/8" hole
61·3
Reddish brown, loose, laterite
Brownish clay
Greyish brown, sandy clay
Clayey sand + qtz frag
Sandy and silty clay
Coarse, loose sand
Black sdy, silty clay
Sand + clayey layers
Gritty clay, rock frag
Rock fragments / boulders
Basement complex rock, solid. Appears to consist of granite gneiss / migmatite
Weathered Basement
Fresh Basement
4 3/4" tricone bit, air flush
17·4 m
4 3/4" tricone bit, mud flush. Jerking at 21·8m
24·5 m
5 7/8" DHH. Foam used below 27-28m
61·3 m
Caliper
8" temp casing
Pre-casing
Gamma
SP
PR
25Ωm
10mV
II-83

Groundwater Research Department - National Water Resources Institute

COMPLETION REPORT - BOREHOLE NR.GWR-7/1

1 General/Summary

Research Project	: Niger State Water Board (NSWB)
State	: Niger
National Data Bank Nr.	:
Local Govt. Area	: Lavum
River Basin	:
Location	: Rural Health Centre, Kutigi
Map Sheet Nr.	: 183 SW
Longitude	: 05 37 E
Latitude	: 09 12 N
Rig	: Halco V866
Rig on Site	: 28/1 - 12/3/86
Depth Drilled	: 114.9m
Drilling Method	: Mud circulation
Screen Installed	: 17.1-20.1,40.2-45.9,54.6-57.6,100.5-103.5m
Open Hole	: None
Reference Point	: Ground level
Elevation Ref. Pt.	: 140m
Source Elev. Data	: Polservice, 1979
SWL (Date)	: 8.7m (27/2/86)
EC (Date)	: 85 uS/cm (1/3/86)

2 OBJECTIVES

The borehole was the first of a group of three proposed to investigate the Nupe Sandstones Formation for the NSWB. The intention was for it to drilled as deep as the drill pipes would allow (270m) in order to obtain as complete a lithological picture of the formation as possible. Unfortunately, however, a leakage from the mud swivel and blockages to the bit prevented the borehole from being drilled any deeper than 114.9m. It was completed as a piezometer with 4" PVC casing and screen.

Borehole Nr.GWR-7/1

3 PROGRAMME OF OPERATIONS

Nr.	Operation(s)	Date
1	Drilled with 4 3/4" tricone bit by mudflush to 19m - drilling stopped by blockages to the bit	3/2/86
2	Installed 8" steel casing to 7m and drilled with 7 7/8" drag bit by mudflush to 114.9m. Mud swivel started leaking at 38m and became so serious that drilling could not continue beyond 114.9m when bit probably became clogged 20 1/2 bags bentonite and 1 tub custom mud used during drilling operations	4-12/2
3	Installation of 4" PVC casing and screen to 114.9m; 4 centralisers placed around screen lengths, and 'gravel pack' emplaced in annulus	21/2
4	Geophysical logging from 75m (SP-PR) and 72.5m (gamma)	27/2
5	Well development by airlift to 82m	27/2
6	Pumping test and water chemistry analysis	1/3

Borehole Nr.GWR-7/1

4 LITHOLOGY AND AQUIFERS

Depth (m) From	To	Thick-ness (m)	Interpreted Lithology	Hydrogeological Characteristics
Lateritic Layer 0 - 8.8m (8.8m)				
0.0	0.9	0.9	Rdsh brn, cly, fin-cse, qtz sand	
0.9	3.2	2.3	Rdsh brn, sdy clay	
3.2	5.2	2.0	Rdsh brn, cly, gvly, cse sand	
5.2	8.8	3.6	Red/rdsh brn, yl with mottled gy, slightly sdy clay	SWL 8.7m gl
Nupe Sandstones Formation 8.8 - 114.9m (106.1m)				
8.8	10.0	1.2	Lt brn, red off wh, slightly sdy, slty clay	
10.0	16.8	6.8	Lt brn/brn/red yl/ off wh, med-cse, very gvly sand with cl bands	Aquifer
16.8	30.0	13.2	Lt brn/brn/rdsh brn/ ppl/mottled gy/off wh, slightly gvly, sdy, slty clay	
30.0	32.0	2.0	Lt brn, cly, med-cse sand	Aquifer
32.0	36.5	4.5	Lt brn/brn/rdsh brn/ yl, sdy clay, becoming more sdy with depth	
36.5	44.3	7.8	Lt brn/brn/off wh, cly, gvly, med-cse, sub-ang/ang, qtz sand	Aquifer
44.3	50.8	6.5	Lt brn/brn/off wh/mottled gy, slightly sdy, slty clay	
50.8	53.0	2.2	Lt brn/brn/rdsh brn/ off wh/gy, cly, med-cse sand	Aquifer
53.0	63.9	10.9	Dk gy/gy/rdsh brn, plastic and sticky, slightly sdy clay with ferrug nodules	
63.9	66.4	2.5	Lt brn/dk gy/gy, cly (indurated cl),cse, sub-ang, qtz sand	Aquifer
66.4	78	12	Dk gy/gy, plastic and sticky, slightly sdy, slty clay with clst bands	
78	79	1	Dk gy/gnsh, cly, med-cse, sub-ang/ang, sand	Possible aquifer

79	82	3	Dk gy/gnsh, plastic and sticky, slightly sdy clay with clst and ferrug nodules	
82	86	4	Dk gy/gysh brn, sdy, slty clay with clst bands	
86	88	2	Gy, med-cse, sub-ang/ang, cly sand	Possible aquifer
88	93	5	Dk gy/gy, sdy clay with med-cse sdy bands	
93	95	2	Dk gy/gysh brn, med-cse, sub-ang/ang, cly sand	Possible aquifer
95	100	5	Dk gy/gysh/dk brn/ rdsh brn, med-cse, sub-ang/ang, cly sand	
100	104	4	Dk gy/lt gy/gnsh/ brnsh, med-cse, sub-ang/ang, cly sand	Possible aquifer
104	114.9 (TD)	11	Dk gy/lt gy/brnsh/ ylsh, sdy, slty clay with cse sd bands	

5 SAMPLING/AIRLIFT TESTS DURING DRILLING

None

6 WELL DESIGN

The following string of 4" PVC casing and screen (0.5mm slots) was installed:

3 x 5.7m lengths	casing	0.0- 17.1m
1 x 3.0m length	screen	17.1- 20.1m + centraliser
1 x 3.0m "	casing	20.1- 23.1m
3 x 5.7m lengths	"	23.1- 40.2m
1 x 5.7m length	screen	40.2- 45.9m + centraliser
1 x 3.0m "	casing	45.9- 48.9m
1 x 5.7m "	"	48.9- 54.6m
1 x 3.0m "	screen	54.6- 57.6m + centraliser
7 x 5.7m lenghts	casing	57.6- 97.5m
1 x 3.0m length	"	97.5-100.5m
1 x 3.0m "	screen	100.5-103.5m + centraliser
2 x 5.7m lengths	casing	103.5-114.9m

A 'gravel pack' was emplaced in the annulus - the results of a particle size analysis are as follows:

D10 = 0.38mm, D50 = 0.74mm, D60 = 0.88mm, UC = 2.3, (69% coarse sand).

Unfortunately no plug was placed in the bottom of the casing, and

sand from the 'gravel pack' and formation backfilled the borehole to a depth of about 75m.

7 WELL DEVELOPMENT

The borehole was developed by airlift to 82m for 5 hours 40 minutes.

8 PUMPING TESTS

The borehole was tested using the C32 P301 BC pump provided by Mono as an alternative to the larger P631 pump previously supplied. The pump was installed to 46m.

Discharge was measured by timing the filling up of a bucket of known volume. Water level could not be measured because there was insufficient annular space between the casing (103mm id) and the pump column pipe (65mm) for an electric contact probe to enter. However, water level measurements were made in two nearby dug wells (80 and 100m distant) during the test.

The test was run for 660 minutes and the yield was 3.1 m3/h (weighted average). There was no decline in the water levels of the dug wells.

9 WATER QUALITY

The results of a chemical analysis using a Hach DR-EL/4 portable laboratory are given below:

calcium	0.62	meq/l
magnesium	0.30	"
bicarbonate	0.36	"
sulphate	0.10	"
chloride	1.27	"
EC	85	uS/cm (temp. compensated)
water temp.	17	degrees C
pH	6.25	
silica	>50	mg/l
total iron	< 0.05	"
nitrate	8.4	"
fluoride	0.3	"

10 CONCLUSIONS AND RECOMMENDATIONS

The Nupe Sandstones Formation to the depth drilled (114.9m) consists of two main horizons:

(a) brownish, silty clays with significant layers of clayey, gravelly sands, to 53m;
(b) greyish, silty clays with a few thin clayey sand layers, below 53m; ferruginous nodules occur in places.

The main aquifer layers occur in the upper horizon, although permeability is probably relatively low due to the clayey content of the sands.

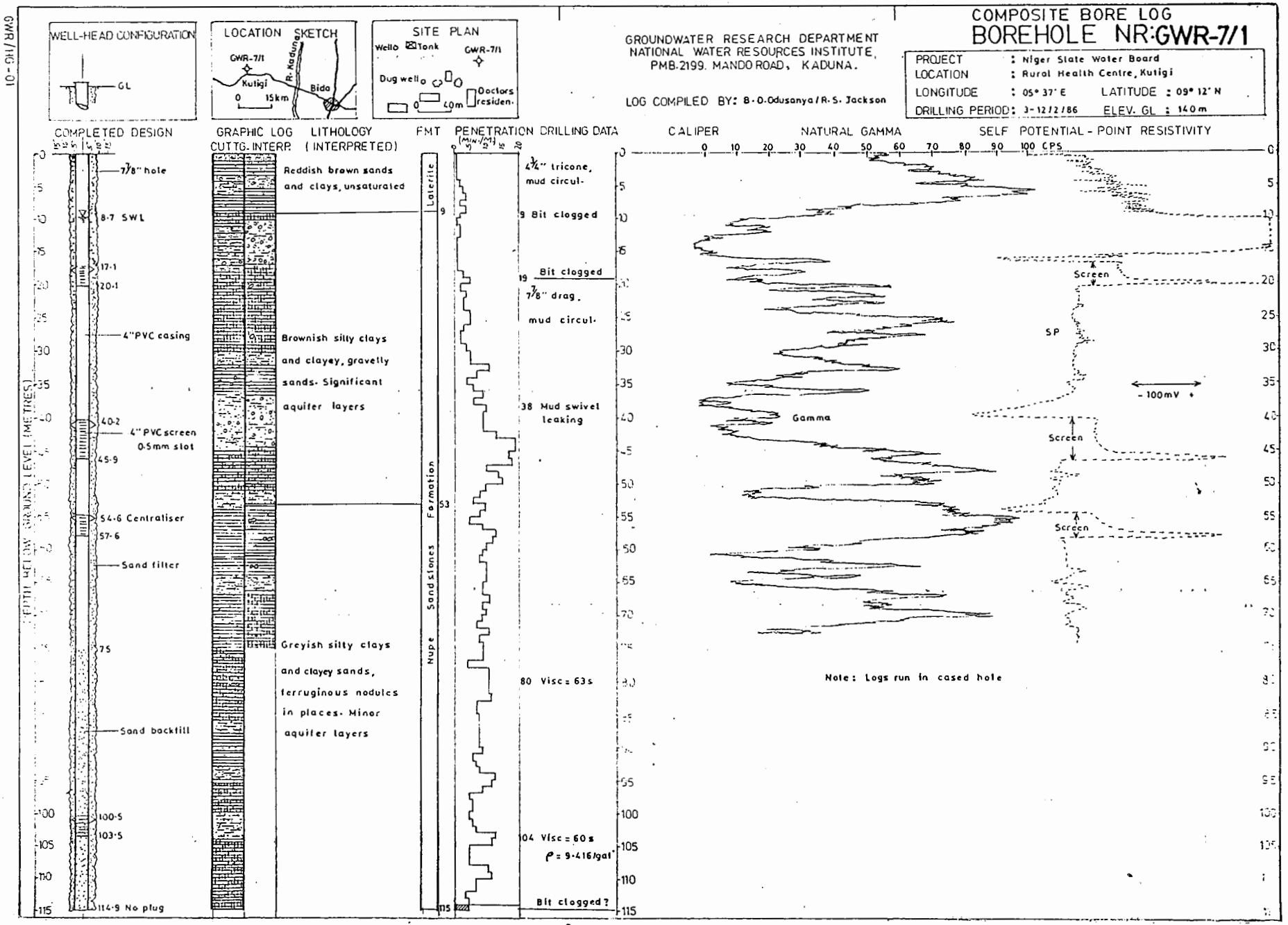
The borehole provided the first opportunity for the staff to work in a thick, sedimentary formation. Unfortunately some mistakes were made:

- geophysical logging was not carried out immediately after the completion of drilling, and screen settings were estimated on the basis of cutting sample descriptions and drilling data alone. Logging was not done until after the installation of casing and screen, and showed that some screen lenghts missed the sand layers intended to be tapped (this is probably a major reason why the NSWB has reported so many failures in the Nupe Sandstones);
- a plug was not placed in the bottom of the casing/screen string, with the result that sand from the 'gravel pack' and formation backfilled the borehole to 75m.

Learning from mistakes is an effective way of training, and it is hoped that the staff will heed the lessons gained from the experience of drilling this borehole.

The borehole will be used as a piezometer for the test well to be drilled at the site at a later date.

GWR/HG-01



06-11

Groundwater Research Department - National Water Resources Institute

COMPLETION REPORT - BOREHOLE NR.GWR-8/1

1 General/Summary

Research Project	: -
State	: Kaduna
National Data Bank Nr.	:
Local Govt. Area	: Kachia
River Basin	:
Location	: St.Gerard's Hospital, Kaduna South
Map Sheet Nr.	: 144 NE
Longitude	: 07 25 15 E
Latitude	: 10 28 02 N
Rig	: Halco V866
Rig on Site	: 12-27/3/86
Depth Drilled	: 73.3m
Drilling Method	: Air flush + some foam
Screen Installed	: 12.9-24.3m
Open Hole	: 24.5-73.3m
Reference Point	: Ground level
Elevation Ref. Pt.	: 615m
Source Elev. Data	: 1: 50,000 map
SWL (Date)	: 6.70m (26/3/86)
EC (Date)	: 105 uS/cm (27/3/86)

2 OBJECTIVES

To provide an independent supply for St.Gerard's Hospital which has been facing severe water shortages for some time.

3 PROGRAMME OF OPERATIONS

Nr.	Operation(s)	Date
1	Drilled with 4 3/4" tricone bit by air and some foam to 21.0m	13/3/86
2	Reamed with 9 5/8" tricone bit to 21.0m, and installed 8" steel casing to 20.8m	14/3
3	Drilled with 7 7/8" tricone bit from 21.0 to 24.5m	15 & 17/3
4	Drilled with 5 7/8" DHH from 24.5 to 73.3m	17/3
5	Geophysical logging from 72m (E-log, gamma and caliper) - resistivity log did not respond correctly	18/3
6	Installation of 6" PVC casing and screen to 24.5m	19/3
7	Well development by bailing and airlift jetting	19-21 & 24/3
8	Emplacement of cement seal in annulus to 10m	24/3
9	Pumping test and water chemistry analysis	26-27/3

Borehole Nr.GWR-8/1

4 LITHOLOGY AND AQUIFERS

Depth (m) From	To	Thick-ness (m)	Interpreted Lithology	Hydrogeological Characteristics
Laterite 0 - 8m (8m)				
0.0	6.0	6.0	Reddish brown, silty clay with sandy and pebbly lenses	
6.0	8	2	Reddish brown, clayey sand	SWL 6.7m gl
Weathered Basement 8 - 24.0m (16m)				
8	12	4	Greyish brown/brownish clayey sand	Aquifer from 6.7 to 24.0m (17.3m), permeability probably increases with depth
12	17	5	Brown, medium grained sand	
17	19.3	2	Brown, medium grained, clyey sand with whitish gravel	
19.3	23.2	3.9	Blocks of decomposed Basement rock in clayey sand and gravel matrix	
23.2	24.0	0.8	Fracture in weathered rock	
Fresh Basement 24.0 - 73.3m (49.3m)				
24.0	26.0	2.0	Granite	
26.0	26.4	0.4	Fractures	Aquifer
26.4	53.0	26.6	Granite	
53.0	55.0	2.0	Fractures	Aquifer
55.0	73.3 (TD)	18.3	Granite	

5 SAMPLING/AIRLIFT TESTS DURING DRILLING

None

6 WELL DESIGN

A 6" PVC string of casing and screen (1.0mm slots) was installed as follows:

1 x 1.5m length	casing	0.0 - 1.5m
2 x 5.7m lengths	"	1.5 - 12.9m
2 x 5.7m "	screen	12.9 - 24.3m
1 x 0.2m length	casing	24.3 - 24.5m

The bottom short length of casing was wrapped around with inner tubes to form a seal against the inflow of the 'gravel pack' around the screen above to the open 5 7/8" hole below - the base of the casing was left open.

The 'gravel pack' consisted of gravel at the base and sand above - the results of a particle size analysis on the sand are given below:

D10 = 0.31mm, D50 = 0.83mm, D60 = 1.10mm, UC = 3.5 (49% coarse sand, 25% medium sand).

After well development the top 10m of the annulus was filled with a cement mixture to form a sanitary seal against any contamination from nearby septic tanks.

7 WELL DEVELOPMENT

The borehole was developed by bailing, and by airlift jetting for 5 hours.

8 PUMPING TESTS

A pumping test was carried out using the C32 P301 BC Mono pump installed to 43m. Discharge was measured by timing the filling up of a 212 litre drum, and water level by an Ott KL50 electric contact gauge.

Test data and results are summarised below:

Test	SWL (m)	DWL (m)	s (m)	Q (m3/h)	Duration (min)	T (m2/day)	Method
Pumping	6.70	23.60	16.90	7.20	1440	12.5	Logan
						15.8	Jacob
Recovery					120	26.4	Theis recovery

Notes: (a) water levels measured from top of casing at ground level
(b) discharge is weighted average

Good data plots were obtained for both the pumping and recovery periods - a median transmissivity of 21 m2/day is thought to be plausible.

After the first 6 or 7 hours of pumping the water was clear and sand-free.

9 WATER QUALITY

The results of a chemical analysis using a Hach DR-EL/4 portable laboratory are given below:

calcium	0.59	meq/l
magnesium	0.14	"
sulphate	0.06	"
chloride	0.23	"
EC	100	uS/cm (temp. compensated)
water temp.	28	degrees C
pH	7.3	
silica	45	mg/l
total iron	0.05	"
nitrate	10.1	"
fluoride	0.04	"

Measurements of EC25 with two Kent conductivity meters averaged 105 uS/cm.

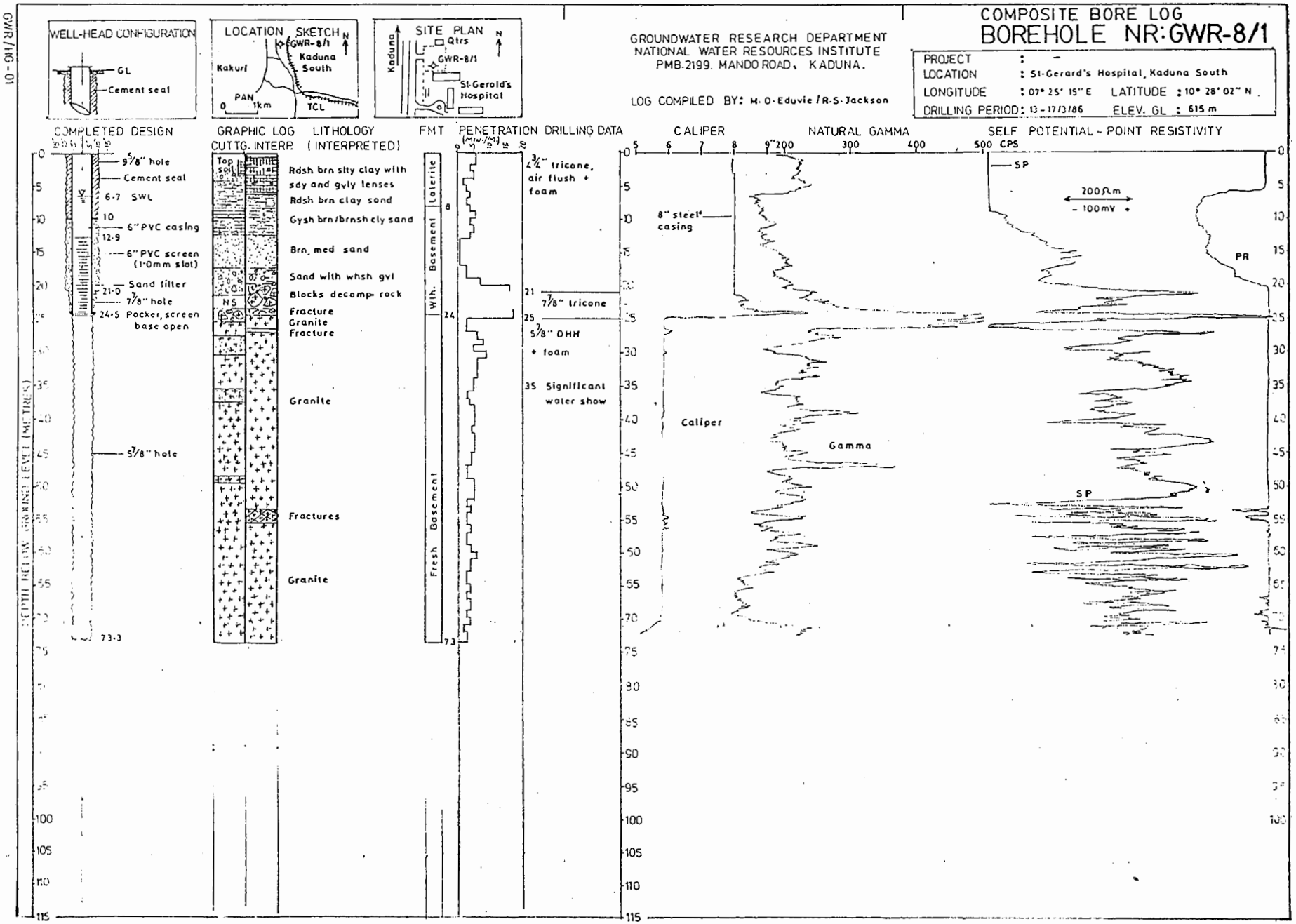
10 CONCLUSIONS AND RECOMMENDATIONS

The borehole taps 11.4m of the weathered zone aquifer (which is well fractured at its base), and 48.8m of the fresh Basement rock (granite) which has fractures at 26.0 and 53.0m. Transmissivity is accordingly relatively high (estimated at 21 m2/day).

The yield during a 24 hour pumping test was 7.2 m3/h - this will fill the hospital's ground storage tank of 118 m3 capacity in just over 16 hours. It is understood that a full tank is sufficient for about two days supply - thus the borehole is well able to satisfy the hospital's needs.

The water is of good chemical quality but the relatively high nitrate content may indicate some bacteriological contamination from nearby septic tanks - care should therefore be taken to boil the water before drinking.

GWR/HG-01


WELL-HEAD CONFIGURATION
GL
Cement seal
LOCATION SKETCH
GWR-8/1
Kaduna South
Kakuri
PAN
TCL
0 1km
SITE PLAN
Kaduna
Qtrs
GWR-8/1
St-Gerold's Hospital
GROUNDWATER RESEARCH DEPARTMENT
NATIONAL WATER RESOURCES INSTITUTE
PMB-2199. MANDO ROAD, KADUNA.
LOG COMPILED BY: M. O. Eduvie / R. S. Jackson
COMPOSITE BORE LOG
BOREHOLE NR: GWR-8/1
PROJECT : -
LOCATION : St-Gerard's Hospital, Kaduna South
LONGITUDE : 07° 25' 15" E
LATITUDE : 10° 28' 02" N
DRILLING PERIOD: 13 - 17/3/86
ELEV. GL : 615 m
COMPLETED DESIGN
GRAPHIC LOG CUTTG. INTERP.
LITHOLOGY (INTERPRETED)
FMT
PENETRATION DRILLING DATA
CALIPER
NATURAL GAMMA
SELF POTENTIAL - POINT RESISTIVITY
DEPTH BELOW GROUND LEVEL (METRES)
9 5/8" hole
Cement seal
6-7 SWL
10
6" PVC casing
12·9
6" PVC screen (1·0mm slot)
Sand filter
21·0
7 7/8" hole
24·5 Packer, screen base open
5 7/8" hole
73·3
Top soil
NS
Rdsh brn silty clay with sdy and gvly lenses
Rdsh brn clay sand
Gysh brn/brnsh cly sand
Brn. med sand
Sand with whsh gvl
Blocks decomp- rock
Fracture
Granite
Fracture
Granite
Fractures
Granite
Laterite
Wth. Basement
Fresh Basement
8
24
73
4 3/4" tricone, air flush + foam
21
7 7/8" tricone
25
5 7/8" DHH + foam
35 Significant water show
8" steel casing
Caliper
Gamma
SP
200Ωm
100mV
PR
SP