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FDWR/EDF WATER RESOURCES PROJECT

GROUNDWATER RESEARCH DEPARTMENT

National Water Resources Institute Kaduna

1985 Annual Report

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MRT CONSULTING ENGINEERS (NIGERIA) LTD

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1 BACKGROUND TO PROJECT

One of the main objectives of the Federal Department of Water Resources/ European Development Fund (FDWR/EDF) Water Resources Project NIG/400/78 is the establishment of a Groundwater Research Department (GWRD) within the National Water Resources Institute (NWRI) at Kaduna. In 1982 the Federal Ministry of Water Resources (now the Federal Ministry of Agriculture, Water Resources and Rural Development) signed an Agreement for Engineering Services with MRT Consulting Engineers (Nigeria) Ltd. to assist with this task. The Consultant was required to:

(a) draw up technical specifications and tender documents for the supply of a drilling rig, ancillary equipment, two support trucks, three personnel carriers and geophysical equipment - following EDF guidelines. One of the conditions was for the drilling rig manufacturer to supply the services of a driller mechanic (master driller) for 24 months;

(b) assist with the tender evaluation, award of contract and inspection and acceptance at the manufacturers' works;

(c) provide the services of a hydrogeologist (project co-ordinator) and a geophysicist for 20 and 12 months respectively in Nigeria, to train the Nigerian technical staff recruited for the GWRD, to supervise the field research programme and to produce reports on the various aspects of the work accomplished.

Two main phases to the work were envisaged at the start of the project:

(a) Phase I - Establishment

(b) Phase II - Operations

Phase I had largely been accomplished by the end of 1984 and consisted of the physical building up of the GWRD in terms of the provision of office and workshop space, recruitment of Nigerian staff, provision of staff accommodation, clearance and delivery of the importd equipment and vehicles, and the procurement of locally available materials. In addition a local budget for capital and operating expenses was prepared as part of a planning and cost exercise, and approved by the Permanent Secretary of the Federal Ministry of Agriculture, Water Resources and Rural Development.

Phase II operations got underway at the start of 1985 and continued throughout the year. A field programme was carried out in Kaduna, Plateau and Niger States, during which the Nigerian staff recruited for the project received on-the-job training. This report describes the activities that were undertaken.

2 OPERATIONS

2.1 Introduction

The programme of work carried out during 1985 is summarised on Figure 1. Work began in January, initially in an experimental catchment area (the catchment of the rivers Chidawaki and Chikaji) close to Kaduna, chosen to provide a convenient test bed for research in all aspects of the hydrologic cycle by the Institute as a whole; some work was also carried out at the Institute itself. The results of this first phase of investigations were presented in a working paper in July.

In June the programme moved away from the Kaduna base and work was carried out at Kwoi (near the southern boundary of Kaduna State) and on the Mar Farms near Nassarawa (Plateau State) at the request of the Federal Ministry of Agriculture, Water Resources and Rural Development.

The Niger State Water Board was visited on 27 and 28 March to discuss about the possibility of carrying out a research project in response to a letter written by the Board to the Institute in December 1984. A proposal was prepared for geophysics and drilling to be carried out at Suleja (representing the Basement Complex) and at Kutigi (representing the Nupe Sandstones of the Niger river basin), and for aerial photograph interpretation at other locations on the Basement. Work started in July at Suleja, and two boreholes were drilled following a geophysical survey. Further geophysical work was carried out at the other locatities on the Basement in November, following earlier photogeological mapping. Investigations at Kutigi will be carried out early in 1986.

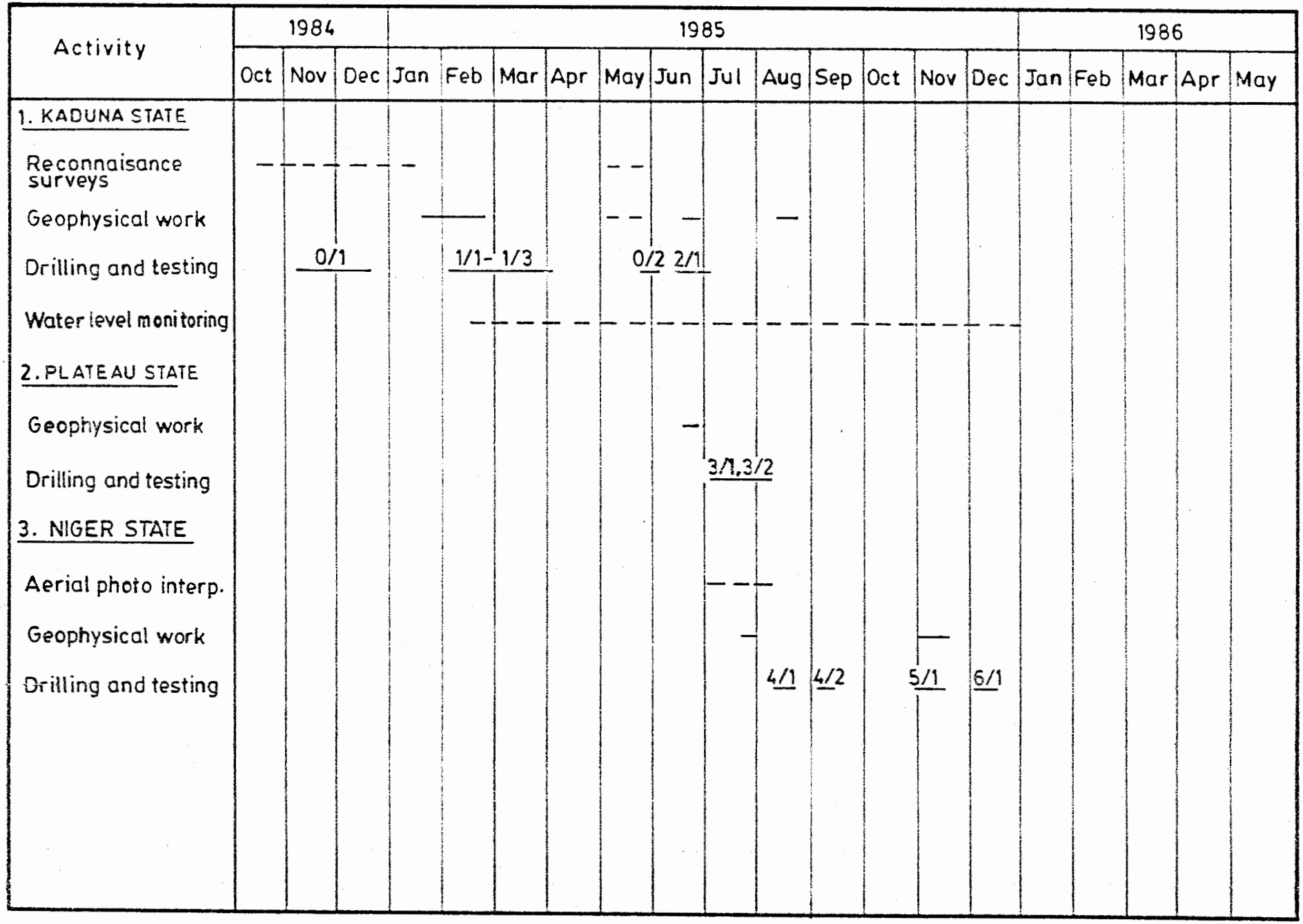
In November a borehole was drilled at Minna for the Upper Niger River Basin and Rural Development Authority, and in December on a farm near Lapai (Niger State).

The first year's field programme has been encouraging _ the staff recruited for the project have worked well in the field and benefited from the training, and the equipment, after some teething problems, has performed satisfactorily. However, progress was constrained by several administrative and logistical problems which need resolving if the project is going to continue to be effective. The main problems were:

(a) **Shortage of funds.** Despite the approval of a local currency budget in 1984, little, if any, of the money for capital and operational expenditures was received, and the project had to be financed from the Institute's own limited resources. Invariably there were long delays, particularly during September and October, while funds were awaited from Lagos for the payment of staff salaries and allowances, and the issuing of advances for operational expenses.

(b) **Lack of radio communication equipment.** Radio communication is

Figure 1 Groundwater Research Department - Programme of Fieldwork



essential for the efficient direction of any field programme, and for organising logistical support. Much time (and money) has been spent by senior staff driving to and from the field sites, some as far away as 300km from Kaduna, in order to monitor progress and give necessary directions - this could have been minimised had radios been available.

(c) **Difficulties with field accommodation.** Although tents were provided as part of the project equipment, they have not been found to be very practical for a field programme involving frequent site moves, particularly in the rainy season (April - October). Since early June, when field work moved to areas distant from Kaduna, accommodation has had to be found at each location - sometimes for as many as 25 men. Some of this accommodation was well below the standard expected for expatriate and senior counterpart staff, and privation and frequent illnesses were experienced as a result. Caravans or field accommodation modules are the only satisfactory answer to this problem.

2.2 Drilling

Eleven boreholes were drilled during the year - their locations are shown on Figure 2, and results summarised on Table 1.

Following the registration of the rig and support trucks in January the drilling equipent was mobilised to the experimental catchment area (ECA) near Buruku. Three boreholes were drilled on the fadama (alluvial plain) of the R. Chidawaki near the western end of the ECA.

The first borehole of the group, GWR-1/1, was drilled to the greatest depth (102m) in order to test the fresh Basement rock and to provide further training for the crews in the use of the down-the-hole hammer (some training had previously been given during the drilling of GWR-0/1 at the Institute in November/December 1984). A sampling test was carried out by airlift.

The second borehole, GWR-1/2, was drilled just to the top of the fresh rock at 15m, and 6 inch (150mm) nominal diameter (nd) PVC screen was installed in the overlying alluvium and weathered zone. The crew was introduced to a different drilling method; only water was used as the circulating fluid and the hole was kept open by temporary casing following the bit. The casing was withdrawn as gravel pack material was emplaced around the screen string. After completion, a short pumping test was carried out by airlift.

The third borehole, GWR-1/3, was drilled on the opposite side of the fadama strip to determine the thickness of the alluvium and weathered zone near to the course of the R. Chidawaki. A biodegradable drilling chemical was used for the operation. Screen was installed opposite the alluvium and parts of the weathered zone. Unfortunately the site had to be abandoned just when the borehole was ready for testing because of flooding following a period of heavy rain at the end of March.

FIGURE 2 GROUNDWATER RESEARCH DEPARTMENT-LOCATION OF DRILLING SITES

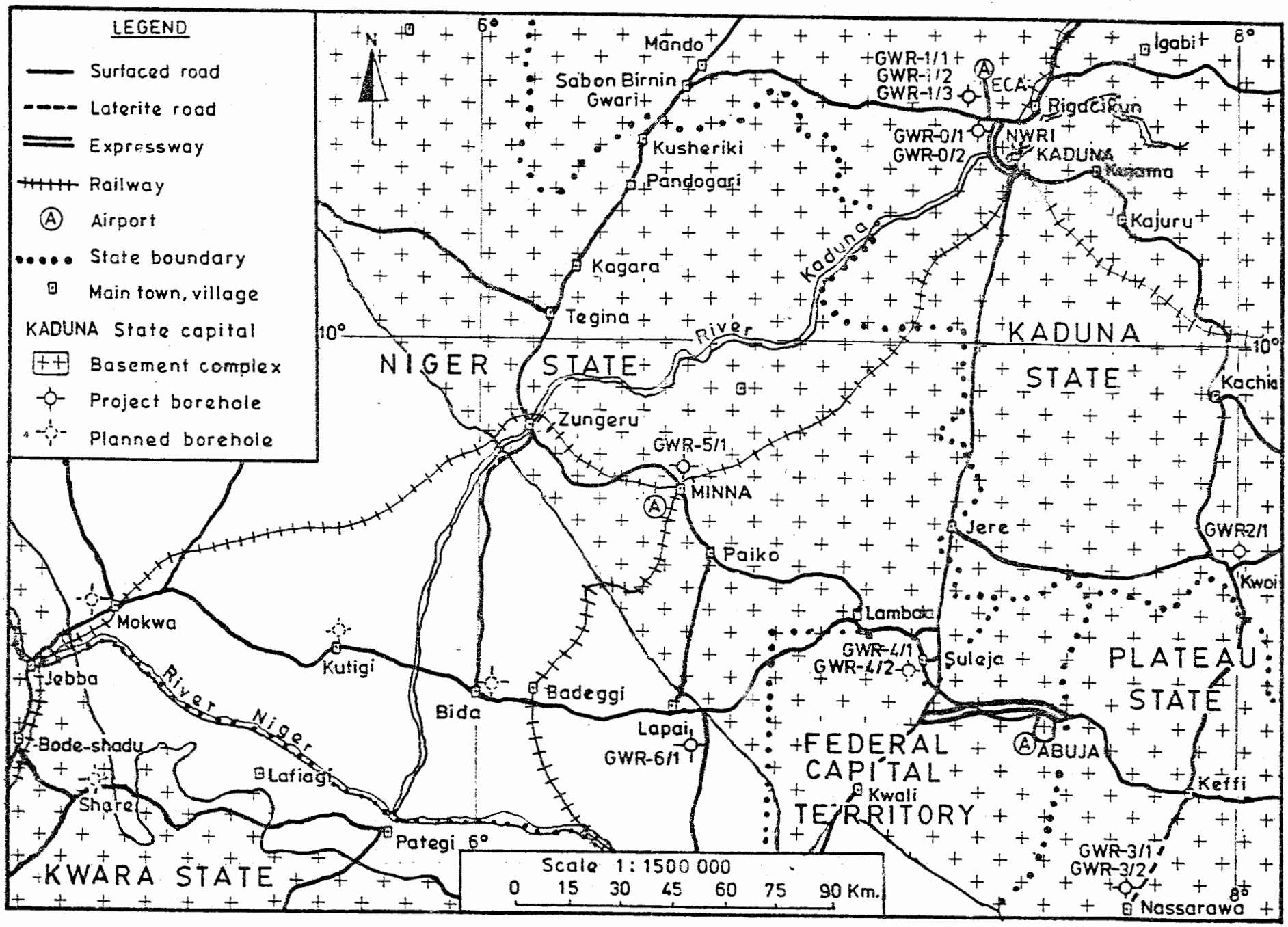


TABLE 1

GROUNDWATER RESEARCH DEPARTMENT - SUMMARY OF BOREHOLE RESULTS

Borehole nr.	Location	Co-ordinates Longitude	Co-ordinates Latitude	Ground Elevation (m)	Total depth (m)	Depth to fresh BC (m)	Completion Screen (m)	Completion Open hole (m)	Test Discharge (m^3/h)	Pumping Duration (m)	SWL gl (m)	Draw-Down (m)	EC (u.S/cm)
GWR-0/1 (1)	N.W.R.I.	07° 25' 18"	10° 34' 55"	625	92.0	38	None	40.8-92.0	2.9	7	7.5	>43	280
" -0/2	"	" " "	" " "	"	29.0	27.1	13.1-23.7	None	1.0	128	6.8	5.8	200
" -1/1	ECA	07° 16' 21"	10° 38' 27"	575.1	102.0	16.0	None	18.0-102.0	0.6e	60	1.9	>80	410
" -1/2	"	" " "	" " "	574.8	15.0	15.0	6.8-13.9	None	7.4	240	1.7	3.7	140
" -1/3	"	" " "	" " "	574.1	40.1	28.0	5.3-11.3) 26.3-32.3)	None	-	-	1.1	-	-
" -2/1	Kwoi	08° 00' 16"	09° 26' 46"	777	61.3	11.4	None	13.1-61.3	0.5	330	10.1	32	95
" -3/1	Nassarawa	07° 43'	08° 34'	?	43.5	14.9	6.0-30	30 - 43.5	1.2	196	3.3	24.4	400
" -3/2	"	" "	" "	?	61.4	12.8	5.3-14.3	14.3-61.4	1.6	1445	2.2	32.0	350
" -4/1	Suleja	07° 10' 21"	09° 10' 22"	410	40.0	5.2	None	9.0-40.0	0.4	1440	4.0	3.4	140
" -4/2	"	07° 10' 35"	09° 10' 49"	415	60.0	8.0	None	8.9-60.0	2.8	1440	6.6	21.3	150
" -5/2	Minna	06° 28'	09° 41'	?	70.0	4.7	None	5.4-70.0	1.4	45+	4.7	10.4	420
" -6/1	Lapai	06° 36' 13"	09° 00' 47"	145	61.3	22.8	13.0-24.4	24.6-61.3	2.5	420	13.8	19.6	250
				Total	675.6								

Note: (1) drilled in 1984

GWR-0/2 was drilled for the hydraulics laboratory calibration tank at the Institute, while funds were awaited for the mobilisation away from Kaduna. The borehole was drilled to 29.0m and fresh Basement rock was encountered at 27.1m. Screen was installed opposite the lower part of the weathered zone, and the annualar space was filled with a sand filter. Unfortunately a break occured in the bottom length of screen which allowed sand to enter the well in large quantities during airlift development. However, this problem was solved by backfilling the bottom 3m of the borehole with gravel and cement. A short airlift test was then carried out, at a discharge of 1.0 m3/h - this is more than enough for the requirements of the calibration tank. The water quality is good, with an EC of 200 u.S/cm.

GWR-2/1 was drilled as a goodwill gesture at the Government Girls Secondary School at Kwoi, following the checking of a FDWR borehole there. The yield of the FDWR borehole was reported to be unsatisfactory and it was thought by the FDWR that the screen may have clogged up in the two years between the completion of drilling (in November 1982) and the installation of the pump. However, it was found after two days of testing that the pump was able to produce a reasonable supply of water (1.8 m3/h), providing some back pressure was applied on the discharge line to prevent air surging.

The drilling of GWR-2/1 began on 13 June but was not completed until 3 July. Much time was spent in trying to install steel casing past a granite boulder in the weathered zone - the boulder was rather loose and kept deflecting the string during reaming. It took 10 days to produce a straight enough hole to enable 6 inch nd casing to be installed to the top of the fresh Basement. The water producing capacity of the borehole is too low for the efficient operation of a mechanically_driven pump. However, the water quality is excellent for drinking purposes, and it was recommended that a handpump be installed to serve the needs of the nearby houses and school buildings.

GWR-3/1 and GWR-3/2 were drilled on the Mar Farms near Nassarawa in Plateau State. Both boreholes were completed with open-ended 6 inch nd PVC screen opposite the weathered zone, and open hole in the fresh rock below. The bottom of the screens was packed around with inner tubes and sacks to ensure a tight seal with the borehole wall to prevent the inflow of gravel pack material from above. Both boreholes have been equipped with electric submersible pumps by the farm owner.

GWR-4/1 and GWR-4/2 were drilled at Suleja as part of the research project proposed for the Niger State Water Board. GWR-4/2 encountered significant fracture zones in the Basement rock at 11 to 15m and 21 to 22m - these render the borehole relatively productive; the terminal yield during pump testing was 2.8 m3/h.

At GWR-3/2, GWR-4/1 and GWR-4/2 pump testing was run for continuous periods of 24 hours.

GWR-5/1 was drilled at the Minna headquarters of the Upper Niger River Basin and Rural Development Authority near a site selected by a

resistivity survey undertaken by Ahmadu Bello University in 1983. The borehole encountered Basement rock at about 5m and some fracture zones to 13m and around 46m. However, the borehole yield was relatively low (1.4 m3/h by bailing).

GWR-6/1 was drilled on the farm of Malle Farms (Nig.) Ltd. near Lapai. The only aquifer occurs in the lower 9m of the weathered Basement; the fresh rock below has no fractures. However, a yield of 2.5 m3/h was obtained during a 7 hour pumping test, and the water quality is good for domestic purposes.

2.3 Geophysics

Geophysical surveys were generally carried out in the same areas as the drilling, in order to select the most favourable sites and to calibrate the results with actual borehole logs. However, some work was also done at three villages on the Basement in Niger Stage, in connection with the photogeological mapping exercise of the research project proposed for the Niger State Water Board.

Both resistivity and seismic refraction methods were employed, although the latter is only of use in areas where the fresh Basement rock occurs at depths of less than 10m or so, because of limitations to the equipment supplied. The resistivity method has been useful in estimating the depth to rock and locating the most favourable zones for productive boreholes - vertical electrical soundings (VES) using both the Offset Wenner and Schlumberger arrays have been used, as well as constant electrode separation traversing.

Field data have been processed and analysed on a BBC microcomputer belonging to the Consultant, and the interpreted results printed out on specially prepared formats.

Table 2 summarises the geophysical work undertaken in 1985.

In the ECA, soundings and traverses were carried out mainly between the group of three boreholes (GWR-1/1, GWR-1/2 and GWR-1/3) and Nagijmbe Hill near the western end of the area, a distance of about 1.4 km. Some work was also done near proposed drilling sites on the watershed between the rivers Chidawaki and Chikaji along the road to the new airport.

TABLE 2

SUMMARY OF GEOPHYSICAL WORK

Location	Number of VES		Number of resistivity traverses	Number of Seismic spreads
	Offset Wenner	Schlumberger		
ECA (Jan-May)	23	2	3	2
ECA (Aug.)	2	2	-	-
Kwoi	1	-	-	-
Nassarawa	6	-	4	-
Suleja	3	3	-	5
Kagara	5	3	8	6
Pandogari	4	-	4	1
Nasko	3	1	2	2
Rijau	2	1	7	4
Total	49	12	28	20

Field work was interrupted at the end of February when the resistivity recording instrument (Terrameter) stopped functioning, apparently with the same fault as had previously required the input amplifier circuit board to be replaced (in 1984). Work did not resume until May, after the instrument had been sent to Europe for repair.

The survey at Mar Farms, Nassarawa was executed from 21 to 26 June. Six vertical electrical soundings (VES) and four 400m long constant separation traverses (25m electrode spacing) were done. The data were analysed in the field by computer, and the interpreted results included in a report prepared by the counterpart hydrogeologist/geophysicists concerned. A plot of apparent resistivity contours was used to select the drilling site for the borehole to supply water to the farm houses (GWR-3/1) - the site for the second borehole (GWR-3/2) was chosen from access and utilisation considerations, before the survey was carried out.

Geophysical investigations were undertaken at Suleja on behalf of the Niger State Water Board with the aim of locating suitable sites for drilling productive boreholes in water-short areas of the town. Only two areas of sufficient size for conducting surveys could be found in the town itself; both were at schools. Six VES were carried out, using both Offset Wenner and Schlumberger arrays, and five seismic refraction spreads (there was not enough space for resistivity traversing). The survey started on 22 July and was completed two days later. A report was prepared by the counterpart hydrogeologist/geophysicist who directed the survey, which gives full details of the results obtained. It was concluded that Basement rock occurs at 5 to 8 metres (this was confirmed by the subsequent drilling of GWR-4/1 and GWR-4/2).

During August the sounding curves produced from a survey carried out by Ahmadu Bello University for the Upper Niger River Basin and Rural Development Authority (UNRBRDA) at Minna in 1983, were analysed using the computer to check on the validity of the interpreted results. Unfortunately, no indication was given in the survey report on what arrays or electrode spacings were used. However, it was decided to use apparent resistivities taken from the curves and feed them into the computer using the Offset Wenner array program. In the event very similar curves were produced, and the interpreted results supported the previous conclusions on the location of the best drilling site (GWR-5/1 was subsequently drilled near to the recommended location).

The survey in Niger State was carried out from 31 October to 19 November. The areas investigated included the villages of Kagara (Figure 2), Nasko and Rijau where photogeological maps had previously been prepared for the Niger State Water Board research project. After the data have been analysed and interpreted, a report will be prepared by the counterparts concerned.

2.4 Aerial Photograph Interpretation

The proposal for a research project submitted to the Niger State Water

Board included the preparation of a photogeological map for Suleja incorporating the results of the geophysical survey and drilling; in addition, aerial photo interpretation was to be carried out for the villages of Kagara (Figure 2), Nasko and Rijau to extrapolate the techniques developed for Suelja.

Unfortunately, it was subsequently found that aerial photographs for Suleja were not available at the Geological Survey in Kaduna so no photogeological map could be prepared. However, photographs for Kagara, Nasko and Rijau were available, and interpreted by the counterpart hydrogeologists/geophysicists. The resulting photogeological maps were used as a basis for the geophysical surveys at these locations to select optimum sites for productive boreholes (see Section 2.3).

2.5 Water Level Monitoring

Regular monitoring of the boreholes at the Institute and the ECA began in April for the determination of seasonal water level flucuations and, eventually, longer term trends.

The elevations of the boreholes in the ECA were determined by instrument survey from nearby national benchmarks and trigonometrical stations, to enable water levels to be reduced to a common datum. A local benchmark was established near the borehole group. The work was carried out by students of the Institute.

2.6 Conclusions of Experimental Catchment Area Investigations

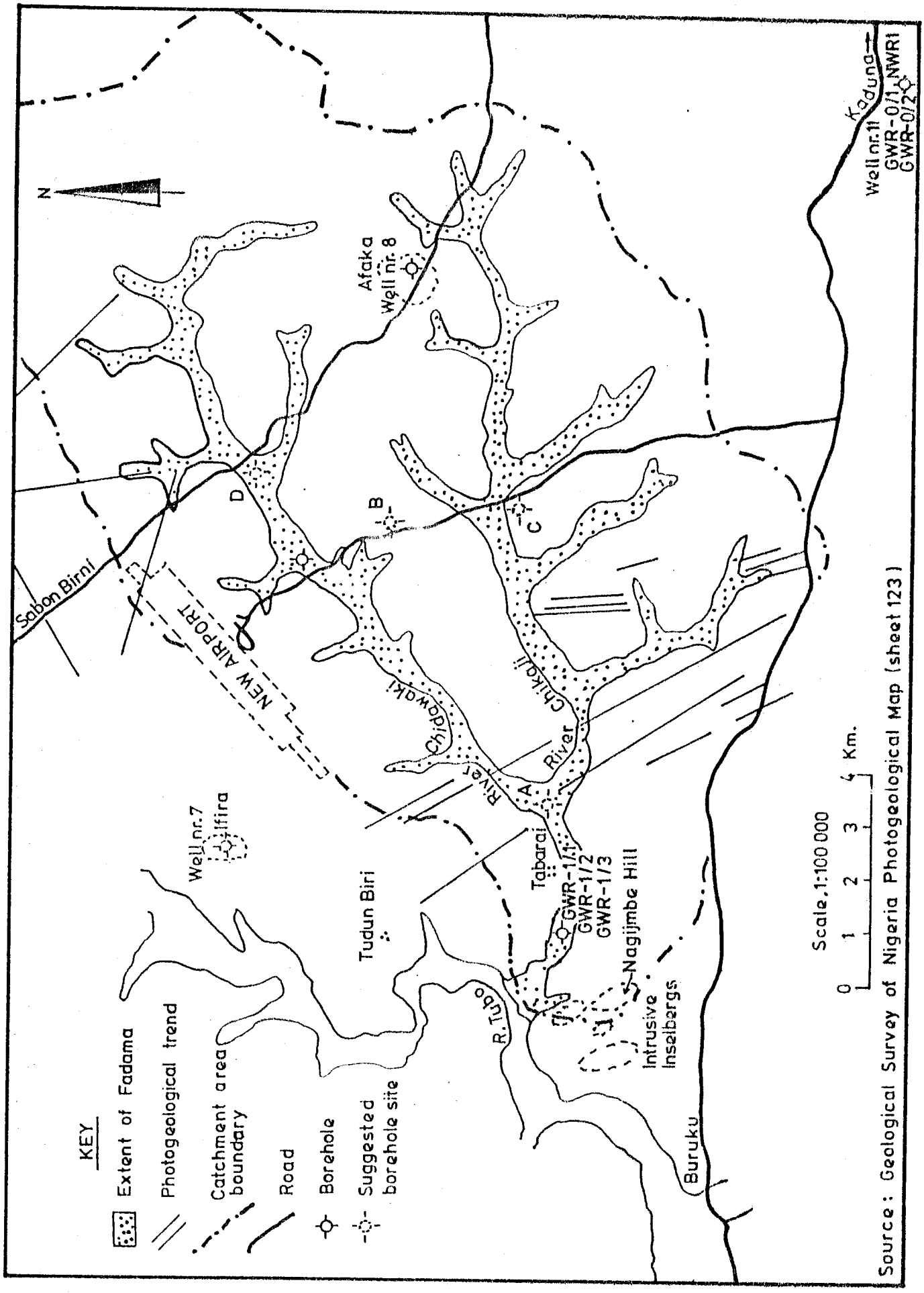
2.6.1 Hydrogeology

The only aquifer of any significance in the ECA occurs within the alluvium of the fadama and the weathered zone of Basement Complex (Figure 3). The fresh Basement is virtually impermeable, the only water occurring in minor cracks and fissures; however, prospects may be better along the lineaments shown on the photogeological map (Figure 3) and it would be worth drilling in this area during a future phase of the research programme.

The aquifer consists of alluvial sand and gravel, containing significant quantities of vegetation and wood remains in the area investigated, underlain by clayey silt of the weathered zone grading down into sand-sized particles and fragments of decomposed Basement rock. The Basement itself consists mainly of dark coloured banded gneiss with some quartzite veins.

The aquifer is phreatic, the water table lying about 2m below ground surface. Its thickness varies from about 14m at GWR-1/1 to 26m at GWR-1/3, and it is probable that the aquifer is thickest along the river courses, where weathering of the Basement is likely to be most pronounced.

Figure 3 Experimental Catchment Area - Extent of Fadama



Only one borehole, GWR-1/2, was pump tested (by airlift). The transmissivity was estimated to be 30 m2/day, and permeability about 4 m/day (screen length 7.1m). However, not much credence can be given to the results of one short test and more substantial tests are required, with observations not only on the borehole but also on piezometers spaced some distance away, before more reliable estimates can be made.

The aerial extent of the fadama in the ECA has been determined to be 23.6 km2. The aquifer is likely to be thinnest in the head reaches and thickest (where the drilling was carried out) towards the outlet of the drainage system. Taking an average aquifer thickness then of, say, 10m for the fadama as a whole, an aquifer volume of 236 million m3 is indicated. Assuming a specific yield of 10% (a value typically applied to clayey sands and sandstones) the amount of water in storage can be estimated to be of the order of 23.6 million m3.

The aquifer storage is increased when recharge occurs. As demonstrated by the events at the end of March the main recharge mechanism appears to be the infiltration of floodwater following periods of heavy rainfall. A water level rise of about 0.8m occured in GWR-1/1 following the flooding of the fadama after the heavy rainfall of 29/30 March (61mm at the new airport and 70mm at the NWRI). The R.Chidawaki rose and flooded the site about 24 hours after the rain fell; the water was about 0.7m deep when the site was visited a few hours later.

The water from the Basement Complex and related aquifer is of good quality (EC 200 to 410 uS/cm). Salinity is lower in the fadama aquifer than in the underlying rock, since the flushing action of fresh recharge water is more pronounced where the premeability is highest. However, the fadama aquifer water appears to have a significant iron content; this will cause staining of pipes and fittings and impart a slightly unpleasant taste to drinking water supplies if untreated.

2.6.2 Geophysics

The ECA provided the first opportunity to test the resistivity equipment, and to train the counterparts in the various techniques.

The Offset Wenner array was found to be much more convenient to use than the Schlumberger. The main drawback of the latter is that it is necessary for the operator to tell his assistants when to move electrodes, and without radios this becomes time consuming at the larger electrode spacings, with a serious risk of mistake which could cause delays or even an erroneous sounding curve. For this reason it was decided to use the Offset Wenner array as the normal array for soundings.

In a number of cases crossed soundings (i.e two soundings with the same centre point but orientated at approximately right angles to each other) were carried out. In most instances the two sounding curves were similar to each other and thus their interpretations are similar, the differences being less than the ambiguities caused by suppression and equivalance.

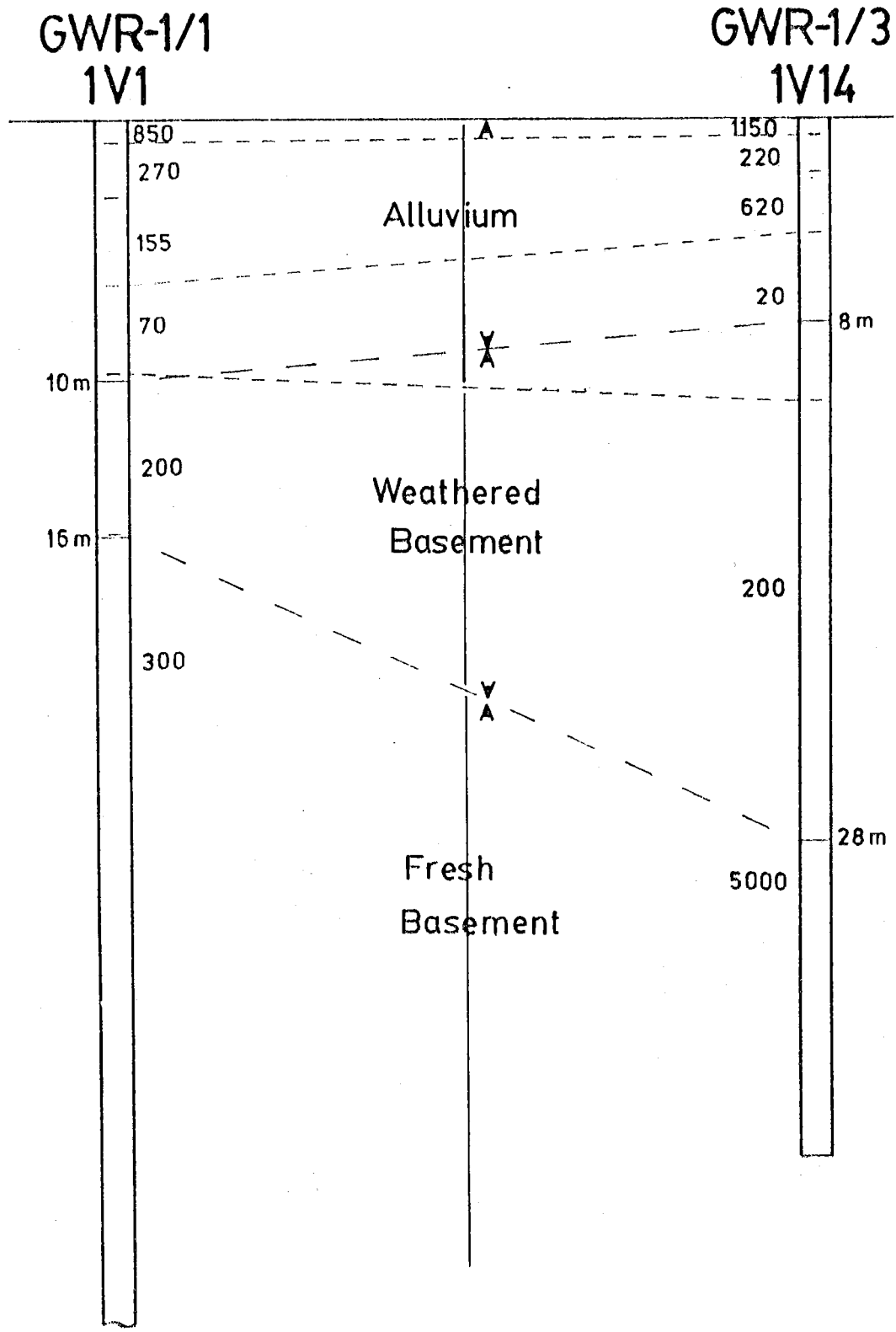
Considerable lateral variations were found between some adjacent soundings towards Nagijmbe Hill from the borehole group. It is believed these variations, which were most notable in the shallower depths, are due to differences in vegetation and tree cover, and the related moisture content of the root zone. Resistivity was found to be higher in the upper layers where tree roots, and their related moisture, were present.

During the early part of the rainy season (in May) two soundings were carried out at the same positions, and with the same orientations, as two earlier soundings which had been carried out during the dry season (in January _ February). The apparent resistivities for small electrode spacings were found to have decreased, but at larger spacings there were no significant changes in the sounding curves. Also, there was no marked difference in the reliability of the two sets of results. However, field work was slightly easier during the rainy season as the electrodes could be pushed into the ground, instead of having usually to be hammered in, and it was not necessary to use water to reduce contact resistances and so allow enough current to be used for accurate readings.

Comparison of soundings with borehole logs is only possible for 1V1 and 1V2 (borehole GWR-1/1) and 1V14 (GWR-1/3). These are shown in Figure 4. The interpretations were revised after the boreholes had been drilled to ensure that the depths were consistent with the drilling results.

In the case of 1V1, the 850 ohm-metre layer is the dry surface layer while the 270 ohm-metre layer could be the capillary fringe. Variations in resistvity in the alluvium below the water table will be caused by variations in grain size and clay content. The main surprise is the relatively low resistivity (300 ohm-m) of the upper part of the fresh Basement rock, which could extend to about 100m

Figure 4 Comparison of Resistivity and Drilling Results



below surface (the sounding curve does not define this depth with any accuracy). This is confirmed by 1V2. A possible explanation of this is extensive fracturing of the rock, but this is not apparent from the drilling results.

In the case of 1V14, the sounding can again be interpreted in a way that is consistent with the drilling results, although it is not possible to identify the interface between the alluvium and the weathered rock.

2.7 Training

Training of the counterpart staff has essentially been on-the-job during the execution of the drilling programme and geophysical surveys.

The experimental catchment area work provided the first opportunity for this training. Staff were introduced to mud and down-the-hole hammer (DHH) drilling, formation sample collection, penetration rate measurement, casing installation and gravel pack preparation. Training was also given in formation sample description, particle size analysis, geophysical well logging, chemical analysis, and pumping test operation and data plotting. Standard forms were prepared for these activities to encourage a uniform approach to data collection and presentation.

Training in geophysics was given on the various field techniques, and data processing and interpretation on the Consultant's microcomputer.

In order to complement the training received in the field a manual on groundwater investigation and development, based on the experience of the project and that of other work undertaken by the Consultant elsewhere, was begun in October. Also sets of reference text books on groundwater exploration and data analysis were ordered for the senior counterparts, using savings in the project's foreign currency budget.

A rota system was initiatd amongst the counterpart hydrogeologists and some of the technicians to ensure that staff were introduced to both geophysical and hydrogeological fieldwork and data analysis. However, those staff with some previous practical drilling experience were allocatd to form the senior members of the drilling crew from the start to ensure that training in the operation of the rig - which is an expensive and potentially dangerous piece of equipment - was concentrated on the most suitable personnel.

Some of the mishaps that occurred during the year provided valuable experience for the staff - these included: coping with breakdowns on the equipment; extracting bogged-down plant and vehicles from a flooded site; emplacing a gravel/cement backfill to prevent the flow of sand through broken screen; and recovering a broken-down vehicle over 400 km from Kaduna.

The success of the training programme can be judged from the fact that

geophysical surveys and data analysis continued after the departure of the Consultant's geophysicist (in August), and that boreholes GWR-3/2 and GWR-4/1 were drilled without any major problems when Mr Rigg (the master driller supplied by Halco, the rig's manufacturer) was on home leave and undergoing medical treatment in July-September.

After the end of the academic year (in July) two students were attached to the project as part of their industrial training programmes; one was from the Institute itself, and the other from the Anambra State University of Technology.

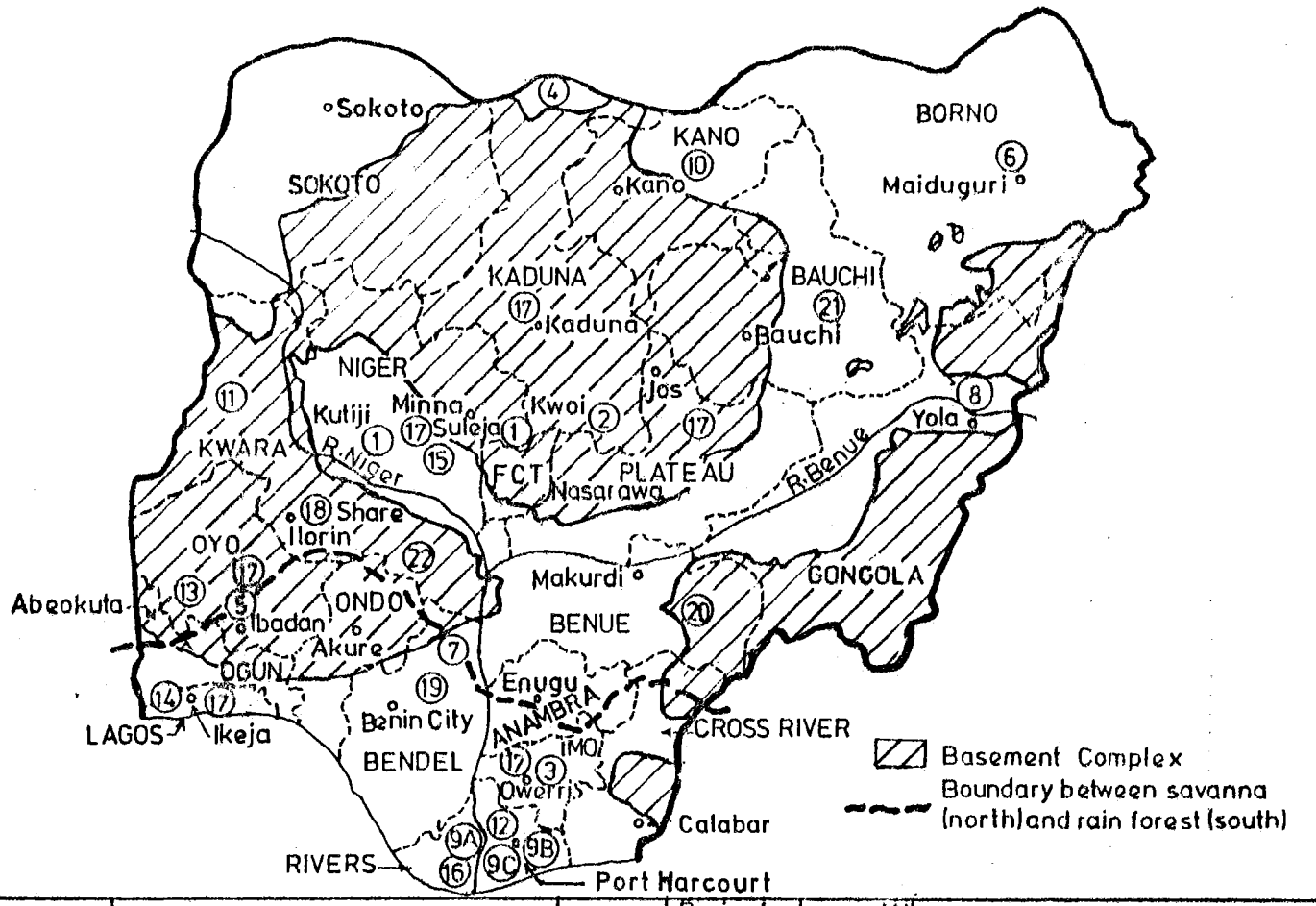
2.8 Research Proposals

A questionnaire to gather proposals for possible research projects was sent to all the State Water Boards, River Basin and Rural Development Authorities, and FDWR zonal offices in February.

The response was very encouraging _ 24 proposals were received (the figure includes the request from the Niger State Water Board, received before the questionnaires were despatched). The locations of the proposed projects are shown on Figure 5.

It is estimated that a research programme based on the proposals already received will occupy the GWRD for at least 5 years.

Figure 5 Proposals for Groundwater Research Projects



Proposal Number	Authority	State	Project size (km²)	Geology (1)	Scope/objectives
1	Niger State Water Board	Niger		B&S	B-borehole siting; S-well design
2	Kaduna State Water Board	Kaduna	225	B	Borehole siting
3	Imo State Water Board	Imo		S	To delineate gw. occurrence
4	Min.of Agriculture & Co-operatives	Kaduna	1000	A	Development of fadama aquifer
5	Oyo State Water Corporation	Oyo	490	B	Borehole siting & design
6	FDWR/BSWB/CBRDA/LCR/	Borno	50,625	S	Recharge of aquifer by boreholes
7	Benin River Basin & Rur.Dev.Auth.	Bendel	-	S	Influence of topography on gw.occur.
8	Upper Benue River Basin & RDA.	Gongola	10	S	Reasons for falling yields & wl.
9A	Delta Basin & Rural Devel. Auth.	Rivers	2	S	Relationship high Fe.content gw/creeks
9B	Rivers State Utilities Board	"	0·02	S	Saltwater instrusion/location fresh gw.
9C	Federal Dept.of Water Resources	"		S	Determination fresh/salt gw.interface
10	Kano Hadejia River Basin & RDA.	Kano	2,500	S	Feasibility gw. irrigation
11	Kwara State Water Corporation	Kwara		B	Borehole siting and design
12	University of Port Harcourt	Rivers		S	Inventory of groundwater data
13	Min.of Agriculture & Natural Res.	Oyo		B	Gw. exploration for agric settlements
14	Min.of Agriculture & Co-operatives	Lagos	0·2	S	Groundwater irrigation development
15	Upper Niger River Basin & RDA	Niger	1	S	Reasons for low yield of Nupe Ss.
16	Rivers State Utilities Board	Rivers		S	Salinity, high Fe. content
17	Federal Department of Fisheries	Various		B&S	Groundwater explorat.for fisheries
18	Niger River Basin Devel. Auth.	Kwara			Aquifer properties, bh design & op.
19	Bendel State Water Board	Bendel	5	B&S	Gw.resource eval.using api.
20	Benue State Water Board	Benue	4,400	B	Borehole siting (geophys).drilling
21	Gongola-Jama'are River Basin RDA	Bauchi	28,750	S	Aquifer evaluation
22	FDWR Ilorin Office	Kwara	1,310	B	GW potential for domestic/irrigat.

(1) B - Basement, S - Sedimentary Formations, A - Alluvium (fadama)

3 EQUIPMENT AND VEHICLES

3.1 Drilling Equipment

3.1.1 Equipment Supplied by Hydreq

The bulk of the equipment supplied by the Halifax Tool Company (Halco) and Hydreq was delivered in 1984 and a ceremony was held on 25 March 1985 at the ECA drilling sites to formally hand over the equipment from the EEC/EDF (European Economic Community/European Development Fund) to the FDWR/NWRI.

However, some items from Hydreq's third consignment could not be cleared from Lagos port at the same time as the rest of the equipment, and were delivered about 12 months later: a double axle trailer, and case nr.51 (containing two Monolift test pump sets and related spare parts) on 22 April; and case nr.50 (containing welding spares, hand tools, Land-Rover spares, vehicle manuals, bulbs for lighting sets, and casing items) on 29 June.

A provisional acceptance committee convened to inspect these items on 12 and 15 July. The committee consisted of the following members:

(a) Mr K.A. Afolabi - FDWR Zonal Office Kaduna;

(b) Mr A.J.R. Goodwin - Delegation of the Commission of the European Communities, Lagos;

(d) Mr R.S. Jackson - MRT Consulting Engineers (Nigeria) Limited.

Although most of the equipment was in reasonably good condition, some items were damaged or missing - probably because of the 12 months storage period at Lagos port - and needed replacing; also, some items had not been supplied, despite being specified and tendered for. Table 3 lists these items, and gives the status of their replacement or supply.

The EEC and FDWR agreed to the Consultant's proposal that the replacement of the items found deficient during the provisional acceptance of the bulk of the equipment in 1984 could be waived, providing that the value of the items (estimated at2192 pound sterling CIF) be refunded by Hydreq to the EEC. The absence of these items (12v truck batteries, tool kit and clock for the Peugeot 504 family estate, Land-Rover door lock cylinders and keys, cable for lighting towers, and 8 lengths of steel casing) will not adversely affect the progress of the project, and the time involved in administering their clearance and internal transporation will be saved.

However, before these issues were resolved, the EEC called for Hydreq's guarantee maintenance bond (10% of the contract sum) in September for non-performance over the supply of replacement items. But Hydreq was taken over by Dando Drilling Systems Ltd. (also of the UK) in August, and the new management has pledged to resolve all

TABLE 3

HYDREQ'S THIRD CONSIGNMENT - FINDINGS OF PROVISIONAL ACCEPTANCE COMMITTEE

Item (Contract List Nr.)	Description	Quantity	Reason for replacement	Status at 31/12/85
2.5	Peugeot diesel engine manual	2	Damaged by water	Hydreq due to despatch 2 drivers handbooks and microfiche workshop/ service instructions for Peugeot 504 in January 1986.
2.6	Workshop manual for Land-Rover	1	Damaged by water	Received Kaduna 5/11/85
	Parts " " " "	1	" " "	" " "
3.1B	Bulbs for lighting sets	12	Missing from Case Nr. 50	" " "
3.2B	BH 250 D Monolift pump assembly	1	Jammed - seized up, cannot be rotated.	Mono Pumps Limited will replace free of charge, delivery Kaduna expected February 86.
3.2	2½" discharge regulating valve	1	Not supplied	Due to be despatched in January .
	4" " " "	1	" "	Not yet received Kaduna.
	Ott KL 50 electric water level sounding tapes	2	" "	

outstanding obligations. The bond was accordingly extended to 22 November, and then by a further two months to 22 January 1986 - however, since the Monolift pump replacement will not be effected until early February, Hydreq will request for the bond to be extended to 22 February 1986.

Following the provisional acceptance of the bulk of the equipment in 1984 several deficiencies came to light when the equipment was used for the first time; the most serious were found on the water tanker (the suction hose and tanker pipework were of different diameters), and the generator (no compression on one of the engine cylinder heads). Replacement parts were supplied by Hydreq, which arrived in Kaduna on 4 May.

3.1.2 Equipment Supplied by Halco

Various items supplied by Halco to make good deficiencies noted during the provisional acceptance in September 1984 were delivered to Kaduna on 12 January. These included: brake air line, and cable and connector for the mud pump trailer; rear light assembly for the compressor; bearing collars and seals for the gearbox on the rig; air swivel extracting tools; and assorted washers and O-rings. Two inner tubes for the rig truck were purchased locally.

Of the outstanding items to be provided, the Consultant agreed to waive the requirement for a replacement tyre to the compressor owing to the minor nature of the damage to the original tyre.

Since there were no further issues to be resolved the Consultant advised the FDWR on 8 July that a recommendation could be made to the EEC to release the 5% retention payment.

3.1.3 Equipment Performance and Modifications

Generally, the equipment has performed satisfactorily. The only breakdowns occurred in March - to the variable displacement hydraulic pump on the rig; and to the mud pump, when the clutch plates on the power take-off burnt out. The hydraulic pump was easily put back into service by the replacement of a corroded part on the drive shaft. New clutch plates for the mud pump, however, had to be procured in Port Harcourt when a visit was made there to obtain a 3 inch high pressure ball valve, also for the mud pump (the valve was required to control the pump pressure while using the mixing line for mud preparation).

There have been some problems with the smaller of the two Monolift test pumps supplied (model P631 CE). The pump initially would not work, and success was only achieved after a non-return valve (fashioned from a coach bolt, washer and spring) was installed in the inlet assembly below the pump. The manufacturer, Mono Pumps Limited, recommended immersing the pump in water for some time before operation to permit a good seal between the stainless steel rotor and rubber stator - this practice worked, and the non-return valve was

then removed.

However, the pump is not really suitable for the very low yields associated with Basement Complex boreholes - its rated capacity is 9.5 m3/h at 80m total head (and 1000 rpm), whereas the yields of the boreholes so far drilled lie in the range 0.4 to 2.8 m3/h. In order to prevent the pump from running dry the regulating valve on the discharge line has had to be almost closed - on a positive displacemtnt pump such as the Monolift this causes water slip at the rotor/stator interface which may eventually damage the pump. In order to correct this situation Mono have offered to supply a P301 BC pump unit, which is better able to cope with these very low flows, on a free-of-charge basis as a direct alternative to the original pump.

The trailer which was supplied with the test pumps could not be towed by any of the project vehicles because the tow bar was at a different height to the vehicle hitches. However, modifications were made to the bar so that the trailer could be towed by the project Land-Rovers.

A lockable caravan was loaned from the FDWR Kaduna office in February for use as a mobile workshop and store on site. A work bench was installed, and wiring for lights and power points for connection to the generator.

A weir tank, with a 90 degree V-notch, was constructed in May for the measurement of discharge during airlift pumping tests; a 30 degree notch was subsequently fitted since the 90 degree notch is too large to measure the extremely low yields characteristic of Basement Complex boreholes with any level of accuracy.

3.1.4 Use of Consumables and Well Components

Since much of the drilling has been by compressed air (with the DHH), consumption of consumables such as bentonite and drilling chemicals has been moderate, as indicated below:

Chemical	Unit	Qty supplied (contract document)	Qty as at 31/12/85	Qty used 1985
Foam	200 litre barrel	20	16	4
Bentonite	50kg sack	200	159	41
CMC Hi.Vis.	25kg sack	15	10 (5 damaged)	_
Q-Broxin	25kg sack	40	45	_
Drill Aid Custom Mud	10kg tub	80	74	6

During the visit to Port Harcourt (to procure a 3 inch high pressure ball valve for the mud pump) several suppliers of drilling materials were contacted, in particular those dealing in bentonite. It is recommended that the Institute purchases a future supply of bentonite from there since it is muoh cheaper than in Kaduna.

No bit has yet been worn out and become unusable. However, some buttons were lost from the DHH bit used in GWR-4/1, and one of the 4 3/4 inch tricone bits has loose bearings.

The casing and screen installed in the boreholes drilled during the year, and current stocks are given in Table 4. Casing and screen usage is summarised below:

Material	Nom.diam. (in.)	Qty actually supplied(m)	Qty in stock at 31/12/85
Steel casing	4	201.0	201.0
Steel casing	6	814.5	751.5
Steel casing	6 5/8	90.0	66.0
Steel casing	8	360.0	312.0
Steel casing	10	144.0	144.0
PVC casing	4	350.1	350.1
PVC casing	6	299.1	226.8
PVC screen	4	402.6	396.6
PVC screen	6	367.8	290.4
PVC screen	8	200.7	199.2
PVC screen	10	117.0	117.0
Stainless steel screen	4	40.6	40.6
Stainless steel screen	6	60.9	60.9

3.2 Geophysical Equipment

The resistivity recording instrument (ABEM SAS 300 Terrameter) suddenly stopped working on 22 February during field work; the error code inidcated a fault in the input amplifier circuit board. The instrument was sent to Europe for repair on 8 March, and returned to Nigeria on 3 May. Since then it has been working satisfactorily.

The borehole logging equipment (SIE Geosource T450) developed a fault in the SP-resistivity mode at the end of July; in some boreholes, no response could be obtained from the E-log. Checks have been carried out on all the connections in the recording instrument, winch and sonde but it is likely that the cable will have to be re-headed before the fault can be rectified.

3.3 Hydrogeological Equipment

Very little hydrogeological equipment was included in the EDF supply contracts. Consequently, it was necessary to borrow as much equipment as possible from existing FDWR zonal offices since most items are not stocked by local survey equipment suppliers. The following items of euipment were loaned from the FDWR:

(a) 2 nrs. Brunton type compass/clinometers;
(b) 3 nrs. 50m carbon fibre reinforced tape measures;

(c) 20 nrs. 200ml capacity sample bottles;
(d) 5 nrs. 1 lb geological hammers, fibre glass shaft;
(e) 1 nr. Beckman Chem-mate pH/mV meter with two electrodes;
(f) 2 nrs. Hach DR/EL-4 portable laboratories.

Use has been made of a set of sieves, a sieve shaker and a balance from the Institute's soil mechanics laboratory for particle size distribution analyses. One of the holding-down rods was made in the workshops of the Federal Superphosphate Fertilizer Company.

A request was made to the EEC in February for some items of hydrogeological equipment to be procured from the project's foreign currency contingency fund, particularly electrolytic conductivity (EC) meters, chemicals for the Hach kits, and graph paper for plotting pumping test and chemical data. However, approval from the EEC was not given until December and, given the short length of time to the end of the project (May 1986), the Consultant is only prepared to procure a few of the more essential items.

Only one electric water level measuring tape was supplied with the project equipment (from Halco), and, because of frequent use, began to give a lot of trouble after May - the bottom weight unscrewed itself and fell down a borehole during a pumping test, and parts of the wire in the tape became exposed. In the Hydreq supply contract document two tapes were specified for the test pumps, but unfortunately they have not yet been supplied (see Table 3).

In order to avoid a situation whereby the project was without a tape in working order - accurate water level measuring is crucial to the successful execution of pumping tests, and borehole monitoring - the Consultant supplied a replacement botton weight in September, and a reconditioned instrument (Wuidart) in November.

3.4 Locally Procured Equipment

The local currency budget drawn up and approved at the beginning of the project in 1984 had provisions for the purchase of capital equipment - this included two vehicles (budget allocation N26,000); office furniture, plain paper copier, air-conditioners, electric typewriter, refrigerator, etc. (N42,000); and technical and camping equipment (N33,907) to support the field operations.

Unfortunately, the necessary funds were not received to enable this equipment to to be procured; only a few minor items could be purchased. Nevertheless, a plain paper copier (Minolta EP 300 RE) and an electronic typewriter (TEC TW-3000) were ordered by the Institute, and delivered on 20 March - only to be taken back by the supplier on 26 June because no payment had been made. The loss of these machines was severely felt by the GWRD, particularly for report production.

The procurement of radio communication sets should have been given high priority; they are essential for the efficient direction of field operations and organisation of logistical support. However,

CASING AND SCREEN SUPPLIED FOR PROJECT

Contract Item	Description	Nominal Diameter (in)	Length (m)	Quantity in contract document	Quantity actually supplied	Quantity installed In Boreholes GWR-												Qty. cut or damaged	Qty. in stock at 31/12/85
						0/1	0/2	1/1	1/2	1/3	2/1	3/1	3/2	4/1	4/2	5/1	6/1		
4/2	Conductor casing (flush-jointed) BS879	16	1.5	12	12	-	-	-	-	-	-	-	-	-	-	-	-	3	9
4/3	" " " " "	15	1.5	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
4/5a	Steel casing (collar-jointed) BS879	4	6.0	25	25	-	-	-	-	-	-	-	-	-	-	-	-	-	25
4/5b	" " " " "	"	3.0	15	15	-	-	-	-	-	-	-	-	-	-	-	-	-	15
4/5c	" " " " "	"	1.5	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
4/6a	" " " " "	6	6.0	100	102	-	-	2	-	-	2	-	-	1	1	1	-	-	96
4/6b	" " " " "	"	3.0	60	60	-	-	-	-	-	-	-	-	1	1	-	-	-	58
4/6c	" " " " "	"	1.5	15	15	-	-	1	-	-	1	-	-	-	-	-	-	4	9
4/7a	" " " " "	8	6.0	50	43	7	-	-	-	-	-	-	-	-	-	-	-	-	36
4/7b	" " " " "	"	3.0	30	30	-	-	-	-	-	-	-	-	-	-	-	-	-	30
4/7c	" " " " "	"	1.5	8	8	-	-	-	-	-	-	-	-	-	-	-	-	4	4
4/8a	" " " " "	10	6.0	20	19	-	-	-	-	-	-	-	-	-	-	-	-	-	19
4/8b	" " " " "	"	3.0	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-	8
4/8c	" " " " "	"	1.5	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
4/9	Conductor casing (flush-jointed) with 1 set head and 2 drive shoes	6⅝	3.0	30	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10
4/11(a)	PVC Casing SBF-K	4	5.7	43	43	-	-	-	-	-	-	-	-	-	-	-	-	-	43
4/11(b)	" " "	"	3.0	30	30	-	-	-	-	-	-	-	-	-	-	-	-	-	30
4/11(c)	" " "	"	1.5	10	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10
4/12(a)	" " "	6	5.7	33	33	-	2	-	1	2	-	1	1	-	-	-	2	-	24
4/12(b)	" " "	"	3.0	27	27	-	-	-	-	4	-	-	-	-	-	-	-	1	22
4/12(c)	" " "	"	1.5	20	20	-	1	-	1	-	-	-	-	-	-	-	1	1	16
4/13(a)	" " " 1.0mm slot	4	5.7	33	33	-	-	-	-	-	-	-	-	-	-	-	-	-	33
4/13(b)	" " " " "	"	3.0	27	27	-	-	-	-	-	-	-	-	-	-	-	-	-	27
4/13(c)	" " " " "	"	1.5	20	22	-	-	-	-	-	-	-	-	-	-	-	-	-	22
4/14(a)	" " " 0.5mm slot	"	5.7	8	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10
4/14(b)	" " " " "	"	3.0	9	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10
4/14(c)	" " " " "	"	1.5	19	9	-	-	-	-	-	-	-	-	-	-	-	-	4	5
4/15(a)	" " " 1.0mm slot	6	5.7	27	32	-	2	-	1	2	-	4	1	-	-	-	2	-	20
4/15(b)	" " " " "	"	3.0	22	22	-	-	-	-	-	-	-	1	-	-	-	-	1	20
4/15(c)	" " " " "	"	1.5	21	21	-	1	-	1	-	-	-	-	-	-	-	-	-	19
4/16(a)	" " " 0.5mm slot	"	5.7	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
4/16(b)	" " " " "	"	3.0	5	23	-	-	-	-	-	-	-	-	-	-	-	-	-	23
4/16(c)	" " " " "	"	1.5	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5

Contd.

4/17(a)	PVC screen SBF-K 1.0mm slot	8	5.7	15?	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
4/17(c)	" " " " "	"	3.0	12?	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
4/17(c)	" " " " "	"	1.5	20?	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
4/18(a)	" " " 0.5mm "	"	5.7	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
4/18(b)	" " " " "	"	3.0	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
4/18(c)	" " " " "	"	1.5	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5
4/19(a)	" " " 1.0mm "	10	5.7	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
4/19(b)	" " " " "	"	3.0	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
4/19(c)	" " " " "	"	1.5	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	None
4/20(a)	" " " 0.75mm "	"	5.7	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
4/20(b)	" " " " "	"	3.0	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
4/20(c)	" " " " "	"	1.5	20	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
4/21	Stainless Steel screen 1.0mm slot	4	2.9	14	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
4/22	" " " " "	6	2.9	14	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
4/23	" " " 0.5mm "	"	2.9	7	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
4/24(a)	Steel to plastic adaptor	4	-	5	5															-	5
4/24(b)	" " " "	6	-	10	10															-	10
4/24(c)	" " " "	8	-	5	5															-	5
4/24(d)	" " "	10	-	5	5															-	5
4/32	Mild Steel reducer 8 - 10"	-	-	3	3															-	3
4/33	" " " 8 - 6"	-	-	5	5															-	5
4/34	" " " 6 - 4"	-	-	5	5															-	5
4/35	Plastic reducer 10 - 8"	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
4/36	" " 8 - 6"	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
4/37	" " 6 - 4"	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
4/38	Mild to stainless steel reducer 8 - 6"	-	-	5	5															-	5
4/39	" " " steel reducer 6-4"	-	-	5	5															-	5
4/40	Mild steel to plastic reducer 10 - 8"	-	-	1	1															-	1
4/41	Steel casing (buttress-ended)	6⅝	6.0	15	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	11

although several quotations were received from suppliers during the year through personal contacts, government regulations require that such items can only be purhased through open tender. Accordingly, notices calling for quotations were posted in the Institute and elsewhere in November. The specifications called for three units: one to be based in the Kaduna office; one in the drilling camp; and one in a vehicle for the geophysical party. Quotations were received from seven suppliers by the closing date of 6 December.

3.5 Equipment Provided by Consultant

An Epson LX80 printer for the BBC micro-computer (which has a word processing facility) and a Wuidart electric water level measuring tape were provided by the Consultant for use on the project; these items were received on 19 November.

The printer will be used for report production during the remaining five months of the project, as there is only one eletric typewriter for the whole of the Institute - and is not always accessible for use.

3.6 Vehicles

As mentioned in Section 3.4 the local currency budget included an allocation for the procurement of two vehicles. The Institute enquired about the purchase of a Peugeot 504 saloon and estate from PAN (Peugeot Automobile Nigeria), but funds were not made available for their purchase.

However, to make up this, the Institute allocated the Toyota Land-Cruiser, originally supplied by UNDP, to the project in late June; this brought the total number of vehicles to four (three vehicles - a Peugeot 504 family estate and two Land-Rovers - were supplied as part of the project equipment). Two new tyres were bought for the vehicle in October.

Stickers, showing the name of the project and the Institute, were procured in March and placed on all the project vehicles and equipment.

All the vehicles received a major service in late September while field operations were held up due to a lack of funds. However, despite this, some of the vehicles subsequently gave problems. The most serious breakdown occurred on 19 November when the geophysical team were returning to Kaduna after a two-week survey in Niger State. The engine of the Land-Rover station wagon they were using seized up at a place over 400km from Kaduna - the flat-bed truck had to be despatched to recover the vehicle.

4 STAFF

4.1 MRT and Halco Staff

Mr R.S. Jackson arrived in Kaduna on 10 January to take over as Chief Hydrogeologist (Project Co-ordinator) from Mr D.M. Ball. His family arrived on 1 September.

Following a review of work loads and logistical requirements during a visit to Kaduna by Mr M.R. Tulett of MRT on 17-19 March, MRT proposed a revision to the staff inputs; for the geophysicist's (Mr L.F.J. Cunningham) to be reduced by 3 months (completion at the end of July), and for Mr Jackson's to be increased by 3 months (completion at the end of May 1986). The advantages of the proposal were that the completion in May 1986 would match the end of the assignment of Mr Rigg, the master driller supplied by Halco; and that Mr Cunningham leaving before the arrival of Mr Jackson's family would mean that no further housing would have to be provided by the Institute.

The proposal was accepted by the FDWR, and Mr Cunningham departed from Nigeria on 4 August.

Details of staff movements and inputs during 1985 are summarised in Table 5.

Mr Rigg was unable to return as planned after his home leave during the summer (he left on 20 July and was due to return on 5 August) since he had to undergo medical treatment for an illness he developed before his departure from Nigeria; he eventually returned on 20 September.

Mr Tulett, from MRT's head office in the UK, paid a second visit to the project on 2 October.

4.2 Counterpart Staff

Details of counterpart staff are given in Table 6.

Mr E.A. Mogekwu, the Institute's Principal Hdrogeologist, assumed the role of project co-ordinator to liaise between the consultants and the Institute in matters concerning project administration and staffing.

Following a review of staffing levels at the beginning of the year, a need was recognised for more drivers and mechanics. Unfortunately, although interviews were held (on 21 February and 14 May for drivers and 12 March for mechanics) no further staff were appointed (except a replacement for a driver who resigned) because of the financial constraints the Institute was faced with. However, the Institute provided the services of its Senior Maintenance Officer, Mr Vincent Ojong, to assist the project with the maintenance of vehicles and plant.

Two of the field assistants were dismissed in February since they were

found to be completely unsuitable for project work, and a bad influence on the rest of the staff.

Mr D.E. Aiya, a FDWR driller who was attached to the project in September 1984 was unfortunately retrenched from the FDWR in July as part of an overall adjustment to staffing levels in the Federal Ministries. However, since he showed himself to be a key member of the drilling team, the Consultant recommended that he be taken on by the Institute as a permanent staff. He was eventually appointed as a Technical officer (Driller) on 20 November.

Following a review of staff qualifications and manpower requirements in September/October some members of staff were transferred to other departments in the Institute: Mr S. Okedi to the Biology Laboratory; Mr H. Elisha to Hydraulics; three labourers to Estate; and one watchman to Security. The staffing level at the end of the year stood as follows:

1	project co-ordinator
2	hydrogeologists
12	drilling team (including 2 drivers)
6	geophysical team (including 1 driver)
2	office staff
3	watchmen
26	

TABLE 5

MRT AND HALCO STAFF MOVEMENTS - 1985

Position	Name	Input dates[1]	Total input During 1985 (months)	Total input on project to 31/12/85 (months)	Contract input (months)
Chief Hydrogeologist (Project Co-ordinator)	R.S. Jackson (MRT)	9 Jan. - 9 April) 3 May - 9 Aug.) 1 Sept.- 31 Dec.)	10.40	17.88[2]	23[3]
Geophysicist	L.J.F. Cunningham (MRT)	1 Jan. - 20 Mar.) 7 Apr. - 4 Aug.)	6.63	9.03	9[3]
Master Driller	J. Rigg (Halco)	11 Jan. - 5 Apr.) 24 Apr. - 20 Jul.) 20 Sep. - 17 Dec.)	8.73	15.86	24[4]

Notes: (1) includes travelling time UK/Kano/UK

(2) includes 7.40 months of Mr Ball's time in 1984

(3) revised as a result of MRT's proposal

(4) according to the agreement Mr Rigg has with Halco this includes leave periods.

TABLE 6

COUNTERPART STAFF - 1985

Nr.	P O S T	N A M E	REMARKS
1	Project Co-ordinator	A.E. Mogekwu	Principal Hydrogeologist at N.W.R.I.
2	Hydrogeologist	B.O. Odusanya	
3	"	S. Okedi	Transferred to Biology Lab in November
4	"	M.O. Eduvie	
5	Technician	A.A. Oyinlola	Driller
6	"	O.T. Olusola	
7	"	S.O. Ololabi	
8	"	I.O. Upuama	
9	Technical Officer (Driller)	D.E. Aiya	Seconded from FDWR until his retrenchment in July. Taken on by NWRI 20 Nov. as driller
10	Mechanical Engineer	V. Ojong	Senior Maintenance Officer at NWRI.
11	Field Assistant	C.E. Dimkpa	
12	" "	U.V. Oche	Dismissed in February
13	" "	H. Elisha	Transferred to Hydraulics in November.
14	" "	A. Ndazhaga	
15	" "	D. Haruna	Dismissed in Feb.
16	Driver	E.B. Njoku	Promotion notice received 24 Dec.
17	"	B. Habibu	Resigned. Replaced by Alh. M. Ibrahim on 10 April
18	Driver/Motor Mechnic	J. Goloba	
19	Labourer	I.I. Amaji	
20	"	D. Musa	
21	"	D. Iwuagwu	
22	"	E.O. Igwe	Promotion notice received 24 Dec.
23	"	S. Abdu	Transferred to Estate in Nov.
24	"	S. Umaru	
25	"	N. Sule	
26	"	M. Ibrahim	Transferred to Estate in Nov.
27	"	H. Umaru	" " " " "
28	Welder	S.U. Jeremiah	

Table 6 (Contd)

Counterpart Staff - 1985

Nr.	Post	Name	Remarks
29	Cartographer	S. Jauro	
30	Confidential Secretary	L.U.O. Njemanze (Mrs.)	
31	Watchman	I. Garba	
32	"	B. Anyawu	
33	"	N. Musa	
34	"	L. Adamu	Transferred to Security in Nov.

5 OPERATIONAL EXPENDITURE

A statement summarising the operational expenditures incurred by the GWRD during 1985 is given in Table 7.

Expenses have totalled N17,961.71, equivalent to N1,496.81 per month. The budget allocation for 1985 operational costs (except staff salaries and accomodation for the consultants) was N45,110 - thus, actual expenditure was only 39.8% of the budget allowance.

TABLE 7

GROUNDWATER RESEARCH DEPARTMENT

OPERATIONAL/RUNNING COSTS (NAIRA) - 1985

Budget Heading Code	Transport (fuel, etc) 4.4	Office Accomod. 4.5	Office Supplies 4.6	Technical Equipment 4.7	Technical Supplies 4.8	Consultant Accomod. 4.9	Training Aids/ Literat. 4.11	Travel 4.12	Report Product. 4.13	Total
Month										
Jan.'85	211.0	240.00	202.25	699.70	463.30	4.00	-	273.00	-	2,093.35
Feb. "	225.70	-	8.00	254.40	965.00	-	-	-	126.00	1,579.10
Mar. "	196.41	-	-	1,419.95	341.80	-	5.00	627.50	100.00	2,690.66
Apr. "	314.30	12.00	170.55	262.35	117.70	635.69	25.00	128.00	-	1,665.59
May "	205.35	-	190.50	155.50	358.90	43.50	-	323.63	-	1,277.38
Jun. "	312.70	-	118.50	47.70	891.80	77.60	-	11.21	-	1,459.51
Jul. "	282.03	-	222.15	130.00	339.26	143.00	-	-	185.50	1,301.94
Aug. "	167.67	-	-	-	12.00	26.00	-	-	257.00	462.67
Sep. "	497.44	-	5.20	-	251.00	484.72		-	-	1.238.36
Oct. "	1,262.95	-	3.00	-	49.95	101.70	-	17.00	199.00	1,633.60
Nov. "	937.66	15.00	142.50	68.70	107.00	11.00	4.00	14.50	-	1,300.36
Dec. "	535.39	-	18.00	-	506.10	65.70	-	19.00	115.00	1,259.19 (1)
Total:	5,148.70	267.00	1,080.65	3,038.30	4,403.81	1,592.91	34.00	1,413.84	982.50	17,961.71
%	28.7	1.5	6.0	16.9	24.5	8.9	0.2	7.9	5.5	100.1

Note: (1) excludes ₦1,096.00 for cables and pipes for new pump for Institute's borehole.

6 REPORTS

The following reports were produced during the year:

(a) 1984 Report (January);

(b) Interim Report Nr.3 (February);

(c) Interim Report Nr.4 (May);

(d) Working Paper Nr.1, Experimental Catchment Area Kaduna, Groundwater Investigations - First Phase (July);

(e) Geophysical Investigations for the Location of Suitable Sites for Drilling of Productive Boreholes in Suleja, Niger State (July);

(f) Interim Report Nr.5 (August);

(g) Interim Report Nr.6 (November).