3-1-5. Hydrology and Groundwater

(1) Surface Water

As shown in Figure 3-5 (Hydrogeological Map), the surface water system covers the River Kaduna system with a total length of 547.1 km, the River Gbako with a total length of about 150 km and the River Gurara with a total length of about 250 km, all of which are the tributaries of the River Niger having a total length of about 4,180 km.

The River Kaduna is flowing and meandering from south to north in the central zone of Shiroro LGA. The River Kaduna is flowing at the west-end and the River Gbako is flowing and meandering in the central part of Gbako LGA. Lapai LGA is included in the catchment area of the River Gurara which is flowing to southward in the eastern part of the LGA and a distributary of the River NIger. And the River Niger is flowing at southwest end of the Project area.

The rivers present a dendritic-bone system with many numbers of medium/small rivers and streams. The rivers and major streams, although they reduce remarkably their discharge in the dry season, are permanent ones. The other streams are intermittent rivers which are drying up in the dry season. Under these circumstances, inhabitants who cannot have water other than river water are trying to secure a little water from pits which are dug in the river beds.

Recently, the Shiroro dam body with height of 100 m has been constructed at downstream of the junction of the River Kaduna and the River Dyna for electric power generation purpose, however, power facilities are still under construction.

(2) Hydrogeology

Hydrogeology of the Project area is composed of basement rocks and sedimentary rocks as shown in Figure 3-5. The basement area can be divided into "A area" mainly consists of schist belts and mylonite, "B area" mainly consists of granitic rocks and migmatites. The sedimentary rocks area can also be divided into two hydrogeological areas; namely, "C area" and "D area". The former area consists of sandstone, mudstone and shale of Bida group, and the latter consists of Alluvium deposits of the River Niger floodplain.

The features of the above four areas are as follows:

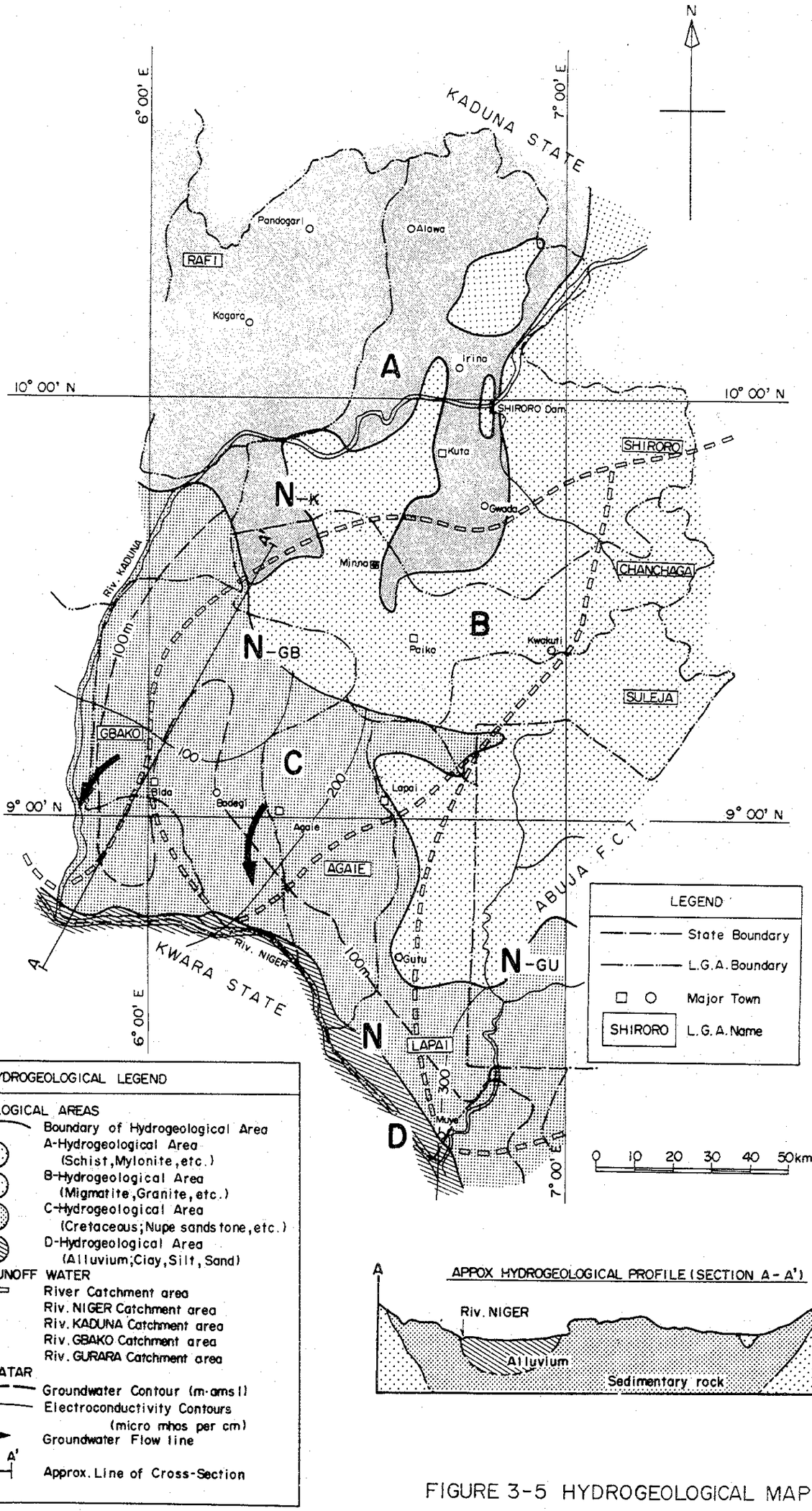


FIGURE 3-5 HYDROGEOLOGICAL MAP

Source ; PROVISIONAL, NATIONAL MASTER PLAN FOR GROUNDWATER DEVELOPMENT
FEDERAL MINISTY OF WATER RESOURCES (1979)

1) A-area: Consists of schists and mylonite, and weathered/fissured zone of them are usually saturated with groundwater.

2) B-area: Consists of granites and migmatites, and weathered/jointed zone of them are usually saturated with groundwater. The rocks of this area are usually hard rocks compared with the rocks of A-area.

3) C-area: Consists of Cretaceous sandstones, mudstones and shales. Groundwater conceived in porous zone of this area are usually a target for the development.

4) D-area: Aquifer is composed of Alluvium gravel and sand layer in the River NIger floodplain.

Boreholes constructed in A and B areas which have depths of less than 30 m are often dried up during dry season.

(3) Geo-electric Prospecting (GEP)

The study team carried out the geo-electric prospecting (GEP) to grasp the general features of the aquifer located in the Project area. The survey points were decided near the existing boreholes taking the geological conditions into consideration for the correlation between geology and borehole results.

The technical specifications of GEP are as follows:

Method of GEP: Vertical prospecting by Wenner's method.
Survey depth: 100-150 m
Instrument: Mc-OHM (produced by OYO Corporation)
Analysis: By Sundbarg's standard curves

The surveyed points are shown in Table 3-3, and results of GEP are shown below. The geology and the surveyed points are given in Figure 3-6, and as previously indicated, the Project area is divided into the Basement rock and the Sedimentary rock areas.

Some typical ρ-a curves and topographical maps are shown in Appendices 7 and 8. These curves and maps show the representatives of the hydrogeological features at the surveyed sites and the results of GEP of each hydrogeological area are summarized as follows:

Table 3-3 Results of Field Survey

Name of Survey Site	GEP No.	No. of Water Quality Test	Existence of G-W Patients	LGA
1. Tawali	E-1	Q-1	- Nil - ※	Shiroro
2. Gwada	E-2	-	〃 ※	〃
3. Dobogi	E-3	Q-2	〃 ※	Lapai
4. Gulu/Kpada	E-4 (West clinic)	Q-3 (Kpada)	〃	〃
5. Egba	E-5	Q-4	〃	〃
6. Duma	E-6	Q-5, 6	- Existing -	〃
7. Takuti	E-7	Q-7, 8	〃	〃
8. Lafiagi	E-8	Q-9	〃	Gbako
9. Badegi	E-9	Q-10	〃	〃
10. Katearigi	E-10	Q-11	〃	〃
11. Gbamaba	-	Q-12	〃	〃
12. Kologa	E-11	Q-13	〃	〃
13. Kukawu	E-12	Q-14	〃	Shiroro
14. Fuka	E-13	Q-15	〃	〃
15. Boladna	E-14	Q-16	〃	〃
16. Ungwan kawo	E-15	Q-17	〃	〃
17. Irina	E-16	Q-18	〃	〃
18. Kato	E-17	Q-19	- Nil -	〃
19. GAma	E-18	Q-20	〃	〃
20. Mailo	E-19	Q-21	- Existing -	〃
21. Shakwata	E-20	Q-22	〃	〃

Note ; ※ The areas where G-W diseases have been eradicated after construction of Boreholes.

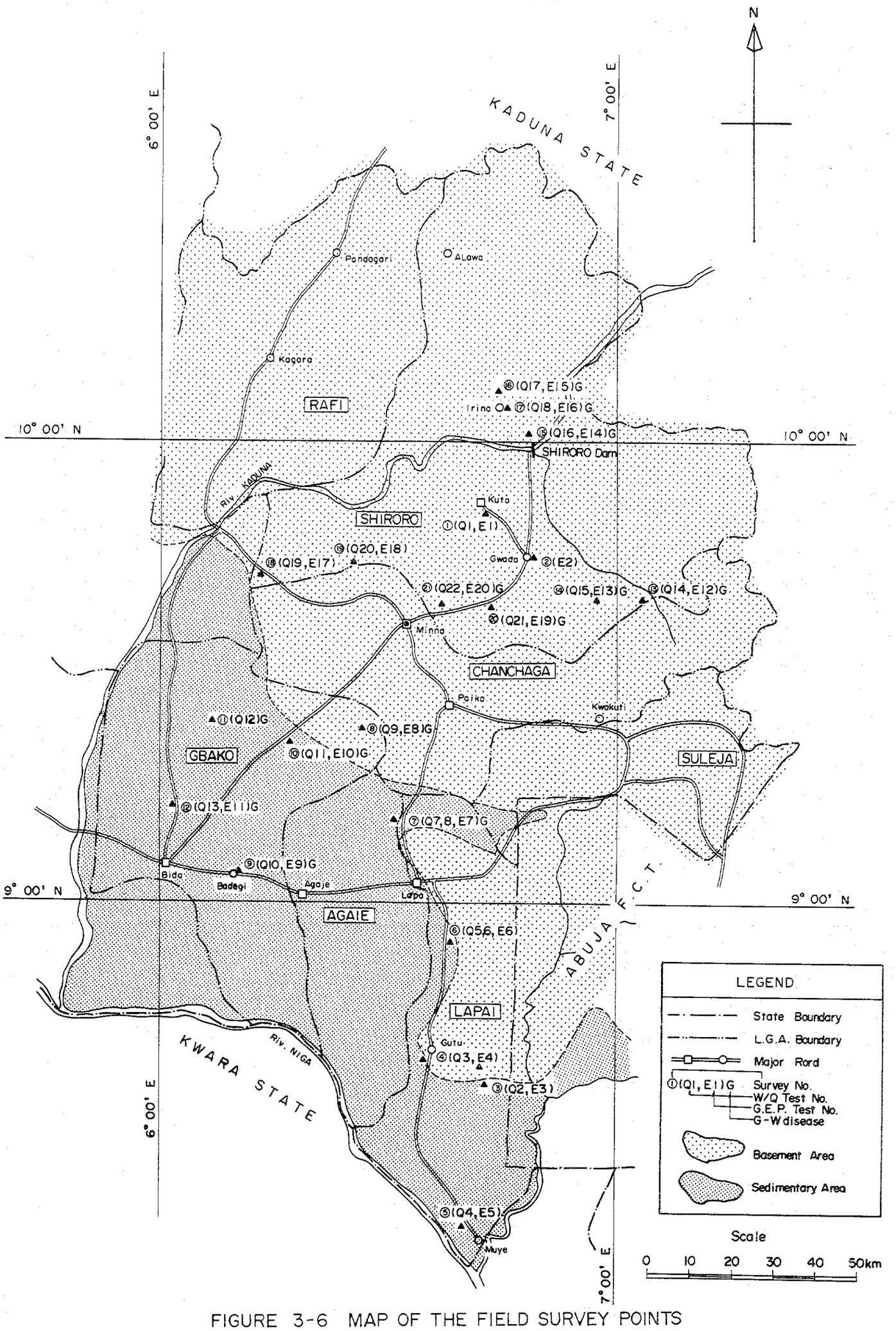


FIGURE 3-6 MAP OF THE FIELD SURVEY POINTS

Kushaka Schist Belt

Top Soil: Consists of 1.9-9.0 m of silty-sand and/or laterite with apparent resistivity value of 24-250 ohm-m, especially laterite which shows the apparent resistivity value of more than 100 ohm-m.

Highly-weathered Zone: Consists of maximum 25 m of highly-weathered schist with apparent resistivity value of 100-570 ohm-m. These rocks are greatly altered by superficial weathering and there are partially weathered zone borne by intrusion of dikes. This zone is promising aquifer for the groundwater development.

Weathered Zone: The apparent resistivity value ranges 570-1,450 ohm-m. Consists of hard rocks with maximum depth of 70 m, however, joints are developed and included some fractured zone. There are deep boreholes located in this aquifer (E-1, E-2) which wre constructed by the Water Board. This zone has normally high possibility to develop groundwater.

Fresh rock Zone: Consists of fresh rock with apparent resistivity value of more than 1,200 - 1,500 ohm-m. This zone has a few chance to develop groundwater.

Granitic Rocks, Migmatite

Top Soil: Consists of 1.0-7.4 m of silty-sand and/or laterite with apparent resistivity value of 23-10,000 ohm-m. Especially, fresh laterite shows apparent resistivity of more than 3,000 ohm-m.

Highly-weathered Zone: Apparent resistivity value ranges 26-520 ohm-m. Consists of less than 20 m depth of highly-weathered rocks and fractured zone below 20 m, and all of them are promising aquifer. However, some of boreholes are drying up in the dry season.

Weathered Zone: Apparent resistivity value ranges 520-1,900 ohm-m with maximum depth of 100 m. Weathered zone is developed along the joints and conceived by groundwater. This zone has normally high potential for development.

Fresh Rock: Consists of fresh rock with apparent resistivity value of more than 2,000 ohm-m. This zone has a few chance for groundwater development. The distributed areas of the younger granite are relatively having shallow-weathered zone.

Sedimentary Rock Area

Alluvium: Consists of silt and gravelly-sand with apparent resistivity value of 16-1,050 ohm-m. However, some alluvium with a value of over 100 ohm-m are composed of consolidated sandy beds.

Bida group (Cretaceous) has not been classified in detail. The Bida group of this area, however, can be divided into (1) Upper-sandstone, (2) Upper-mudstone, (3) Lower-sandstone, and (4) Lower mudstone based upon the points surveyed. These layers are forming interfinger beds and mostly lying with flat structure. The survey results of the sedimentary rocks are as follows:

Upper-sandstone: This is Nupe sandstone of the top of Bida group located at survey point E-3 and having an apparent resistivity value of 105-3,070 ohm-m. The resistivity value of 100-300 ohm-m means that it is composed of fissured zone and may be a good aquifer.

Upper-mudstone: On the basis of the result of E-6, 9, 11, this layer consists of mainly mudstone containing some shale beds showing resistivity value of 11-96 ohm-m, which means that the layer is not a very good aquifer.

Lower-sandstone: Located at points E-5, 6, and consists of sandstones. At E-6 point, it is found at 50-60 m depth with an apparent resistivity values of more than 100 ohm-m. The layer having low resistivity has normally high potential for groundwater development.

Lower-mudstone: This layer showing the resistivity value is composed of mudstone and distributed in the lowland along the River Niger. This layer is considered the lowest one in the Project area. Generally, this layer is not a good aquifer.

(4) Data of Existing Boreholes

There are existing boreholes data obtained from WATSAN Office and Water Board. The results of data analysis for the Project are summarized as follows:

Data for basement rocks area

The WATSAN Office has drilled 134 boreholes in Suleja and Chanchaga LGAs. These data are shown in Appendix 8, and summarized in Table 3-4 by each LGA below.

Table 3-4. Result of Drilling under WATSAN Project

			Total
LGA	Sleja	Chanchaga	
GEOLOGY	Basement Rock	Basement Rock	
DEPTH			
Below 30 m	4	0	4
30m - 40 m	26	30	56
40m - 50 m	35	21	56
Above 50 m	14	3	17
Unknown	1	0	1
Total	80	54	134
Maximum	65.0 m	54.0 m	
Minimum	23.3 m	30.0 m	
Average	42.6 m	39.2 m	
STATIC LEVEL			
Maximum	35.0 m	34.0 m	
Minimum	5.0 m	5.0 m	
Average	16.0 m	17.0 m	

The borehole logs drilled by Water Board in Shiroro LGA are shown in Figure 3-7. On the basis of the above logs, the minimum and maximum depths are 23 m and 65 m, respectively. However, most depths of the boreholes are in a range of 30-50 m. These boreholes can be judged that water development are aimed against the weathered zone and/or fractured zone, and the static water level has a range of 5-35 m and 17 on an average.

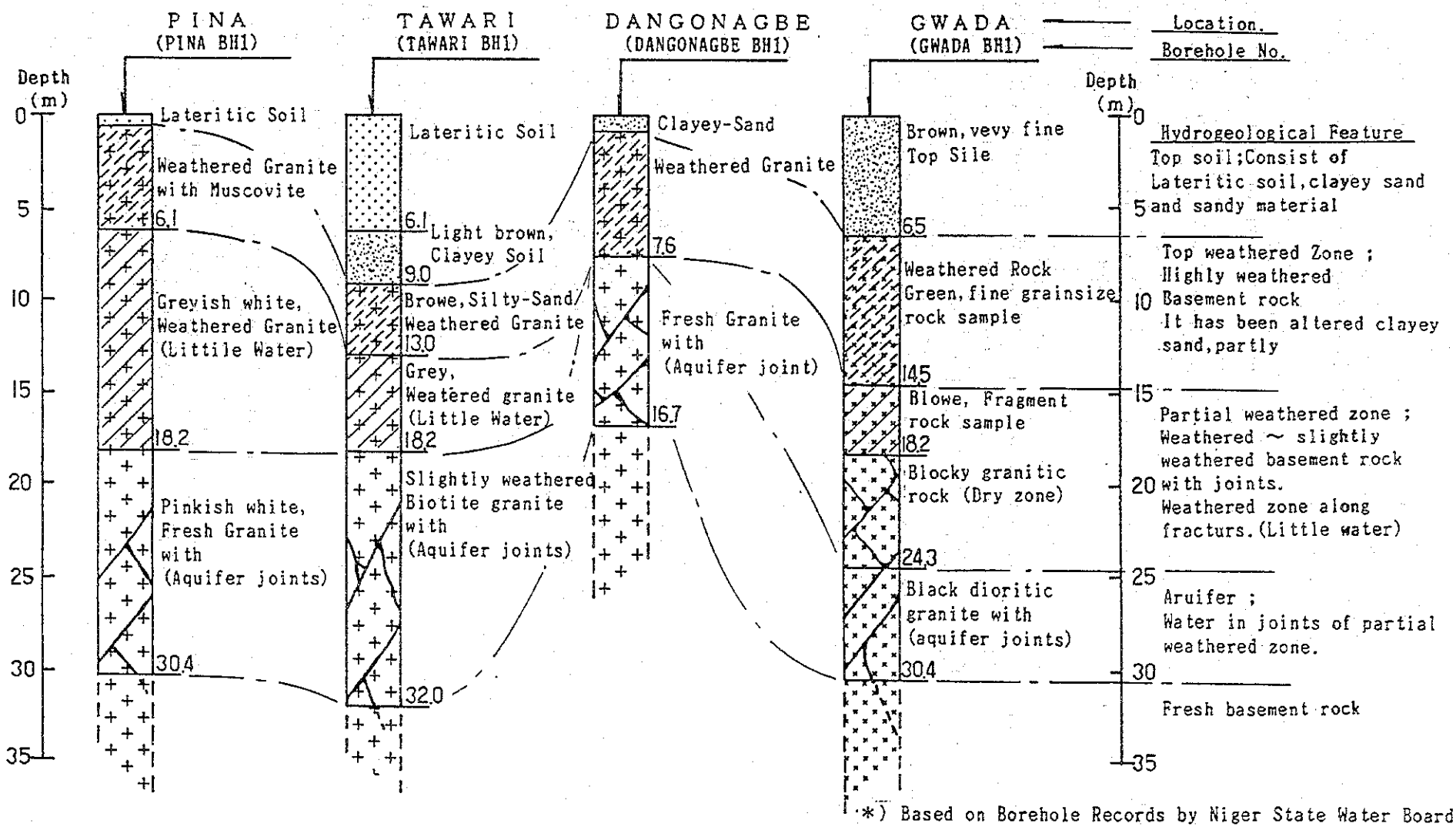
Data for sedimentary rocks area

The existing boreholes in the sedimentary rocks are drilled by Water Board. Table 3-5 showing the data in Luvan LGA are appropriate to the Project area due to non-availability of data in the area.

Table 3-5 The Existing Borehole Data at Lavan LGA in sedimentary area

	Boreholes	Feature of Aquifer				
Villege name	No.	Drilling Depth (m)	Dept (m)	Static w/level (m)	Geology	Yied
SEBO WORO	SEBO WORO-BH1	54	15~	36	Medium~Coarse sandstone	High
KASHIKOKO	KASHIKOKO-BH1	55	36~	37.5	Whitish, fine sandstone	
MUWO	MUWO-BH1	37	6~	24.3	Medium, clayey sandstone	High
RUGAN CHIBO	RUGAN CHIBO-BH1	45	30~	30	Coarse, clayey sandstone	High
BOKANI	BOKANI-BH1	73	12~55	48	Dark brown sandstone with thin coal bed	
LWAFE	LWAFE-BH1	38	5~	18	Fine~Medium sandstone, gravelly	
LWAFE	LWAFE-BH2	38	5~	12	Fine~Medium sandstone, gravelly	
MA ALI	MA ALI-BH1	30	6~	18	Fine~Medium sandstone,	High
ROKOTA	ROKOTA	36	15~	26	Fine~Medium sandstone,	
BOKATA	BOKATA-BH1	53	17~	36	Dark brown, sandstone	
DANCHITAGI	DANCHITAGI-BH1	30	7~	18	Medium~Coarse sandstone, gravelly	High
DANKAN MASALACI	DANKAN MASALACI-BH1	23	6~	17	Fine~Coarse sandstone, gravelly	
DAAN	LAVAN-BH1	60	36~	38	Dark brown sandstone with thin coal bed	
POLICE/Q MOKWA	POLICE/Q-BH1	45	25~	25	Medium~Coarse sandstone with clay, gravelly	
GBARA	GBARA-BH1	50	27~	40	Fine sandstone	
	Total 15 boreholes	45m (Ave)		28m (Ave)		

(Source : Niger State Water Board, 1987)



*) Based on Borehole Records by Niger State Water Board

Fig. 3-7 Existing Borehore in SHIRORO L.G.A.

(Constructed by NIGER STATE WATER BOARD ; JuLY. 1987)

On the basis of the above data, the maximum/minimum depths of the boreholes are 73 m and 23 m, and the mean is 28 m. According to the information from the Nigerian officers, there are some boreholes which depth reaches 100 m or deeper in Gbako and Lapai LGAs.

The data of yield in the project area are not available, however, the field investigation by the Team has revealed that only seven boreholes are available among the total nineteen boreholes. The other twelve boreholes have problems on water-level to be pumped and/or pumping facilities. Problems on water-level have been derived due to insufficient survey and/or inadequate design of boreholes and as a result water level subsided below the pump cylinder depth in the dry season.

However, this fact does not mean non-availability of the aquifer, considering the existence of boreholes which are able to pump in the area where the same geology exists. The boreholes not used may be left because of limited budget and/or personnel required for keeping proper maintenance.

Based on the above situations, WATSAN Office is conducting the training to the users by each village-basis and aiming to shift the maintenance responsibility to the users including the share of its cost.

(5) Water Quality Test of Existing Boreholes

- Result of Water Quality Test by WATSAN Project

The result of the above test for Suleja LGA is given in Table 3-6. Following are standards (maximum permissible level) for water quality test by WATSAN Office. These standards are principally followed by WHO, however, the WATSAN Office has adopted a higher value against the WHO's standard due to its local condition prevailing.

- Ph Standard - 6.5 - 8.5

Sixteen (16) samples show a value with less than 6.5, which is equivalent to 40% of the total samples. The Office has a policy that a borehole of which water Ph showing less than 6.5 is to be installed with stainless steel materials for riser pipes and rods of handpump considering anti-corrosion by acidic water.

- E-Conductivity (WHO's Standard - unspecified)

The result shows that the values are within a range of 18-530 micro-mhos/cm; thus, this value signifies good quality.

- Mineral Contents

  * NO3 (mg/l)

    The standard value of this item is 132 by the Office as compared to 44 by WHO. Out of the total thirty-nine (39) samples, one sample shows a value of 387 which is about three times of the standard value. Two of them, however, show a value of more than 45. The rate of samples which exceeds the standard value is low, however, this item will be monitored in the same manner as the coliforms as this is an important index of organic pollution.

  * Fe (mg/l)

    Fe contents standard is 3.0 mg/l as compared 0.3 mg/l of WHO's value. The policy of the Office is to install a Fe-removal facility when water exceeded the standard value of 3.0 mg/l. Seven samples, equivalent to 18%, exceed the standard with a maximum value of 8.0 mg/l.

  * Mn (mg/l)

    The standard of Mn contents is 0.1 which is the same as the WHO's standard. The Office does not have a counterplan on Mn contents, because this item does not directly harm human health. The range values of 0.3-0.5 are not a big problem for drinking water, considering that the standard value of Mn was 0.3 mg/l in Japan.

  * Coliforms (Standard, 2 nos./100 cc)

    Out of forty (40) samples, six (6) samples exceed the standard with a maximum value of 250/100 cc. If water exceeds the standard value, the Office makes periodical inspection (once every three months) to maintain user's health.

  Other items such as Cl, Ca and Mg have met with the standard values.

- Result tested by the Team

The Team carried out some simplified water quality test along with GEP in the Project area. The number of samples are shown in Table 3-3, and the results are given in Table 3-7.

The result of water quality test carried out by the Team is almost the same as that of the Office. However,all of those samples for shallow wells and surface water have problems on the contents of coliforms; moreover, twenty (20) samples (over 50%), have values of over 20 which is hazardous to human health.

Table. 3 - 6 RESULTS OF WATER QUALITY TESTS OF BOREHOLES IN SULEJA LGA

Community/Village	Depth (m)	pH	Temp. (C)	Colour (Unit)	Turbidty (Unit)	E/Cond. m-mho/cm	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	NO3 (mg/l)	Fe (mg/l)	Mn (mg/l)	T/Hard (mg/l)	Coli-form n/100cc
Max. Permi. V. (WHO)	-	6.5-8.5	-	50	50	-	250	200	150	44	0.3	0.1	500	2
CHANA	32.0	6.5	31.6	500	90	377	22	28	13	57	6.8	0.5	122	Nil
GARAM I	34.8	6.2	28.5	20	5	136	5	12	3	11	0.3	Nil	45	Nil
AZU	57.0	7.2	28.8	15	3	337	6	44	9	4	0.2	0.4	148	2
GARAM II	44.2	7.0	28.0	Nil	Nil	373	7	47	9	24	0.3	0.8	157	Nil
AZHIV	38.0	7.2	29.4	1400	300	280	7	18	3	Nil	8.0	2.3	55	150
IJATA	60.0	6.4	29.1	240	40	242	7	29	7	2	3.0	0.3	103	2
DOGON KURUMI	41.0	6.5	29.5	110	18	187	6	21	4	4	Nil	0.2	69	2
NEW BWARI	43.3	6.5	28.0	80	10	225	7	25	7	2	1.0	Nil	91	1
KOPA	57.0	6.3	30.6	20	3	355	32	36	13	387	1.7	0.4	144	6
IJA KORO	47.3	7.0	30.9	Nil	Nil	257	4	28	8	13	0.4	0.3	105	Nil
SUNTI		5.5	20.0	340	52	35	3	2	1	Nil	6.0	Nil	8	Nil
GBARA		6.0	20.0	150	30	80	3	6	5	22	2.6	1.2	34	Nil
KUTIGI		6.0	20.0	10	Nil	30	3	2	1	8	0.4	0.4	8	Nil
GBADAFU		8.2	20.0	25	4	84	3	16	3	9	0.6	0.3	52	Nil
LEMU		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DOKO		5.5	18.0	18	4	18	5	2	1	5	0.1	0.5	6	Nil
BADEGI		5.5	18.0	55	8	55	3	3	2	4	1.5	0.3	15	Nil
AGALE		5.5	18.0	144	2	144	5	8	3	7	0.8	-	32	Nil
KATCHA		6.5	18.0	530	10	530	3	37	7	4	0.6	0.4	121	Nil
BARO		6.9	18.0	30	10	30	5	1	1	4	0.1	-	6	Nil
MADALA	34.8	7.1	27.8	300	50	284	5	22	11	Nil	4.0	0.5	103	Nil
KUANKWASHE	38.0	6.5	28.0	40	-	184	21	14	5	29	3.6	0.5	54	Nil
GAURAKA	38.3	6.3	29.6	25	5	172	7	13	8	11	0.8	1.5	64	Nil
CHACI	31.7	6.5	29.4	5	Nil	197	5	17	11	11	2.0	1.5	88	2
BABBAW TUNGA	38.0	6.3	28.6	25	5	213	15	16	7	37	4.3	0.5	70	Nil

Community/Village	Depth (m)	pH	Temp. (C)	Colour (Unit)	Turbidty (Unit)	E/Cond. m-mho/cm	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	NO3 (mg/l)	Fe (mg/l)	Mn (mg/l)	T/Hard (mg/l)	Coli-form n/100cc
Max. Permi. V. (WHO)	-	6.5-8.5	-	50	50	-	250	200	150	44	0.3	0.1	500	2
SHAKO	47.7	6.6	29.8	80	12	266	6	28	12	11	1.3	0.4	118	Nil
KABO	28.9	6.3	30.0	80	10	138	2	14	5	13	0.6	1.2	55	Nil
SULU	41.4	6.3	30.4	Nil	Nil	158	4	12	3	31	0.7	1.0	44	4
IWA	47.6	6.4	29.1	35	1	224	1	22	9	9	0.3	1.3	90	2
GWAZUNU	28.9	6.3	29.9	Nil	Nil	141	4	11	5	7	0.8	0.6	47	Nil
IJA GWARU	34.8	6.7	31.2	70	10	160	3	15	4	26	2.2	0.2	56	Nil
MADALLA II-B	44.5	6.9	29.4	30	8	354	10	44	10	8	0.9	0.3	150	Nil
IJA GWARU II	4.8	6.8	30.7	260	43	218	7	18	17	62	3.2	0.3	115	78
MADALLA II-C	38.0	6.8	29.6	Nil	Nil	189	4	14	9	10	0.3	0.4	70	1
RAFIN KARZE	35.0	6.8	28.9	50	10	199	6	16	8	9	1.0	1.0	74	Nil
BUNTU	38.0	6.8	28.6	Nil	Nil	261	5	27	10	7	0.4	0.7	109	Nil
MADALLA II	23.3	7.2	30.5	Nil	Nil	356	10	45	10	11	0.3	0.3	152	150
MADALLA I-A	50.7	6.5	29.2	30	5	470	32	108	13	44	1.0	0.5	174	Nil
MADALLA I-B	50.7	6.8	28.9	Nil	Nil	419	32	48	12	9	0.4	0.8	170	Nil
MADALLA II	44.0	6.8	29.9	Nil	nil	516	34	56	14	11	0.5	0.5	137	250

Table. 3-7 Results of Water Quality Tests

Sample No	Tem. (℃)	Ec (μ-mhos/cm)	PH	Coliforms (n/1ml)	M-Organ (n/1ml)	Colour	Odour	Taste	Fe ※ (mg/l)	Mn ※ (mg/l)	Source
Q - 1	28.6	72	6.66	0	0	Nil	Nil	Good	0.2	0.5	Borehole
Q - 2	29.3	122	5.68	27	1	Nil	Nil	Good	0.2	0.5	Dug - well
Q - 3	26.4	80	6.09	7	0	Light Broun	Muddy	Salty	2.0	0.5	River bed
Q - 4	30.2	120	7.44	0	16	Light Broun	Nil	Good	-	-	Borehole
Q - 5	31.0	568	7.42	1	0	Nil	Nil	Good	0.5	<0.5	Borehole
Q - 6	29.1	844	7.14	48	9	Nil	Nil	Salty	0.2	0.5	Dug - well
Q - 7	28.6	68	5.83	40	1	Broun	Nil	Good	0.2	0.5	Dug - well
Q - 8	29.4	518	7.34	-	-	Light Broun	Nil	Good	2.0	0.5	Borehole
Q - 9	29.9	359	7.09	12	0	Broun	Nil	Good	1.0	0.5	Stream
Q - 10	30.6	51	7.23	4	0	Nil	Nil	good	0.5	1.0	Dug - well
Q - 11	29.3	182	7.11	22	0	Nil	Nil	Salty	0.2	0.5	Dug - well
Q - 12	26.2	510	6.36	54	3	Light Broun	Nil	Good	0.2	0.5	Pond
Q - 13	28.7	234	5.57	11	0	Light Broun	Nil	Good	0.2	0.5	Dug - well
Q - 14	26.4	120	6.03	18	0	Broun	Nil	Salty	0.2～0.5	0.5	Stream
Q - 15	25.2	313	7.28	-	-	Light Broun	Nil	Good	0.2	0.5	Dug - well
Q - 16	28.1	74	7.01	31	0	Broun	Muddy	Good	0.2	0.5	Dug - well
Q - 17	27.5	124	7.58	-	-	Broun	Nil	Salty	0.2～0.5	0.5	Stream
Q - 18	30.0	760	7.01	-	-	Nil	Nil	Good	0.5	0.5	Dug - well
Q - 19	26.6	87	6.96	-	-	Broun	Muddy	Salty	1.0	0.5	Stream
Q - 20	26.9	118	6.96	-	-	Light Broun	Nil	Salty	0.5	0.5	Stream
Q - 21	27.1	376	7.50	-	-	Nil	Nil	Good	0.2	0.5	Dug - well
Q - 22	28.9	378	7.56	-	-	Nil	Nil	Good	0.5	<0.5	Dug - well

Note ; ※ ····· Fe and Mn were tested by Simplified Method using Testing Pack.

- Summary of Water Quality Problems

On the basis of the above-mentioned result, the following is a summary of water quality problems which shall be taken into consideration during drilling and handpump installation stage.

- Anti-corrosive materials shall be used for the riser pipes/rods.
- Groundwater in the project area contains much Fe that the riser pipes of pumps may be clogged and maintenance services should be rendered.
- Careful attention shall be paid to the distribution size of filter materials to prevent flowing out of fine particles contained in soil layer.
- It is necessary to provide a deep grouting seal at the top of a borehole to prevent pollution/contamination by water flowing into borehole.

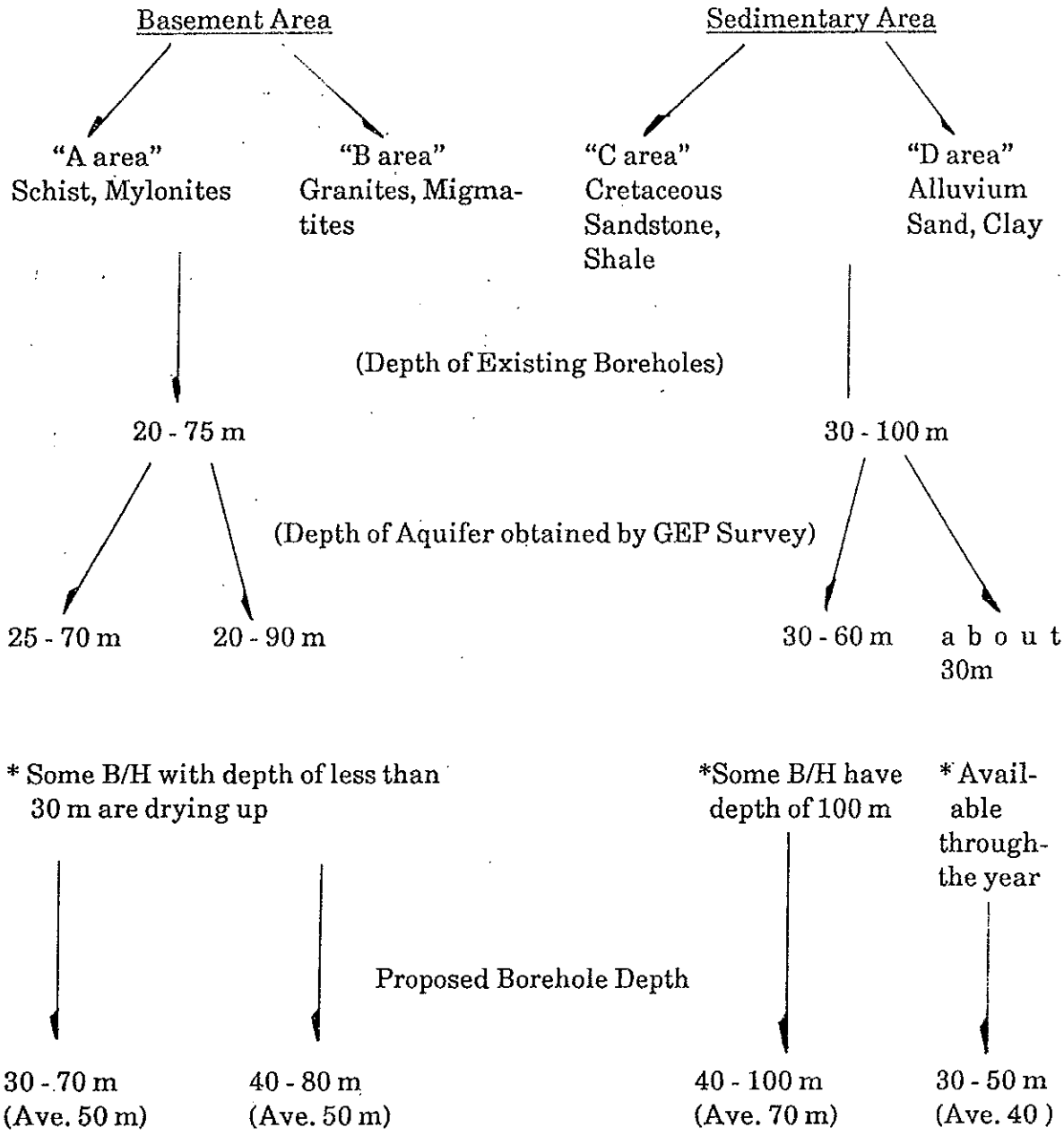
(6) Conclusion of Hydrogeology

As a result of investigation on hydrogeologyof the Project area, the following were concluded:

- The water supply by the boreholes is the most effective method in eradicating Guinea-worm, and the project area has potential for groundwater development in view of suitable geological conditions.
- The project area can be divided into four (4) hydrogeological areas from the viewpoint of groundwater development; namely, "A-area" and "B-area" composed of basement rocks, and "C-area" & "D-area" composed of sedimentary rocks.
- Some boreholes with less than 30 m depth in the basement area are sometimes dried up during dry season. Therefore, the drilling point must be carefully sited by geophysical prospectings such as GEP and E-magnetic prospecting.
- For the groundwater development, it is required that proper selection of materials be used for the riser pipes/rods and water quality treatment for unsuitable water quality.

The proposed borehole depth on the hydrogeological areas are shown in the succeeding page.

PROPOSED BOREHOLE DEPTH
(based on the Hydrogeological areas)



3-2. Socio-economic Environment

(1) Transportation, Communication and Electricity

The transportation available between Lagos, the National Capital, and Minna, the State Capital, are by air and road. For the air route, daily flight is operated, while for the road, car may be used in the well-paved major roads linking the two cities which takes about seven hours.

Minna has the main railway station connecting Lagos and Kano via Minna. Major roads around Minna are well paved ones, but secondary roads are unpaved. The four-wheel vehicles hardly have access to the proposed borehole sites, especially in rainy season. Bridges for the secondary roads reoften broken or impossible to cross the bridge by big vehicles. The areas with hard access conditions are especially in the eastern part of River Dina and northern part of River Kaduna in Shiroro LGA.

International calls from Minna are available at NITEL Office. Telex communication is available connecting Minna and outside of the city. Thus, radio system is important to communicate with other major cities in the country.

The Project area has no electricity yet, while the urban areas such as Gwada, Kuta, Irena in Shiroro LGA, Bida, Baddegi in Gbako LGA, and Lapai, Gutu in Lapai LGA are already equipped with electricity.

(2) Education

There are 918 primary schools and 266 secondary/community schools with pupils of 896,000 and 150,000, respectively in the State in 1979, of which a total of 199,000 primary school pupils are living in the Project area, according to 1984/85 Census by the Ministry of Education, Minna.

The State Government has two institutions: (1) Zunger College and (2) College of Education, Minna. Furthermore, the Federal Government has six institutions in the State. In Bida (headquarter of Gbako LGA), there are two institutions, they are Federal Polytechnic College and Federal Girls College.

(3) Major Local Products

The main and traditional occupation of the people is agriculture, which is the backbone of the economic growth and social progress of the State. The important agricultural products of the State are Guinea-corn, millet, cotton, rice, groundnuts, yams and cattle breeding. In Minna area, yams have the biggest source of supply to the other States located in northern part of the State.

The State is richly blessed with natural resources and industrial potentialities, among which the famous are Suleja pottery and brass/glass works around Nasagu-Bida.

CHAPTER 4. THE PROJECT

4-1. Objectives and Outline of the Project

The Project aims to supply safe water to the people who have no adequate water supply facilities at present in the Niger State, to eradicate Guinea-worm and other water-borne diseases, to stabilize and upgrade their living standards, and to contribute to the national economic development of Nigeria.

Existing water supply system must be improved in order to eradicate the diseases caused by poor quality of potable water, specially the Guinea-worm disease which has high incidence rate on farmers and their children.

The Project is outlined below.

(1) To construct 150 boreholes equipped with handpumps in the three local government areas of Shiroro, Lapai and Gbako suffering from the highest incidence rate of Guinea-worm disease in Niger State for the supply of potable water. The number of boreholes for each local government area is as follows:

LGA	No. of Villages	Population	No. of Boreholes
Shiroro	34	29,430	50
Lapai	48	46,924	50
Gbako	17	31,727	50
Total	99	108,081	150

(2) To provide equipment and materials for the construction of the above-mentioned boreholes.

(3) To conduct on-the-job training of Nigerian personnel who will be able to implement after the termination of Japanese cooperation

4-2. Study on the Request for Grant-Aid

(1) The Project Area

The request for grant-aid was initially made for the two urgent required areas of Chanchaga and Lapai LGAs, among the five high incidence areas of Guinea-worm; namely, Chanchaga, Lapai, Gbako, Rafi and Mariga LGAs. During the discussions between the Government and the Study Team, it was confirmed that Chanchaga LGA was divided into two LGAs; viz., Shiroro and Chanchaga.

The UNICEF-assisted WATSAN Project has constructed boreholes in Suleja and Magama LGAs since 1988, while WATSAN has constructed boreholes in parts of Chanchaga LGA. It is expected to continue their activities in the entire area of divided Chanchaga LGA until 1990. Based on this fact, a discussion was made with the Government of Niger State on the Project area for this grant-aid in view of the demarcation with WATSAN. It was concluded that high incidence areas of Guinea-worm in Shiroro, Lapai and Gbako LGAs would be selected as the Project area for the Japanese grant-aid programme. Furthermore, joint operation of health education programme and the workshop with WATSAN have been agreed in spite of the demarcation of the Project area between Japanese grant-aid programme and WATSAN Project.

(2) Location and Quantity of Boreholes

The initial request of the Government of Nigeria does not indicate the name of the villages where boreholes will be constructed, except the 320 boreholes in Chanchaga and Lapai LGAs. Therefore, detailed locations of the boreholes were discussed with the Government during the field survey. The State Ministry of Health provided a list of villages in Shiroro, Lapai and Gbako LGAs where boreholes will be constructed. The list indicates that one borehole shall be basically allocated to 400 to 500 peoples, however, distributed quantity of boreholes will be adjusted based on the situation of the existing water sources in the villages. Finally, 150 boreholes (50 boreholes for each LGA) were requested for the Japanese grant-aid.

Taking into consideration the framework of Japanese grant-aid and the construction schedule of the Project, the number of boreholes to be constructed in the Project has been decided at 150 as requested by the Government of Nigeria. The locations of the boreholes are summarized in Tables 4-1 and 4-2.

(3) Design Yield and Service Population

The request of the Government of Nigeria indicated that the service population per borehole is 400 persons. This figure is considered reasonable based on the pumping capacity of the handpump which can pump 15 liters per minute from pumping water level of 10 to 20 meters below the ground surface. On the basis of this pumping capacity and the minimum daily demand of 20 liters per person recommended by WHO, it is concluded that one borehole can serve 450 persons with 9,000 liters from 10 hours' pumping operation. Consequently, the service population of 450 persons per borehole is considered adequate for the Project planning.

(4) Drilling Depth and Materials of Boreholes

The initial request of the Government of Nigeria indicated that the proposed drilling depth of boreholes is 60 m. Although the depth of boreholes drilled by WATSAN Project and DFRRI ranges from 30 to 100 m based upon their location and

geology, the average depth of WATSAN boreholes account for about 40 m as shown in Table 3-4.

Reconnaissance prospecting of GEP conducted by the Study Team revealed that the low resistivity layers which can be correlated with a potential aquifer composed of weathered and fractured zones of basement rocks underlies at 30 to 80 m depth in the northern part of the Project area. In the southern part of the sedimentary rocks area, the aquifer underlies 40 to 100 m in depth.

Under this situation, the proposed drilling depth of boreholes may be 61 m on an average as shown in Tables 4-1 and 4-2.

PVC will be selected as the materials for casings and screens as requested by the Government. The PVCs were used for the existing boreholes as well as those constructed by UNICEF. Groundwater in the Project area has a little acid with pH value of about six. Therefore, PVC is preferable than the steel.

The borehole diameter is determined at 4 inches as requested by the Government of Nigeria. This diameter has been adopted to the existing boreholes as well as those constructed by WATSAN, and is economically and technically most adequate for installing handpumps.

(5) Study of Construction Machinery and Materials

a) Drilling Rigs

The capacity of drilling rigs will be selected to drill a depth of 150 m with function of both rotary and percussion drilling to meet various hardness of formations in the area as initially requested by the Government of Nigeria. Judging from the road condition in the Project area, the rig should be of off-road operation and tractor-mounted type.

b) Compressor

As mentioned above, the maximum designed drilling depth in the Project area is 100 m. Therefore, enough capacity of compressor for 100 m drilling will be procured to meet the requirement in air-percussion drilling. The necessary units of compressor will be two in total, one unit for each rig.

c) Supporting Vehicle

In total, eleven units of cargo truck and pick-up were intially requested by the Government of Nigeria as supporting vehicles. However, in accordance with the study, the required types and number of vehicles are selected to cope with the activities of the following five groups to be deployed on site in constructing the 150 boreholes in this Project.

Table 4-1 List of Proposed Borehole Sites (1/3)

Name of Village	Population	Hydrogeo-logic Unit	No of Borehole	Depth of Well (m)
SHIRORO LGA				
Bilanda	500	A	1	50
Iburo	550	A	1	50
Unguwan Madi	755	A	1	50
Baga Missison	700	A	1	50
Ajateiji	1,206	A	2	2×50
Kukoki	608	A	1	50
Unguwan Cirona	700	A	1	50
Unguwan Kawa	500	A	1	50
Unguwan Bako	585	A	1	50
Unguwan Daudu	490	A	1	50
Farin Doki	450	B	1	50
Baga Baro	700	A	1	50
Apawi	500	A	1	50
Ebbe	1,648	A	3	3×50
Kpambbe	995	B	2	2×60
Kpmajia	492	B	2	2×60
Tafa	1,815	A	3	3×50
Atawuyin	780	B	1	60
Jinayi	515	A	1	50
Unguwan Magorot	670	A	1	50
Gyaita	495	A	1	50
Asha	1,570	A	3	3×50
Palita	782	A	1	50
Paina	2,891	A	4	4×50
Agogoyi	512	A	1	50
Dagba	958	A	2	2×50
Dumyi	755	A	1	50
Yanuwako	497	A	1	50
Gbayi	1,900	A	2	2×50
Aligani	554	A	1	50
Gidan Sauro	1,515	A	3	3×50
Jadan Sauro	580	A	1	50
Knuyanapn	782	B	1	60
Atawuyi	480	B	1	60
SUBTOTAL	29,430	-	50	2,580

Note: Hydrogeologic Units--A=Schist, Mylonite
B=granite, Migmatite c=Cretaceous D=Alluvium

Table 4-1 List of Proposed Borehole Sites (2/3)

Name of Village	Population	Hydrogeo-logic Unit	No of Borehole	Depth of Well (m)
LAPAI LGA				
Cheche Tutunwad	445	B	1	60
Cheche	650	B	1	60
Unguwan M.Ahmed	618	B	1	60
Kau	570	B	1	60
Ganan Madi	506	C	1	70
Dangana	1,660	C	1	70
Tudm Filani	720	B	1	60
Saminaka	610	B	1	60
Magudon	512	C	1	70
Kpabasan	632	C	1	70
Dwafu	709	C	1	70
Bwacha	531	B	1	60
Meyaki	1,295	B	1	60
Dunu	2,274	C	1	70
Shaku	1,315	B	2	2×60
Shaku Geropi	1,645	B	1	60
Dapugi	1,240	C	1	70
Tashibo	580	B	1	60
Gbami	570	D	1	40
Takuti Abuja	2,360	B	1	60
Takuti Shaba	2,430	C	1	70
Lenfa	624	C	1	70
Zago	520	B	1	60
Grundi	550	B	1	60
Ajiji	494	B	1	60
Aminiko	575	B	1	60
Sunfada	502	B	1	60
Aliko	712	C	1	70
Tawayi	618	B	1	60
Ekunupan	3,365	B	2	2×60
Ewugi Muna	1,875	B	1	60
Zabo	1,075	C	1	70
Bakyo	505	C	1	70
Gbanchinkwo	925	D	1	40
Sokun	1,765	C	1	70
Egba	489	D	1	40
Gbachi	1,016	C	1	70
Akoyi	760	D	1	40
Katakpa	520	D	1	40
Edzu	1,575	C	1	70
Bwace	508	C	1	70
Gulu Vatsa	1,700	B	1	60
Ewani	560	C	1	70
Ewani II	518	C	1	70
Dagbaje	870	C	1	70
Jifu	662	C	1	70
Favu	1,055	C	1	70
Gurgudu	814	C	1	70
計	46,924	-	50	3,120

Note: Hydrogeologic Units - - A = Schist, Mylonite
B = granite, Migmatite c = Cretaceous D = Alluvium

Table 4-1 List of Proposed Borehole Sites (3/3)

Name of Village	Population	Hydrogeo-logic Unit	No of Borehole	Depth of Well (m)
GBAKO LGA				
Lafiyogi	3,265	C	4	4×70
Maui Dadi	1,230	B	2	2×60
Gbangba	1,500	B	3	3×60
Mansani	967	C	1	70
Bana Bigi	1,125	C	2	2×70
Edotsu	2,324	C	4	4×70
Sidi Saba	906	C	1	70
Wadata Pangu	755	C	1	70
Halilu (Takutu)	2,487	C	5	5×70
Gusadin	744	C	1	70
Amina Woye	1,229	C	2	2×70
Kpotunko	1.085	C	2	2×70
Magayaki	1,955	C	3	3×70
Bisanti	3,440	C	6	6×70
Kansanagi	4,253	C	8	8×70
Matafiyan	2,682	C	3	3×70
Mlagi	1,780	C	2	2×70
計	31,727	-	50	3,450

Note: Hydrogeologic Units - - A=Schist, Mylonite
B=granite, Migmatite c=Cretaceous D=Alluvium

Table 4-2 Summary of Proposed Drilling Depth for the Project

LGA/井戸深度	40 m	50 m	60 m	70 m
SHIRORO	-	42	8	-
LAPAI	5		23	22
GBAKO	-	-	5	45
Total (Hole)	5	42	36	67
Total (m)	200	2,100	2,160	4,690

Drilling Groups (two groups)	:	Drilling boreholes , borehole logging Installation of casings
Testing Group (one group)	:	Pumping tests
Pumping Installation Group (one group):		Installing handpumps; Constructing the foundation of boreholes.
Operation & Maintenance Group(A):		Operation & maintenance of the constructed water supply facilities and workshop.
Operation & Maintenance Group(B):		Transfer of techniques of pump maintenance to villagers.

d) Materials for Borehole Development and Pumping Test

Two sets of materials and equipment will be installed as initially requested by the Government of Nigeria.

e) Quantities of Casings and Screens

The rates of casing and screen lengths to a total depth of designed boreholes are decided at 80% and 20%, respectively, as a result of discussions with the Ministry of Health and WATSAN Office, and 15 % will be added taking into consideration the damages in transportation and custody.

f) Borehole Logger

Two sets of equipment will be installed as initially requested by the Government of Nigeria.

g) Handpump

The handpumps for boreholes will be set for the Project. Those accepted by all WATSAN Projects in Nigeria, such as India Mark II will be used on the condition that the spare parts will easily be available. Necessary units will be 150 instead of 500 as requested by the Government of Nigeria. In adddition, 15% of it will be procured.

h) Geophysical Prospecting Equipment

The Government of Nigeria initially requested one unit of GEP prospecting equipment. Application of different kinds of prospecting, GEP and Electro-

Magnetic, is more effective to meet different properties of aquifers of weathered and fractured rocks lying in the Project area.

Prospecting of the fractured rocks is effectively detected by the Electro-Magnetic method while the weathered layer in sedimentary layers can be more effectively detected by GEP method. Electro-Magnetic equipment has been also applied by WATSAN Office of the State.

i) Drilling Agents

Two kinds of drilling method (air percussion and rotary methods) will be applied in the Project area. The air-percussion method with air foam agent will be applied for drilling of basement rocks and the rotary method with mud-water which is composed of polymer liquid will be applied for sedimentary and soft layers.

j) Communication System

The communication system is poor in Nigeria. Therefore, wireless radio shall be used for communication among drilling groups, testing group and the Project Office, in order to maintain close contact among the groups.

k) Equipment and Materials for the Workshop

The workshop is situated in WATSAN Office. Initially requested equipment to reinforce the workshop will be selected because the existing equipment and materials are not sufficient to meet requirement of the Project.

l) Spareparts

Spareparts of the equipment for about 2-year normal operation shall be secured under the grant-aid.

4-3. Outline of the Project

4-3-1. Executing Body

The Executing Body of the Project will be WATSAN Project Office under the supervision of the Ministry of Health, the Government of the Niger State. This Office will be the implementing organization under the Ministry for the Rural Water Supply and Sanitation Programme and has a total of about 150 staff as shown in Figure 2-5.

4-3-2. Outline of the Project

The outline of the Project is as follows:

- The objective of the Project is to eradicate Guinea-worm diseaes by supplying safe drinking water from the boreholes.

- A total of 150 boreholes shall be constructed in three LGAs located in the south-eastern part of the State.

- The borehole depth is estimated to be 61 m on an average, with a range of 30 to 100 m based on its location. Casing and screen pipes made of PVC shall be installed into drilled boreholes for protection. The rates of the length for casing and screen pipes will be 80% and 20%, respectively.

- The beneficiaries for each borehole will be from 400 to 500, or 450 on an average.

4-3-3. Summary of Equipment and Materials

The equipment and materials necessary for the Project execution are summarized below. The technical specifications and the numbers of the equipment and materials are given in Chapter 5 "Basic Design".

1) Equipment

- Drilling rigs with necessary accessories and tools
- Supporting vehicles
- Equipment for borehole development and test
- Geophysical survey instrument
- Borehole logger
- Radio system for communication
- Spare parts

2) Materials

- Casing and screen pipes
- Handpumps
- Driling agents
- Fuel and oil
- Cement and aggregate
- Others

CHAPTER 5. BASIC DESIGN

5-1. Basic Concept

The basic design of the Project has been made taking into account the conditions prevailing in the Area such as the inaccessibility of the Project area during wet season due to submerged road networks, poor provision of infrastructures and drillings of alternative layers of hard and soft rocks, and at the same time implementing the following Project works within the framework of the Japan's Grant Aid:

(1) Construction of 150 boreholes together with provision of the necessary equipment and materials such as handpumps, casings, screens, etc. for borehole construction.

(2) Provision of drilling rigs, other equipment and materials suitable to specifications to the hydrogeological conditions of the Project area as well as the natural conditions prevailing in the Niger State.

(3) Provision of such borehole facilities consistent with the facilities already constructed by WATSAN Project and can play the role of an economic model facilities for other areas in the State in the future.

5-2. Basic Planning

5-2-1. Project Area

The Project area consists of three LGAs of Shiroro, Lapai and Gbako of Niger State, as shown in the Location Map of this Report.

The area is composed of flat farm land, grassland and savanna.

Hydrogeologically, the northern to southeastern part is composed of basement rocks of pre-Cambrian age and southern to south-western part is composed of sedimentary rocks of mesozoic. Aquifers can be found in the horizon of 30-60 m deep in the basement rocks area and 30-100 m in the sedimentary rocks area, and a weathered/fissured zone of basement rocks and/or sandstone would be a target for development.

5-2-2. Designed Water Supply Demand and Benifited Population

As shown in item (3) of section 4-2, the designed water demand for the Project is 20 liters per capita with 450 benefited population per borehole.

Table 5-1. Benefited Population in Project Area

LGA	No. of Village	Total Population	Planned Boreholes	Benefited Population
Shiroro	34	225,300	50	22,500
Lapai	48	99,200	50	22,500
Gbako	17	449,000	50	22,500
Total	59	774,000	150	67,500

5-2-3. Potentiality of Groundwater Development

The groundwater development potential is shown in Table 3-9 which is taken from the performance of boreholes of the Water Board. As shown in the table, a borehole could yield 110-230 tons/day, equivalent to 76-160 lit/min under the 24 hours' operation. This yield is more than the pumping capacity of handpump by 15 to 20 lit/min and the designed water demand can be taken by 15 lit/min.

5-2-4. Designs of the Proposed Borehole Facilities

(1) Location of Proposed Borehole Facilities

The proposed number of boreholes requested by the Ministry is 150 located in 99 villages/communities, as shown in Table 4-1.

(2) Designed Borehole Depth

The designed depths are ranging from 30 to 100 m with average depth of 61 m as shown in item (6) of 3-1-5 "Conclusion of Hydrogeology".

(3) Successful Rate of Borehole Drilling

Over 90% of borehole drilling for WATSAN Project has been successful in 1988 (refer to attached Appendix 8), however, this rate shows only the pump installation rate. After taking into account the water quality (refer to Table 3-6) such as turbidity, colour and content of iron, the successful rate, therefore, could be taken by 90% based on the actual rate in the past.

5-2-5. Criteria of Borehole Site Selection.

The proposed sites is mentioned in the previous chapter. However, actual sites will be selected by applying the following criteria for the sites proposed:

* Heavily polluted villages with Guinea-worm.
* Villages where the inhabitants depend on unsafe water sources and have a high risk of acquiring Guinea-worm.
* Public places such as schools, clinics, markets, etc.
* Densely populated villages.
* Places where geophysical prospecting results show promising aquifers.

5-3. Basic Design of Facilities

(1) Design of Boreholes

The borehole depth is to be designed at 30-80 m for the baseement area, while 30-100 m for sedimentary rock area, and 61 m on an average. The designed borehole diameter is 100 mm, which is adopted in the WATSAN Project and existing boreholes equipped with handpumps.

The materials to be used for casings, screens, etc. will be PVC products considering the anti-corrosivity, since water quality of the Project area is acidic. The grout sealing will be made to a minimum of six meters from the top to prevent pollution from surface water flowing into the borehole.

The proposed typical borehole is as shown in Figure 5-1.

(2) Design of Appurtenant Structures

For the headworks of the boreholes, 20 cm thick concrete slab will be placed to prevent direct infiltration of sewerage from the ground surface.

Drainage will be made with 4.0 m long concrete drain to carry water to a flower bed, placed at the end of the drain. The bed will be arranged by the villagers to encourage the local people to join in the Project and possess ownership of the facilities. Therefore, the cost for flower bed arrangement shall be borne by themselves.

The layout of the facilities is given in Figures 5-2 and 5-3.

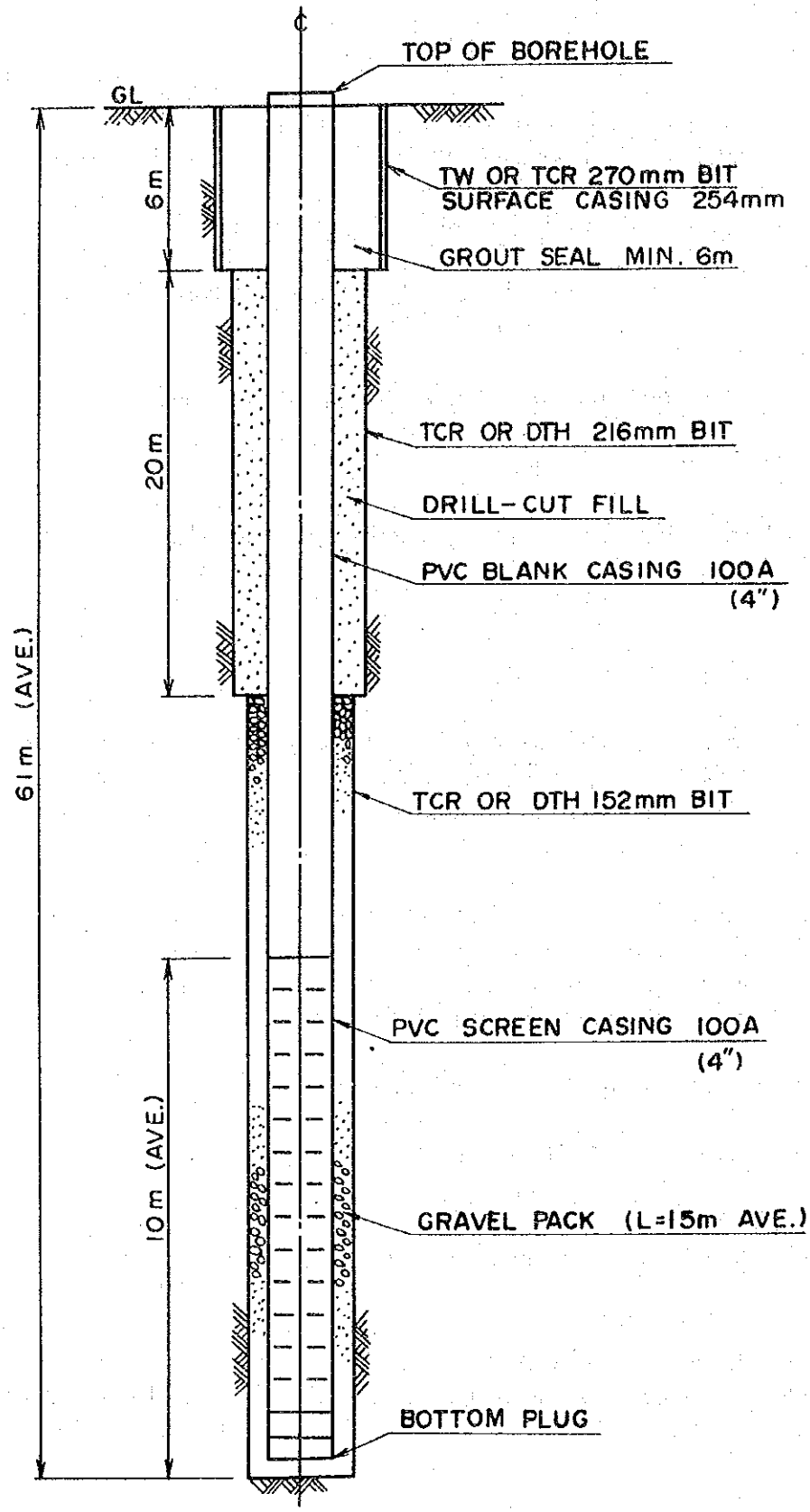


Fig. 5-1 DESIGN OF TYPICAL BOREHOLE

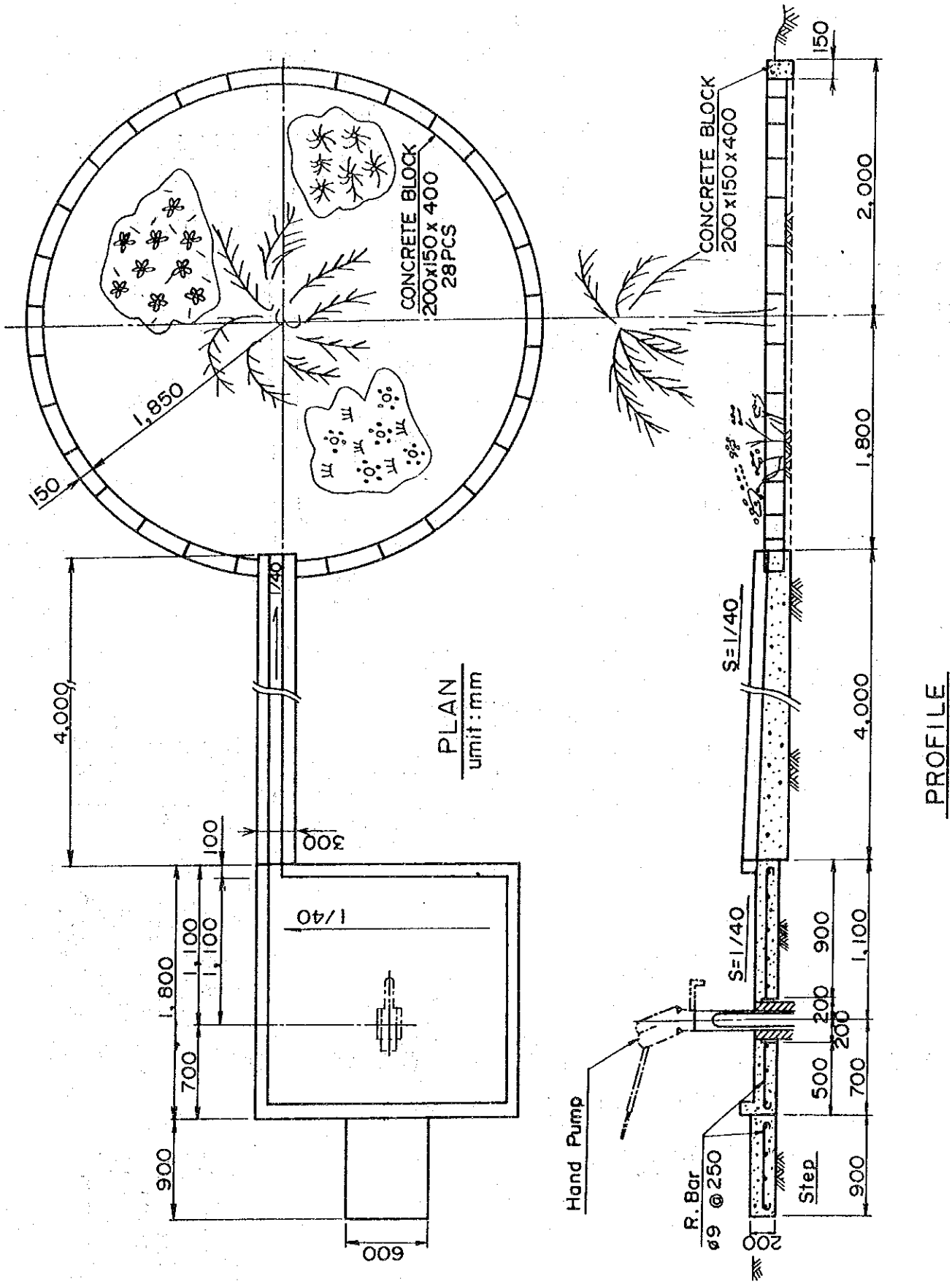


Fig. 5-2 GENERAL PLAN FOR BOREHOLE FACILITY

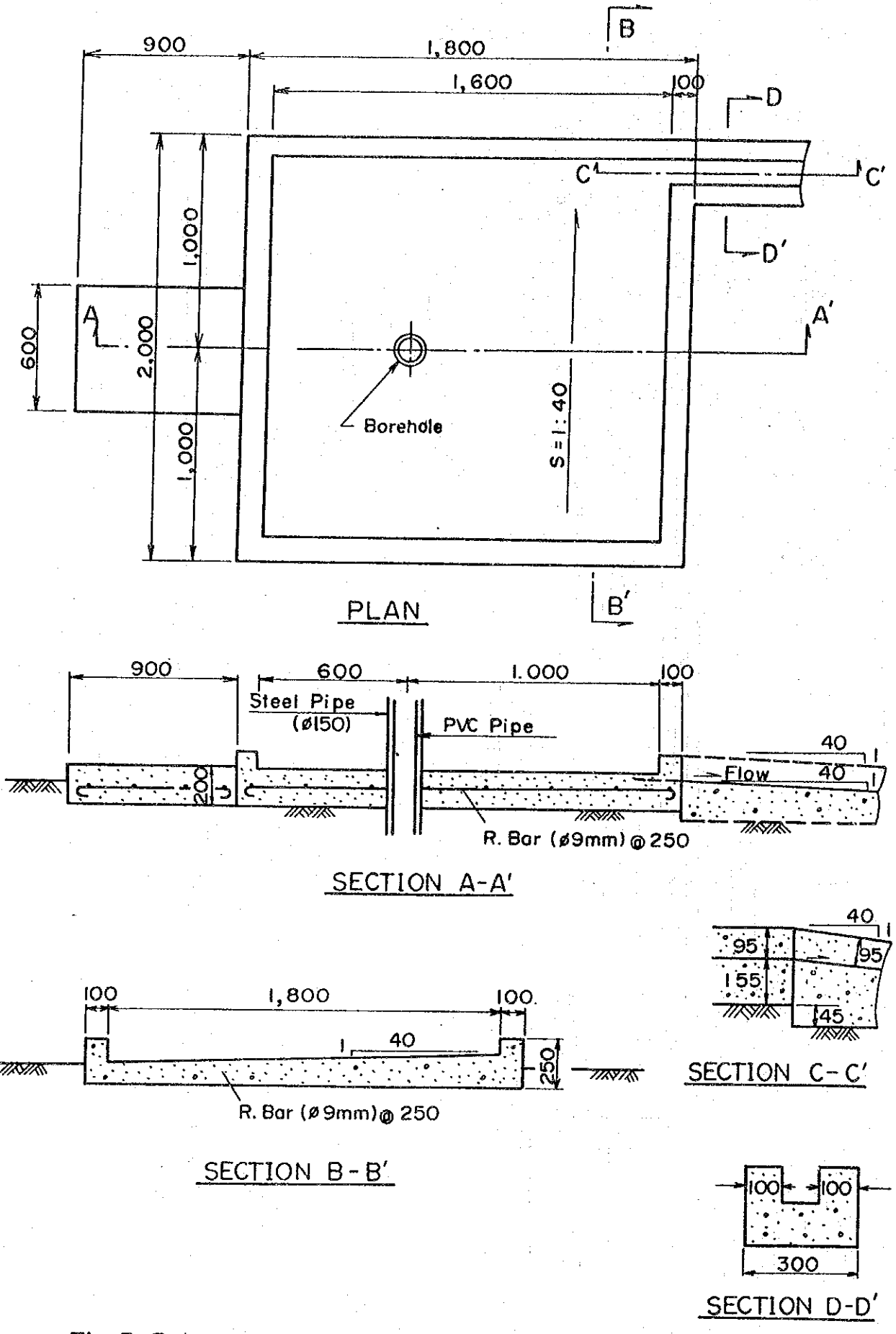


Fig. 5-3 CONCRETE SLAB DESIGN OF BOREHOLE

5-4. Basic Plan of Equipment and Materials

(1) Drilling Rig 2 units

Judging from the geology of the Project area, the drilling rig employed for the Project should meet the requirements for drilling of both soft and hard rocks, and the top head drive type with percussion should be used for application of both the rotary type and percussion type. Due to unfavorable conditions of the road networks, particularly the difficult access to the drilling site in the wet season, a tractor mounted-typed shoudl be employed for higher mobility of the rig. Based on the working period and quantity, two sets of drilling rigs will be required.

The specifications and quantities are shown as follows:

a) Top Head Drive Type Drilling Rig

Equipment available for both the Rotary and Air Percussion Method (Down-the-Hole, DTH).

Holdback Capacity	:	5,000 kg
Rated Capacity	:	150 m with 3-1/2" Drill Pipes
Mud Pump Capacity	:	600 lit/min.

b) Standard Accessories and Drilling Tools

c) Rig Carrier Tractor (4 x 4)
Diesel Engine, 70HP, Off-road Type

(2) Air Compressor 2 units

One compressor shall be provided to each rig for DTH drilling, with a delivery capacity of 20 cu.m/min. at 10.5 kg/sq.cm.

(3) Supporting Vehicles

The field works of the Project will be executed by six groups consisting of Drilling Group(2), Testing Group (1), Construction Group(1) and Operation/Maintenance Group(2).

The types, specifications, quantities, purposes, etc. of the vehicles required by the above groups are shown in the succeeding table.

Table 5-2. List of Supporting Vehicles

Type	No.	Specifications and Major Purpose
Cargo Truck	2	Capacity: 10 tons, 6x6 with 6-ton crane. For carrying drilling tools and compressor.
Caro Truck	1	Capacity: 6 tons, 4x4 with 3-ton crane. For carrying PVC pipes, mud agents, aggregate, etc.
Small Truck	2	Capacity: 2 tons, with 0.9-ton crane. For borehole test and construction works.
Water Tank Lorry	1	Capacity: 7,000 lit., 4x4. For carrying water for drilling works.
Pick-Up	3	Double cabin type, 4x4. For carrying personnel and tools.
Station Wagon	3	6 passengers, 4x4. For carrying personnel for siting, maintenance of equipment/constructed boreholes.

(4) Equipment and Materials for Development and Borehole Test

The equipment and materials for development and borehole test are shown below.

a) Equipment and Materials for Development

Air Pipe : 180 m
Air Hose : 20 m
Other Accessories : 1 lot

b) Equipment for Borehole Test

Submergible pump (for 100 mm diameter, 7 KW, 240V) : 2 units
Generator (20 KVA) : 2 units
Water level detector (for 100 m depth) : 2 units

(5) Welder 2 units

One welder shall be employed for each drilling rig to repair the equipment on the working sites. Two units of welders with a capacity of 15 HP shall be provided.

(6) Mud Agent 1 lot

The expected drilling lengths are about 4,300 m for basement rocks and 4,900 m for sedimentary rocks. The required agent types will be the foaming agent for DTH drilling and polymer agent for rotary drilling.

The foaming agent shall have weight of 560 kg, while polymer shall weigh 2,500 kg.

(7) Radio System 1 lot

A radio system shall be provided for communication among the base camp (Minna), site camp and job sites to ensure close liaison for smooth and safe progress of the works.

Base Station : Output 100W, 2 sets
Mobile Station : Output 30W, 6 sets

(8) Geophysical Prospecting Instrument 1 lot

One set of each of portable Electro-Magnetic (E-M) and Geo-Electric Prospecting (GEP) for 100 m depth prospecting, shall be provided for geophysical prospecting.

(9) Borehole Logger 2 units

Two units of borehole loggers for determining the screen position shall be provided, the details of which are as follows:

Measuring items : Specific resistivity, Caliper, Temperature
Recorder : Auto-recorder
Cable : 100 m

(10) Water Analysis Kit 2 sets

The water analysis shall be made on the following 18 items regulated by WHO:

Measuring items --- Turbidity, color, taste, odor, potassium per manganate demand, pH, nitrite-nitrogen, nitrate-nitrogen, ammonium-nitrogen, chlorine, hexavalent chromium, total iron, copper, zinc, total hardness, chloride, micro-organisms, coliforms

a) Water analysis kit for field measurement (for 100 samples)
b) Portable pH meter
c) Portable E-conductivity meter

(11) Casing Pipe 1 lot

The casing pipe shall be 100 mm dia. PVC pipe taking into consideration the anti-corrosivity and workability. The screen pipe shall be same materials with the casing and prepared in length to correspond to 20% of the total expected borehole length. Also, the excess of 15% of the pipes shall be prepared taking into account the losses during transportation and site works.

The total designed borehole depth, as shown in section 3-1-5(6), is about 9,200 m with a range of 30-100 m depth and 61 m on an average. The required quantities of pipes are calculated at about 10,500 m in total.

a) PVC casing pipes (100 mm, l=4.0 m) : 2,100 nos.
b) PVC screen pipes (100 mm, l=4.0 m) : 525 nos.
c) Bottom plugs : 165 nos.
d) Centralizer : 1,250 nos.

(12) Handpump 173 nos.

There are several types of handpumps available and the types of handpump selected for the Project shall be those that can be easily repaired and supplied with spareparts because a handpump would be damaged within one or two years after its installation.

In Nigeria, India Mark-II type of handpumps are generally used at the recommendation of the UNICEF. Recently, a new type of pump (open top type) has been developed for easy maintenance and adopted by the WATSAN Project. The same type of pump will be adopted for the Project. The pumps are installed into 100 mm diameter borehole and the riser pipes are to be of stainless steel, considering the anti-corrossivity due to its acidic water quality in the Area.

These 173 handpumps include 15% of the total number of boreholes.

(13) Equipment and Tools for Workshop 1 lot

The WATSAN Project has already set up its workshop, however, its equipment and tools are not sufficient in terms of both items and quantities, therefore, some additional equipment and tools will be required for the proper execution of the Project.

(14) Spart Parts

The spare parts for the equipment supplied will be provided in order to meet the estimated two-year operation.

5-5. Project Cost

The project implementation cost to be provided by the Government of Nigeria is estimated as follows:

i)	Construction Cost	:	430,000 Naira
ii)	Operation & Maintenance Cost	:	861,000 Naira

Other conditions of the project implementation are as follows:

i)	Estimated date	:	September 1989
ii)	Project period	:	31.0 months after E/N for Stage-1
iii)	Contractor	:	Japanese firm/contractor
iv)	Others	:	To include the exemption from customs duty on import goods required for the Project and from business tax for the Japanese Contractor.

CHAPTER 6. PROJECT IMPLEMENTATION PROGRAMME

6-1. Organization of Project Implementation

6-1-1. Executing Agency

The executing ansency of Project will be the Ministry of Health, the Government of Niger State. This has been confirmed with the Ministry through a series of discussion with the Study Team. The Ministry is presently executing WATSAN Project and has established the WATSAN Project Office in Minna.

The organization of the project implementation prepared by the Ministry is illustrated in Figure 6-1, and WATSAN Project Office shall be responsible for the Japanese-assisted Guinea-Worm Eradication Project together with the WATSAN Project. WATSAN Office would carry out the both Projects since the major concept of bothProjects has the same objective -- to provide safe potable water in the rural areas.

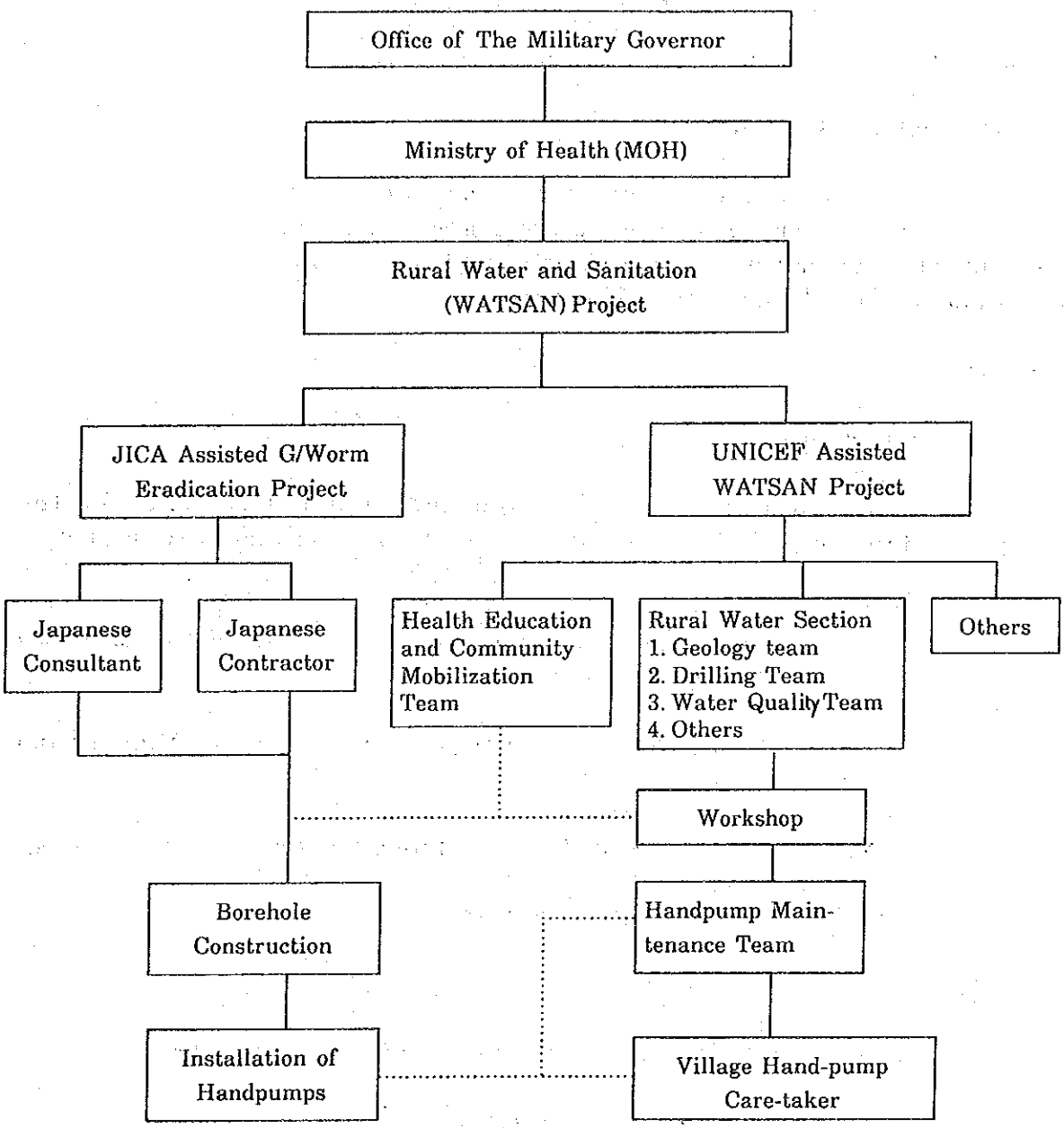
The organization chart of the WATSAN Office is shown in Figure 2-5. As is shown, the WATSAN Office has over 150 staff. Figure 2-5 shows the details of the Staff including 82 technical/engineering staff and over 70 staff in supporting and administrative units. Among the technical units, Water Supply and Workshop/Store Units have 56 staff which is equivalent to 70% of the total technical staff, who are engaged in water supply subjects.

The Japanese Staff will be under the WATSAN Office and engaged in the Project execution, in cooperation with the WATSAN Nigerian Manager, who wil be newly or concurrently assigned for the Guinea-worm Eradication project.

The Japanese staff will carry out technical transfer to Nigerian staff thorugh the "On-the-Job Training". After return of Japanese staff, Nigerian side shall continue the Project and execute the maintenance and operation of the constructed boreholes.

In the State, Water Board is another authority responsible for the water supply scheme, however, the Water Board has suspended the new borehole scheme for rural area due to mechanical problem of the old rig. The Board has dispatched its geological/drilling staff to the WATSAN Office. The WATSAN Office has full responsiblity for the rural water supply scheme and will be the executing body for both the UNICEF and Japanese-assisted Projects.

Figure 6-1 Organization Chart of Executing Agency



The Ministry of the State, in close cooperation with the authorities concerned of the Federal Government, will implement the Project after the Exchange of Notes are mutually confirmed by the Goverment of the Federal Republic of Nigeria and the Government of Japan.

6-1-2. Detailed Design and Construction Supervision Plans

(1) Consultant and Contractor

The Project will be executed under the Grant-Aid of the Government of Japan, and the Japanese consulting firm and contractor will carry out the following works based upon the agreements with the Ministry, and in accordance with the regulation and formality of the Japan's Grant-Aid System.

1) Consultant

(a) Detailed Design

- Preparation of detailed design and tender documents for the procurement of equipment and materials as well as the construction works.
- Carrying out of the tender procedures on behalf of the Ministry including the tender evaluation.
- Witnessing and advising on the negotiation between the Ministry and the successful tenderer.
- Supervision of procurement/transportation of eqipment and materials.
- Other necessary consulting services.

(b) Construction Supervision

- Coordination with authorities and organizations concerned.
- Total management of the Project works.
- Comprehensive management for technorogy transfer.
- Confirmation and approval of reports on the construction works.

2) Contractor

- Procurement and transportation of equipment and materials.

- Dispatch of the construction staff to Nigeria.
- Implementation of the construction works.
- Technology transfer to Nigerian staff through on-the-job training.

The necessary contractor's staff and their works are as follows:

(a) Construciton Management Engineer

- Control and arrangement of construction schedule/staff.
- Supply and management of construction materials.
- Operation and management of the base camp.
- Management of technical transfer.

(b) Senior/Assistant Driller

- Borehole drilling works
- Borehole test (pumping test)
- Technical transfer on borehole drilling

(c) Mechanical Engineer

- Maintenance of drilling rig and other supporting equipment.
- Management of stocked spare parts.
- Technical transfer on the above subjects.

(d) Civil Engineer

- Installation of handpumps and construction of borehole facilities.
- Technical transfer on the above subjects.

(e) Borehole Test Engineer

- Borehole test and water quality analysis.
- Preparation of construction report.

- Technical transfer on the above subjects.

(f) Hydrogeologist

- Carrying out of geophysical prospecting.
- Preparation of construction report.
- Technical transfer on the above subjects.

(2) Responsibilities of the Government of Nigeria and Japan

When the Project is executed under the Japan's Grant-Aid, the responsibilities to be undertaken by both governments will be as follows:

1) Undertakings of the Government of Japan

- Procurement and transportation of equipment and materials referred to in paragraph 5-4.
- Construction of borehole facilities.
- Technical transfer to Nigerian Staff.
- Delivery of equipment and remaining materials.

2) Undertakings of the Government of Nigeria

- To secure the necessary Nigerian counterparts for the Project implementation and to bear all the expenses.
- To secure the Nigerian staff for technical transfer and bear such costs as salary, per diem.
- To procure the equipment and materials necessary for the Project implementation and bear all expenses other than those to be borne by the Japanese grant-aid.
- To allow to use the necessary equipment/facilities provided for the WATSAN Office to Japanese staff, if required.
- To ensure tax exemption and customs clearance to facilitate the import of equipment and materials for the Project implementation.

- To ensure the exemption of taxes and duties on all personal goods, equipment and effects which are to be brought into Nigeria by Japanese personnel related to the Project.

- To ensure Japanese staff for their smooth entry/exit/re-entry into/from Nigeria for the project implementation and to assist them for the above procedures.

- To bear the bank commissions based upon the banking arrangement.

- To bear responsibility for the operation and maintenance of constructed boreholes and delivered equipment and materials.

(3) Construction Plan

The construction of the borehole facilities shall be implemented by the Japanese Contractor under the superintendence by the WATSAN Project Office of the Ministry. The construction works shall be executed in Shiroro, Lapai and Gbako LGAs in the State as shown below.

Table 6-1. Quantities of Borehole Construction

LGA	Proposed Site No.	Proposed B/H No.	No. of Dry Holes	Total Drill. Depth (m)	*Depth of Casing (m)
Shiroro	34	50	5	3,355	2,580
Lapai	48	50	5	3,355	3,120
Gbako	17	50	5	3,355	3,450
Total	99	150	15	10,065	9,150

* -- including screen portions.

The construction works are sub-divided into seven sections as described below.

a) Project Management

- Coordination and communication with the government agencies concerned, both the Federal and State,

- Supervision of the construction works.

- Management/coordination of the construction schedule,

- Management of standby equipment and spare parts,

- Recording, accounting, and others.

b) Construction Management

- Management/coordination of construction schedule and personnel,
- Supply and mangement of construction equipment and materials,
- Operation/management of base camp, etc.

c) Site Selection

- Selection of borehole sites/access road by geophysical prospecting and other field surveys.

d) Drilling Work

- Moving in/out of the rig and materials,
- Drilling, logging, development of boreholes, etc.

e) Borehole Test

- Borehole tests of successful boreholes to confirm yield and water quality.

f) Construction Works of Appurtenant Facilities

- Installation of hand pumps,
- Construction of the concerte structures.

g) Maintenance

- Daily maintenance and management of rig, vehicles and so forth,
- Operation and maintenance of completed boreholes.

(4) Construction Schedule Plan

The proposed 150 boreholes will be drilled according to the following schedule. The working progress rate is estimated taking into consideration the actual results obtained in various African counties as well as the current situation in, Nigeria.

a) Required Days for Drilling

The typical borehole with 61 m averaged depth will require the following period:

i) For successful boreholes

Moving in and preparation,		1.0 day
Drilling,		1.5
Logging and Casing installation,		0.5
Graveling, and Developing,		0.5
Moving out and finishing up,		0.5
	Total	4.0 days

ii) For unsuccessful borehole

Moving in and preparation		1.0 day
Drilling		1.5
Moving out, and finishing		0.5
	Total	3.0 days

b) Borehole Test (Pumping Test, Water Quality Test)

Moving in and preparation		0.5 day
Pumping test and Water quality test		1.0
Moving out, finishing up,		0.5
	Total	2.0 days

c) Pump Installation and Cnstruction Works

Moving in, and Pump installation		0.5 day
Earth/Concrete Works		1.0
Test operation and finishing		0.5
	Total	2.0 days

d) Workable Days and Construction period

Workable days in a year are estimated as follows;

- Work condition	8 hours/day (8:00 AM-5:00PM), 6 days per week, 12 days of public holidays per year.
- Climatic condition	60% progress rate in rainy season (June-September).
- Religious condition	50% progress rate during Ramadan.

Under the above-mentioned conditions, the workable days per year are computed at 111 days as follows:

Weekly, public holidays: 12 months x 5	=	60 days
Time loss by rainy season: 4 months x 25 x 40%	=	40
Time loss by Ramadan: 22 days x 50%	=	11
Total	=	111 days

Thus the annual working days are estimated at 254 days (365 - 111); 194 days in dry season and 60 days in rainy season.

Total required days for the drilling works are calculated at 323 days as follows:

(150 Nos. x 4 days + 15 Nos. x 3 days)/2 rigs = 322.5
322.5/254 = 1.27 years (15.2 months)

On the other hand, the required days for the borehole tests and pump installation are 300 days in total, respectively, and these days are within the period for drilling work.

Required days for site selection are estimated at 150 days with an average progress rate of 1.0 day/site.

(5) Personnel Plan

The necessary personnel for the Project implementation is shown in Table 6-2.

Table 6-2. Staffing Plan by each Section

Category	Project Office	Siting	Drilling	Borehole Test	Facility Const'n.	O&M	Total
Manager	1						1
Const. Eng.	1						1
Geologist		1					1
Mechanic	1						1
Civil Eng.					1		1
Test Eng.				1			1
Driller			2				2
Asst. Driller			2				2
Driver (heavy)			6				6
Driver (light)	1	1	2	1	2	2	8
Skilful Worker	2		4	2	4	2	14
Clerk/Account	2						2
Typist	1						1
Watchman	2		6		2		10
Worker		5	10	5	5		20
Total	11	7	32	9	14	4	77

(6) Implementation Plan

In line with Japan's Grant-Aid procedures, the Project implementation has been divided into two phases; as follows:

Phase I

- Procurement of equipment and materials,
- Borehole construciton for 50 numbers, including siting.

Phase II

- Borehole construction for 100 numbers, including siting,
- Delivery of equipment and remaining materials.

The project will commence after the Exchange of Note (E/N) is signed by both the Governments of Nigeria and Japan.

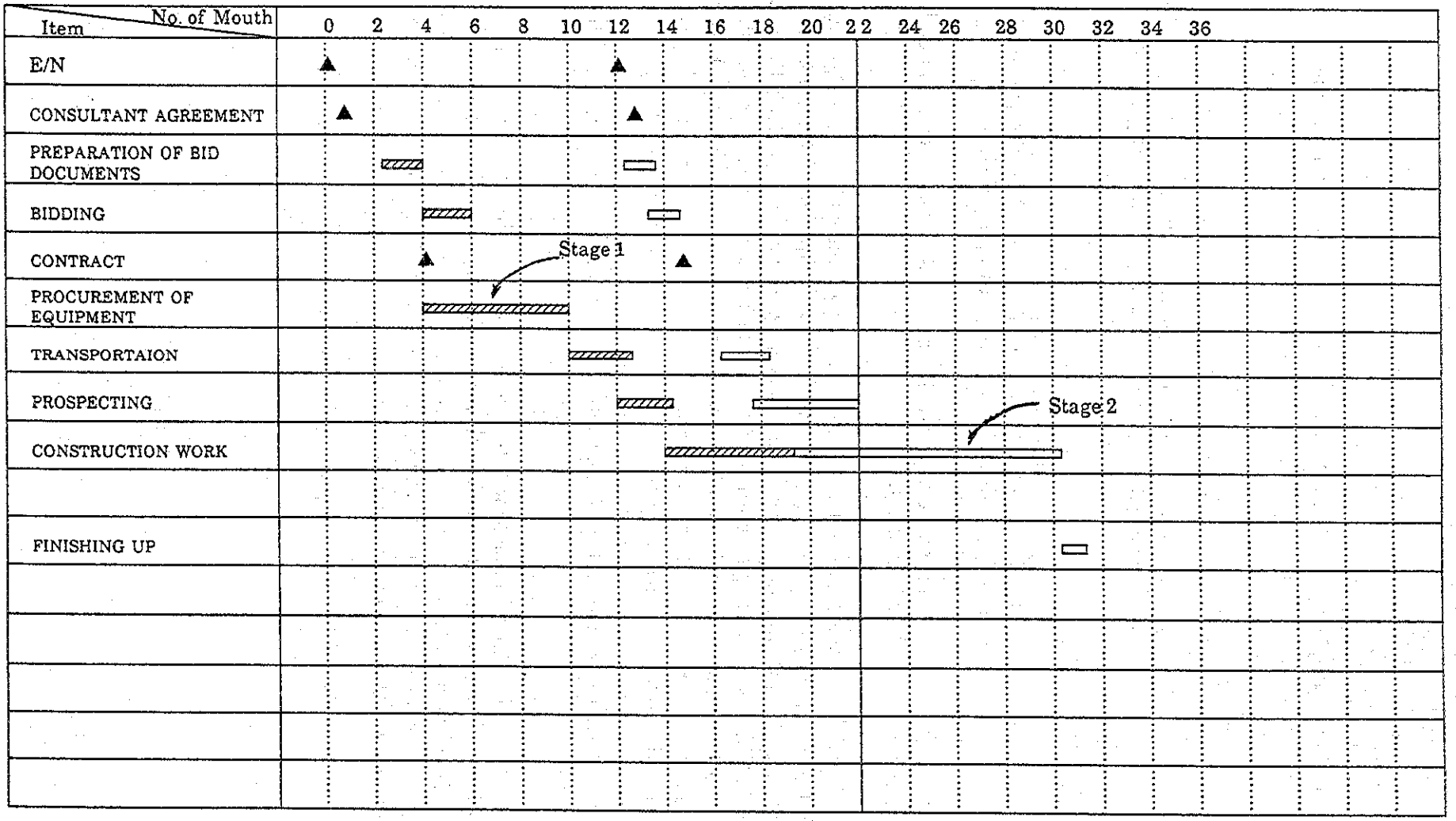
The Contractor's contract will take about four months from the signing of E/N after the Consultant agreement and tendering procedures. The contractor will commence the procurement and manufacturing immediately after the contract becomes effective. These procedures will take about six months. Another about two and a half months for ocean and inland transportation will be necessary, therefore, a total of twelve months will be required after signing of E/N upto the arrival of equipment and materials in Nigeria.

The required period for 50 boreholes for the Phase I is estimated to be about 5.5 months.

The E/N for the Phase II will be signed one year after signing of the E/N for the Phase I. The Phase II works will be started after the completion of Phase I, which is seven months after the signing of E/N for Phase II. The Phase II work will cover the construction of 100 boreholes and delivery of equipment and remaining materials, which will take about eleven months.

The implementation schedule is shown in Figure 6-2.

Figure 6-2 PROJECT IMPLEMENTATION SCHEDULE



CHAPTER 7. OPERATION AND MAINTENANCE PROGRAMME

7-1. Operation and Maintenance Programme

1) Water Supply Facilities

Operation and maintenance for the borehole facilities constructed under the Project will be executed by the Operation & Maintenance (O & M) Team to be newly established by the WATSAN Office. An additional vehicle will be provided to the new O & M Team under the Project.

The Team will be composed of a foreman, two technicians, two workers and a driver. The Team will render periodical borehole inspections and proper maintenance, and carry out the training to members selected in each borehole for daily maintenance works.

2) Drilling Equipment and Materials

After completion of the Project, the equipment and materials procured for the Project shall be handed-over to the Ministry and used for the WATSAN Project for the further construction of boreholes.

The equipment and materials used for the Project shall be placed under the control of the workshop of WATSAN Office, and the engineers assigned/trained to/under this Project shall successively execute the operation and maintenance works for the equipment along with the technical training to the staff.

7-2. Operation and Maintenance Cost

The operation and maintenance cost (O & M cost) shall cover expenditures by the O & M Team for the proper O & M services for a period of ten years, such as periodical borehole inspection and repair of the pumps for the total 150 boreholes, which may be necessary once every one a half years.

The O & M cost for the equipment are not included in this estimate because the said cost shall be borne by the WATSAN Project.

(1) Composition of the Maintenance team

Vehicle	:	Pick-up truck (1 unit)
Staff	:	1 Foreman, 1 Driver, 2 Plumbers, 2 Workers
Moving Distance	:	150 km x 1 Round trip (300 km)/day

(2) Spare Parts : 215 Naira/year x 150 Nos. x 8 years
(The cost for the first two years are included in the Project)

The following O & M cost for 150 boreholes for a period of ten years has been estimated based on the current prices of commodities (excluding price escalation)

(1) Personnel Expenses	468,000 Naira
(2) Fuel and Oil	135,000 "
(3) Spare Parts	258,000 "
Total	861,000 "

CHAPTER 8. PROJECT EVALUATION

The Niger State is considered a low endemic area on Guinea-Worm according to the map of Nigeria prepared by UNICEF in 1987. However, the eastern part of the Niger State where the Project area of Shiroro, Lapai and Gbako LGAs is delineated as high endemic area. This fact has been confirmed from the case study conducted by the State Ministry of Health in October 1988 on the Guinea-worm disease,and field survey by JICA Study Team. Both case study and survey revealed that the incidence rate of Guinea-Worm in the Project Area account to about 10% of the total population by the State Ministry of Health, while JICA obtained 20% of the selected villages. Furthermore, the study of University of Sokoto revealed that 84% of the total villagers have acquired Guinea-Worm disease where safe drinking water have not provided in the village.

The Guinea-worm disease is acquired mostly among farmers and their children. The study of University of Sokoto indicates that high incidence rate of this disease appeared to those whose ages range from 10 to 20 as well as the workers from ages 20 to 40. Consequently, if these farmers in this agri-based state who have acquired this disease do not engage in farming activities, the national economy will be adversely affected.

As stated previously, Guinea-worm disease can be completely eradicated if safe potable water can be secured by the people, according to the result conducted by the UNICEF-assisted WATSAN Project in Kwara State. Furtheremore, the Study Team of JICA verified that Guinea-worm disease were totally eradicated in three villages of Tawali and Gwada in Shiroro LGA, and Dobogi in Lapai LGA when their sources of drinking water have been replaced by safe water supplied from boreholes.

The direct benefits expected to be derived after the implementation of this Project will be as follows:

(1) to supply clean and safe potable water to the village inhabitants throughout the year in areas where there exist no appropriate water supply facilities;

(2) to provide water supply facilities with groundwater as a source so that the patients who are infected with Guinea-worm at the rate of 10 to 20 percent and potential risk of more than 80 percent can be aided and to curb other water-borne diseases;

(3) to alleviate heavy burden of securing water by manual labour and to reduce the time devoted to securing water.

The proposed 150 handpump-equipped boreholes can cover the villages with drastically high patient rates of Guinea-worm disease although they cannot supply

clean and safe potable water to all the local inhabitants in the Project Area. The Project will benefit directly the number of people shown in the following table.

LGA	No. of Villages	Population	Benefited Population
Shiroro	34	225,300	22,500
Lapai	48	99,200	22,500
Gbako	17	449,500	22,500
Total	99	774,000	67,500

The transfer of technology through the implementation of the Project will bring a favorable effect not only in the objective area but also the entire Niger State contributing greatly to the development of a clean and safe potable water supply by exploiting groundwater.

CHAPTER 9. CONCLUSIONS AND RECOMMENDATIONS

9-1. Conclusions

On the basis of the field survey, series of discussions with Nigerian Government officials and the further study made by the Study Team in Japan, the following conclusions have been obtained:

(1) The Project aiming at development of the rural water supply with 150 boreholes equipped with handpump is part of the whole programme for rural water supply development programme in Nigeria.

(2) The arrangement of water supply facilities under this Project will not only eradicate the Guinea-worm disease in which more than 20 percent of incident and 80 percent of potential risk of the local people have been suffering, but will also curb the occurrence of water-borne diseases carried in the unsanitary water.

(3) The Project shall be urgently implemented in the affected area especially where no proper water supply facilities are provided.

(4) The Project essentially requires provision of two drilling rigs and other associated equipment and materials necessary for the successful completion of the borehole construction.

(5) Taking into consideration the foreign currency situation of Nigeria, Japan's Grant-Aid Assistance is quite necessary to procure the necessary equipment and materials and implement the construction work urgently.

The Project is technically and financially sound, and grant-aid assistance is therefore justifiable.

9-2. Recommendations

The following will be recommended to the Government of the Federal Republic of Nigeria.

(1) The beneficiaries to be served under this Project shall not include the whole population in the Project Area since the Project will be implemented urgently in the most affected areas. The National Plan of Action on Ginea-worm Enadication has already been launched in Nigeria; thus, safe potable water should be supplied to all the inhabitants not covered by the Project.

(2) In order to carry out the operation and maintenance of the water supply facilities to be constructed in the Project area, it will also be important to establish and maintain closer cooperation with UNICEF-assisted WATSAN Project.

APPENDIX 1

List of Members of the Study Team

Name	Position
Satoshi ABE	Leader, Grant Aid Division, Economic Corporation Bureau, Ministry of Foreign Affairs.
Hisao ANDO	Water Supply Planning, Sanyu Consultants Inc.
Komei OZAKI	Groundwater Prospecting, Sanyu Consultants Inc.
Yoshio MATSUMURA	Machinery Planning, Sanyu Consultants Inc.

APPENDIX 2

Itinerary of the Field Survey

Date	Day	Activity	Stay
Jul. 9	Sun.	Left Tokyo	London
10	Mon.	Left London and Arrived in Lagos	Lagos
11	Tue.	Courtesy call on Embassy of Japan, Federal Ministry of Finance and Economic Development (MOFED) and Ministry of Health(MOH)	Lagos
12	Wed.	Courtesy call on MOH, Niger State and Submittal of Inception Report	Minna
13	Thu.	Discussion on Contents of Inception Report	Minna
14	Fri.	Team meeting on a further schedule	Minna
15	Sat.	Site Inspection	Minna
16	Sun.	Off	Minna
17	Mon.	Meeting with officials and Confirmation of Inception Report	Minna
18	Tue.	Visit RUWATSAN Office and Water Board	Minna
19	Wed.	Visit Federal University of technology, Minna and MOFED, Niger State	Minna
20	Thu.	Commenced GEP Survey and Discussion on Project Area/Size with MOH Officials	Minna
21	Fri.	GEP Survey and Site Inspection for Shiroro LGA	Minna
22	Sat.	GEP Survey and Review of the collected data	Minna
23	Sun.	Review and Analysis of the collected data	Minna
24	Mon.	GEP Survey, Discussion on the Project Area and Site Inspection for Gbako/Lapai LGA	Minna
25	Tue.	GEP Survey and Data Collection from the University, Water Board and MOFED	Minna
26	Wed.	-do-	Minna
27	Thu.	Arrival of the Leader in Lagos	Lagos
		GEP Survey and Data Collection from RUWATSAN Office	Minna
28	Fri.	Courtesy call on FMOH	Lagos
		GEP Survey and Discussion with RUWATSAN Office	Minna
29	Sat.	Preparation Works for the International Symposium on Guinea-Worm Eradication Programme	Lagos
		GEP Survey and Review of collected data	Minna

30	Sun.	Meeting on the above Symposium	Lagos
		Review of collected data	Minna
31	Mon.	Attendance to the Symposium	Lagos
		GEP Survey and Discussion on the Proposed Borehole Sites	Minna
Aug. 1	Tue.	Trip to Minna and Meeting with MOH	Minna
		GEP Survey	
2	Wed.	Site Inspection and Visit RUWATSAN Office	Minna
3	Thu.	Trip to Lagos	Lagos
4	Fri.	Meeting on "Minutes of Discussion" and Signing	Lagos
5	Sat.	Leader left Lagos	Lagos
		Review of collected data	
6	Sun.	Review of collected data	Lagos
7	Mon.	Supplemental Data Collection	Lagos
8	Tue.	Courtesy call on Embassy of Japan and Federal MOH	Lagos
		Supplemental Data Collection	
9	Wed.	Left Lagos	in Air
10	Thu.	Arrived Paris via London	Paris
11	Fri.	Visit JICA Office in Paris	in Air
		Left Paris for Tokyo	
12	Sat.	Arrived in Tokyo	

APPENDIX 3

OFFICIALS CONTACTED BY THE STUDY TEAM

Name	Organization	Position
Mr. Mitsuro Donowaki	Embassy of Japan	Ambassador
Mr. Toru Yamamoto	-do-	Fisrst Secsetary
Mr. Takashi Kato	-do-	First Secretary
Mr. Teiji Takeshita	-do-	Special Assistant
Mr. M.P.U. Obaro	Department of External Finance and International Aid Development, Federal MOFED	Director
Mr. J.C. Chalokwu	-do-	Deputy Director
Mr. B.A. Adewusi	-do-	Assistant Director
Mr. A.A.Aderinto	-do-	Principal Assistant Secretary
Prof. O.Ransome-Kuti	Federl Ministry of Health	Minister
Dr. G.A. Williams	Department of Disease Control International Health, Federal Ministry of Health	Director
Mr. Joseph Giordano	Global 2000	Director of Operation
Dr. Craig Withers	-do-	Project Coordinator
Dr. D.R. Hopkins	-do-	Adviser
Mr. M. Hassan	BCCI(Bank of Credit and Commerce International)	
Dr. Nuhu Shem Zagbayi	Ministy of Health, Niger State Government	Commissioner
Dr. Susan Ojomoh	-do-	Director General
Dr. A.B.C. Nwosu	Ministry of Health, Anambra State Government	Commissioner
Dr. Zakari Wambai	Niger State Task Force on Eradication of Gunea Worm	Chairman
Mr. Mohammed A. Isah	-do-	Secretary
Mr. Tony Lanko	Niger State Liaison Office	Liaison Officer
Mr. Gambo Umaru	-do-	

OFFICIALS CONTACTED BY THE STUDY TEAM

Name	Organization	Position
Dr.Y.M. Salifu	UNICEF Assisted Rural Water Supply and Sanitation Project	Project Manager
Mr. Hussaini Babanna	-do-	Workshop Manager
Mr. Jonah J. Anyadanyi	-do-	Head,Monitoring and Evaluation
Mr.G.A.K. Elegbe	-do-	Sanitation Officer
Mr.H.A. Shuaiky	-do-	Geologist
Mr.Akinyemi Sunday	-do-	Goelogist
Dr.May.M. Yacoob	USAID	Associate Director, Water & Sanitation for Health Project
Mr.R.R.N. Tuluhungwa	UNICEF	Representative for Nigeria
Mr.Bade Olokun	-do-	Liaison Officer in Lagos
Mr.L.A. Donaldson	-do-	Water Supply Engineer
Mr.Montazul Karim	-do-	Equip.Maint. Instructor, RUWATSAN
Mr.A.Y. Mohammed	Ministry of Lands and Survey	Surveyer General
Mr.S.A. Kontagora	-do-	Chief Technical Officer
Mr.Abdullahi S. Muye	-do-	Chief Supt. Press
Mr.A.Y. Usman	Niger State Water Board	General Manager
Alh. A. Abdulsalam	-do-	Secretary
Mr.Mohammed I. Zakari	-do-	Civil Engineer, Head of O&M
Alh. A.N. Aliyu	-do-	Chief Water Engineer, Head of Quality Control
Alh. Ahmadu Umaru	Statistical Division, Ministry of Finance & EconomicPlanning	Chief Statistician
Mr.J.S. Are	Planning Division, -do-	Principal Planning Officer

OFFICIALS CONTACTED BY THE STUDY TEAM

Name	Organization	Position
Mr. Musa S. Balco	Shiroro LGA	Assit. Secretary
Mr. Abubakar Doma	-do-	Staff Officer
Mr. N.T. Abdullahi	-do-	Treasury Div.
Alh. Yusufu Kokoyi	-do-	Principal Rural Health Supt. II
Alh. Abubakar Y.S. Kuta	-do-	Principal health Supt. II
Mr. Ibrahim Mohammed	Gbako LGA,	P/Assist. Secretary, Dept. of Medical/ Health
Mrs. Hadiza Umar	Lapai LGA,	Head of Dept. of Medical/Health
Dr. A.C. Ajibade	Dept. of Geology, Federal University of Technology, Minna	Head of Dept.

APPENDIX 4

MINUTES OF DISCUSSION
ON
PROJECT FOR GUINEA-WORM ERADICATION AND
RURAL POTABLE WATER SCHEME
IN
THE NIGER STATE IN THE FEDERAL REPUBLIC OF NIGERIA

In response to the request of the Government of the Federal Republic of Nigeria, the Government of Japan decided to conduct a basic design study on the Project for Guinea-Worm Eradication and Rural Potable Water Scheme in some parts of the Niger State (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). JICA sent to the Federal Republic of Nigeria the study Team headed by Mr. Satoshi ABE, Grant Aid Division, Economic Corporation Bureau, Ministry of Foreign Affairs for 35 days from 9th July to 12th August, 1989.

During its stay in the Federal Republic of Nigeria, the Team exchanged views and had series of discussions with Nigerian authorities concerned in respect of the Project.

As a result of the discussions and the study, both parties have agreed to recommend to their respective Governments the matters referred to in the attachment hereto.

4th August, 1989
Lagos, Nigeria

Satoshi Abe

Mr. Satoshi ABE
The Leader of the
Study Team,
JICA

J.C. Chalokwu

Mr. J.C. Chalokwu
Deputy Director for
Development Aid Division,
Federal Ministry of Finance
and Economic Development

ATTACHMENT

1. Objective

The objective of the Project is to construct boreholes in order to provide safe potable water supply for eradication of Guinea-worm disease and improve the living standard of the rural population.

2. Project Area

The Project Area is composed of the following Local Government Areas(LGA) in Niger State. The location of the project area is shown in APPENDIX I attached hereafter.

1) Shiroro LGA
2) Lapai LGA
3) Gbako LGA

3. Executing Agency

The Ministry of Health, Niger State will be responsible for the technical and administrative matters of the Project. The organization chart of the Executing Agency is shown in APPENDIX II.

4. Undertakings of the Government of Japan

The Team will convey to the Government of Japan the intention of the Government of Nigeria that the former takes necessary measures to cooperate by providing the equipment, materials and services listed in APPENDIX III within the scope of Japanese Grant Aid Program.

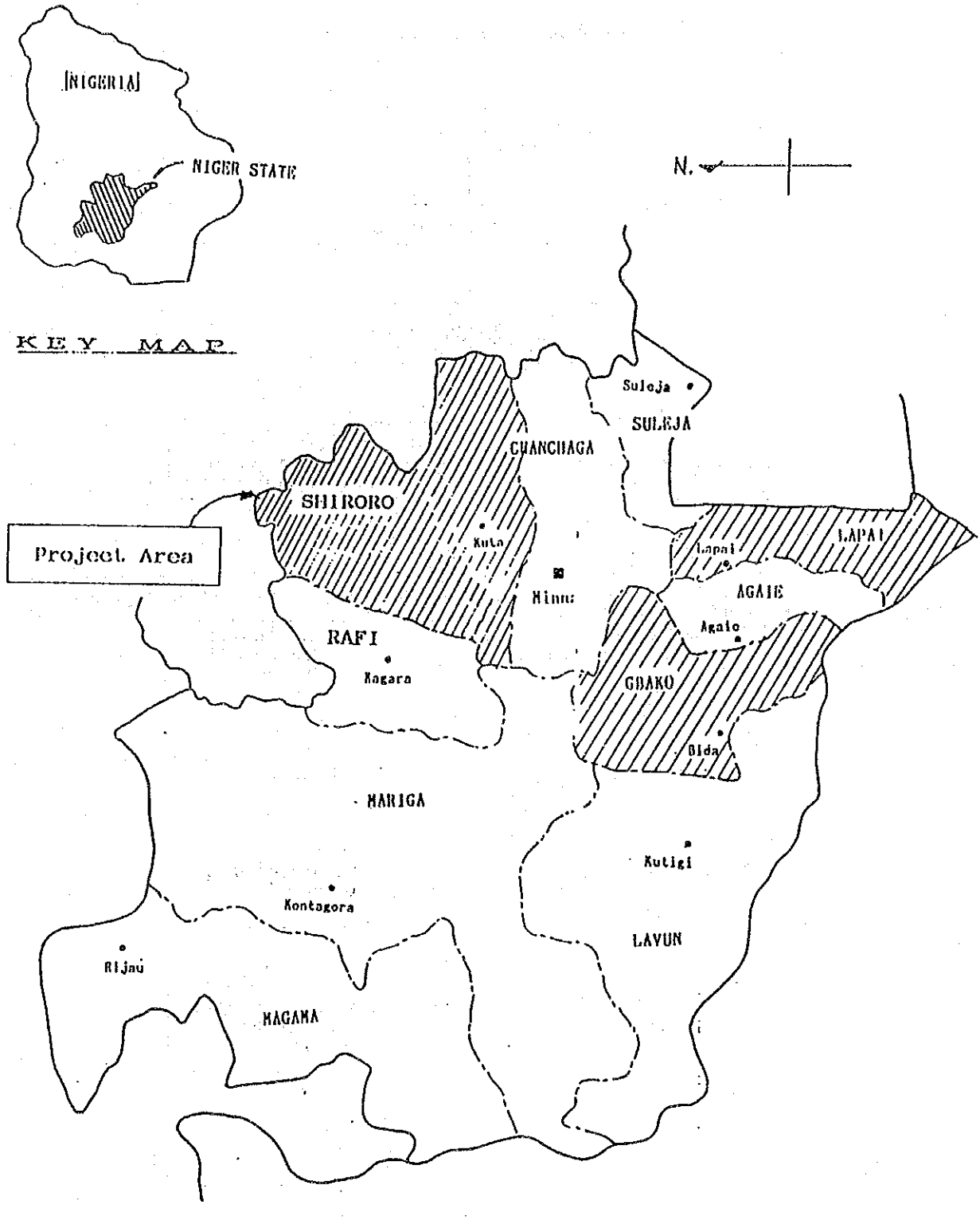
5. Understanding of Japan's Grant Aid System

The Nigerian side has understood Japan's Grant Aid System explained by the Team which includes a principal of use of a Japanese Consultant firm recommended by JICA and Japanese Contractor(s) selected by open tendering.

6. Undertakings of the Government of Nigeria

The Government of Federal Republic of Nigeria will take necessary measures listed
in APPENDIX IV under the condition that the grant aid by the Government of Japan would be extended to the project.

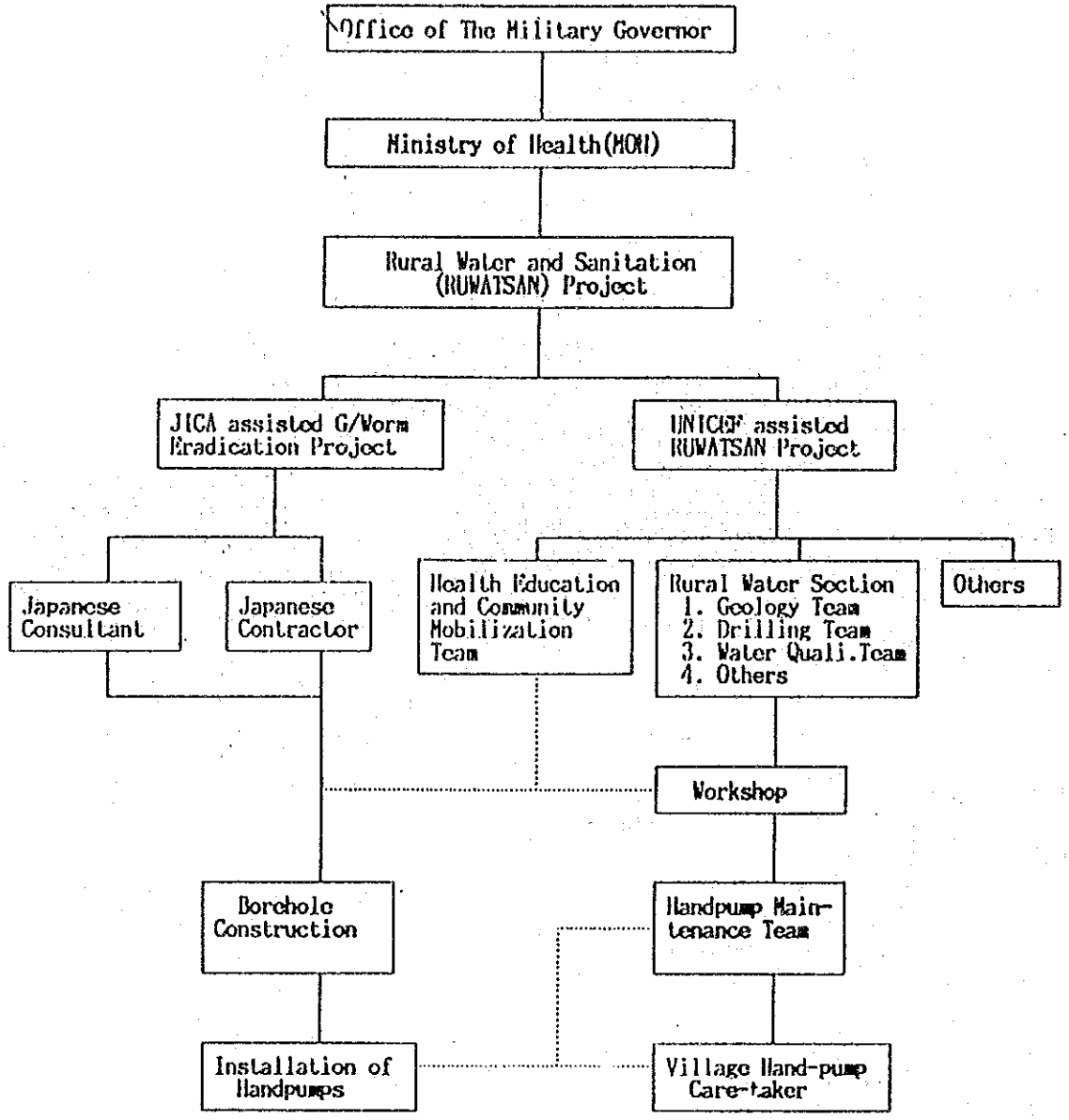
APPENDIX I



LOCATION MAP FOR THE PROJECT

APPENDIX II

ORGANIZATION CHART OF EXECUTING AGENCY



APPENDIX III

The following items are requested by the Government of Nigeria as Grant Aid Assistance:

1. Construction of 150 boreholes and appurtenant facilities inclusive of supply of construction materials and installation of hand pump sets.

2. Provision of equipment necessary for the implementation of the Project:-
    (1) Drilling Equipment
    (2) Supporting Equipment
    (3) Supporting Vehicles
    (4) Equipment for Borehole Development
    (5) PVC casing and screen
    (6) Drilling mud and chemicals
    (7) Hand pump sets
    (8) Spareparts
    (9) Others necessary for the construction works

APPENDIX IV

The following arrangements are to be taken by the Government of the Federal Republic of Nigeria:-

1. To provide necessary data and information for basic design study, detail design and construction works.

2. To secure land for the boreholes and other facilities as needed before the start of the construction works.

3. To undertake incidental civil works such as planting and fencing, if needed.

4. To provide the space necessary for temporary office(s), working areas, stock yards and others required for the project implementation.

5. To secure necessary budget and personnel for the maintenance and operation and to organize proper maintenance programme for the purpose of maintaining properly and effectively the borehole facilities and related equipment provided under the grant aid.
6. To use properly the facilities constructed and equipment purchased under the grant aid.

7. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.
   (1) Advising commission of Authorization to Pay
   (2) Payment of commission

8. To ensure prompt unloading, tax exemption and customs clearance at a point of disembarkation in Nigeria and prompt internal transportation therein of the products and related equipment purchased under the grant aid.

9. To exempt Japanese nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Nigeria with respect to the supply of the related goods and services under the verified contracts.

continued:

10. To accord without delay to Japanese nationals whose services may be required in connection with the supply of the related goods and services under the verified contract such facilities as may be necessary for the entry into Nigeria and their stay therein for the performance of their works.

11. To bear all the expenses other than those to be borne by the grant for the Project.

LIST OF ATTENDANCE

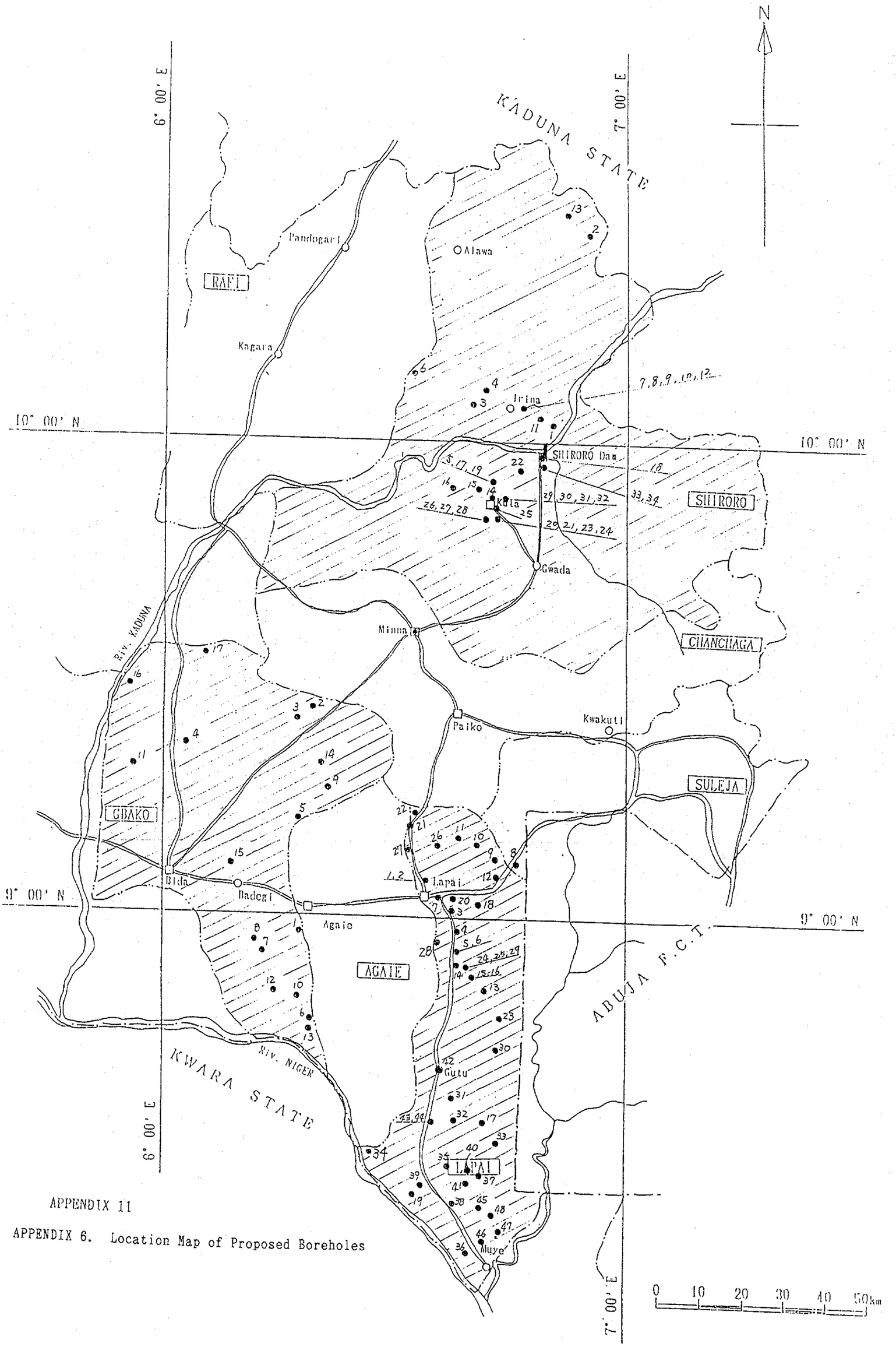
Name	Position
JICA STUDY TEAM	
Mr. Satoshi Abe	Leader, Grant Aid Division, Economic Corporation Bureau, Ministry of Foreign Affairs
Mr. Hisao Ando	Water Supply Planning, Sanyu Consultants Inc.
Mr. Komei Ozaki	Groundwater Prospecting Sanyu Consultants Inc.
Mr. Yoshio Matsumura	Machinery Planning Sanyu Consultants Inc.
EMBASSY OF JAPAN	
Mr. Toru Yamamoto	First Secretary
GOVERNMENT OF NIGERIA	
Mr. J.C. Chalokwu	Deputy Director, Development Aid Division, Federal Ministry of Finance and Economic Development
Mr. B.A. Adewusi	Assistant Director, Development Aid Division, Federal Ministry of Finance and Economic Development
Mr. A.A. Aderinto	Principal Assistant Secretary, Development Aid Division, Federal Ministry of Finance and Economic Development
Mr. T. Lanko	Liaison Officer, Niger State Liaison Office

APPENDIX 5

COLLECTED DATA AND INFORMATION

Name of Data, Information	Collected from	Feature
Nigerian Guinea Worm Eradication Programme: National Plan of Action, 1989. Draft Copy for Second National Conference on Dracunculisis, 20-22 March 1989.	Federal Ministry of Health(FMOH)	Draft Copy
A proposal to eradicate Guinea Worm Disease in Nigeria by 1995: Global 2000, March 1989	FMOH	Copy
Facts and Figures about Nigeria, 1989	Federal Office of Statistics	Publication
Digest of Statistics, June, 1987	-do-	Publication
Annual Abstract of Statistics, 1987	-do-	Publication
Economic and Social Statistics Bulletin, 1988 Edition	-do-	Publication
The Consumer Price Index	-do-	Publication
Weekly Epidemiological Record WHO, No.27 1989	Global 2000	Copy
Dracunculiasis Eradication Global Strategic plan: 1989-95 Cater Center Inc.	Global 2000	Publication
Outline of UNICEF-ASSISTED WATER AND SANITATION PROGRAMME IN NIGERIA Feb. 1989	UNICEF, Lagos	Publication
A VILLAGE LEVEL OPERATION & MAINTENANCE(VLOM), SYSTEM FOR "WATSAN PROJECT" HANDPUMP EQUIPPED BOREHOLES IN NIGERIA, Dec. 1988	UNICEF, Lagos	Publication
Niger State Statistical Year Book, 1985	Ministry of Finance and Economic Planning(MFEP)	Publication
Basement-Cover relationships in the Minna region of the Pan African domain of Nigeria, Dr. A.C. Ajibade	Federal University of Technology, Minna	Offprint
Report on Niger State Guineaworm Eradication Programme presented at	Ministry of Health(MOH)	Copy

the Second National Conference on Guineaworm in Nigeria		
1989 Budget Proposal of Water Board	Water Board, Niger State	Copy
Government of Niger State of Nigeria, Estimate for 1984-1989(6 volumes)	MFEP, Niger State	Publication
Guideline for Niger State Fourth National Development Plan, 1981-1985	MFEP, Niger State	Publication
Third Annual Report, 1984 Niger State Water Board	Water Board	Publication
A set of Topo-maps, in a series of 50,000, 100,000 and 250,000 scale	Ministry of Lands and Survey	Publication
Administrative Map for Niger State, Road Map of Niger State, Vegetation Map of Niger State	Ministry of Lands and Survey	Blue copy
Inventory of Boreholes	RUWATSAN Project Office	Copy



APPENDIX 11

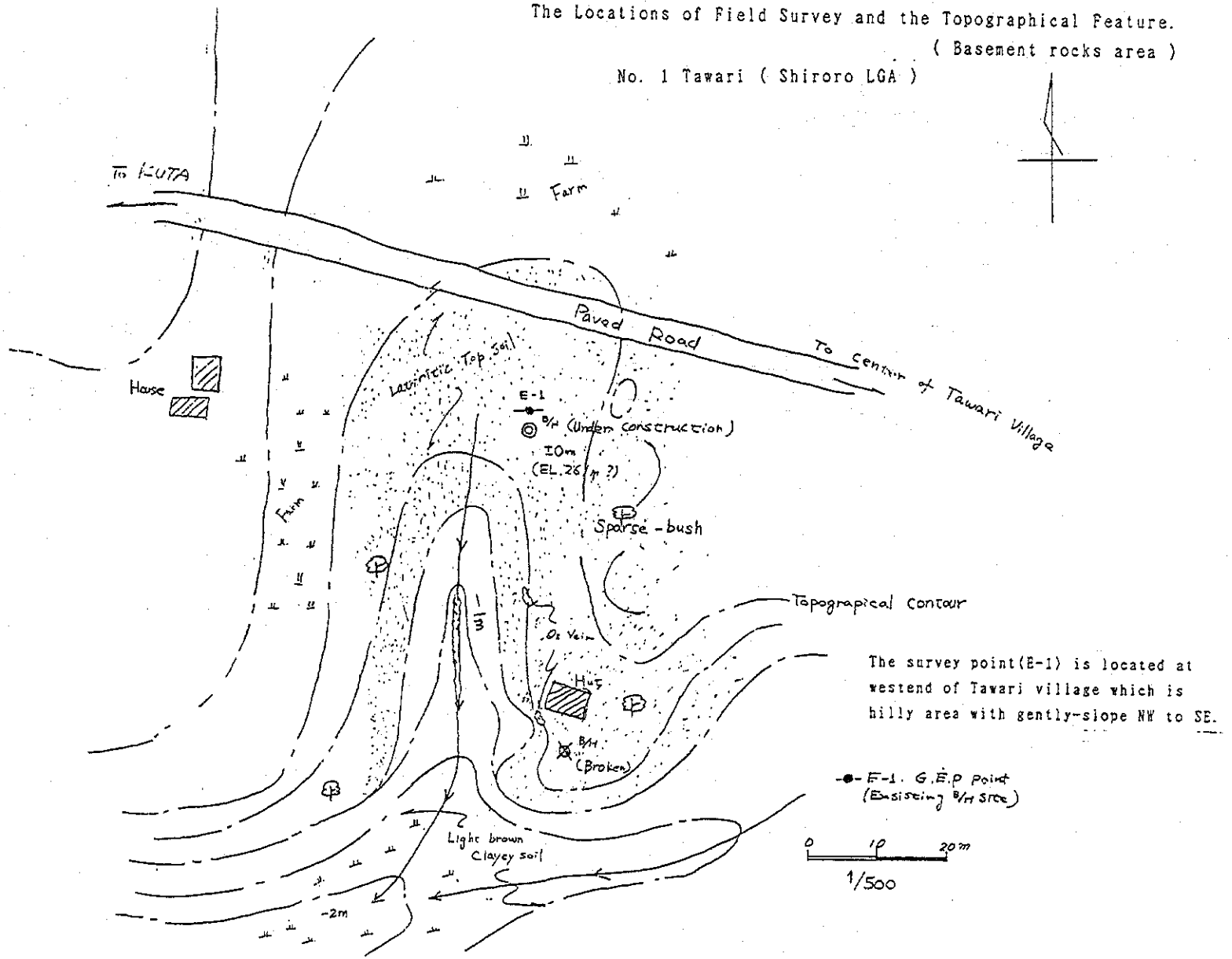
APPENDIX 6. Location Map of Proposed Boreholes

APPENDIX 7. Physiographic Sketches for Selected GEP Sites

The Locations of Field Survey and the Topographical Feature.

(Basement rocks area)

No. 1 Tawari (Shiroro LGA)

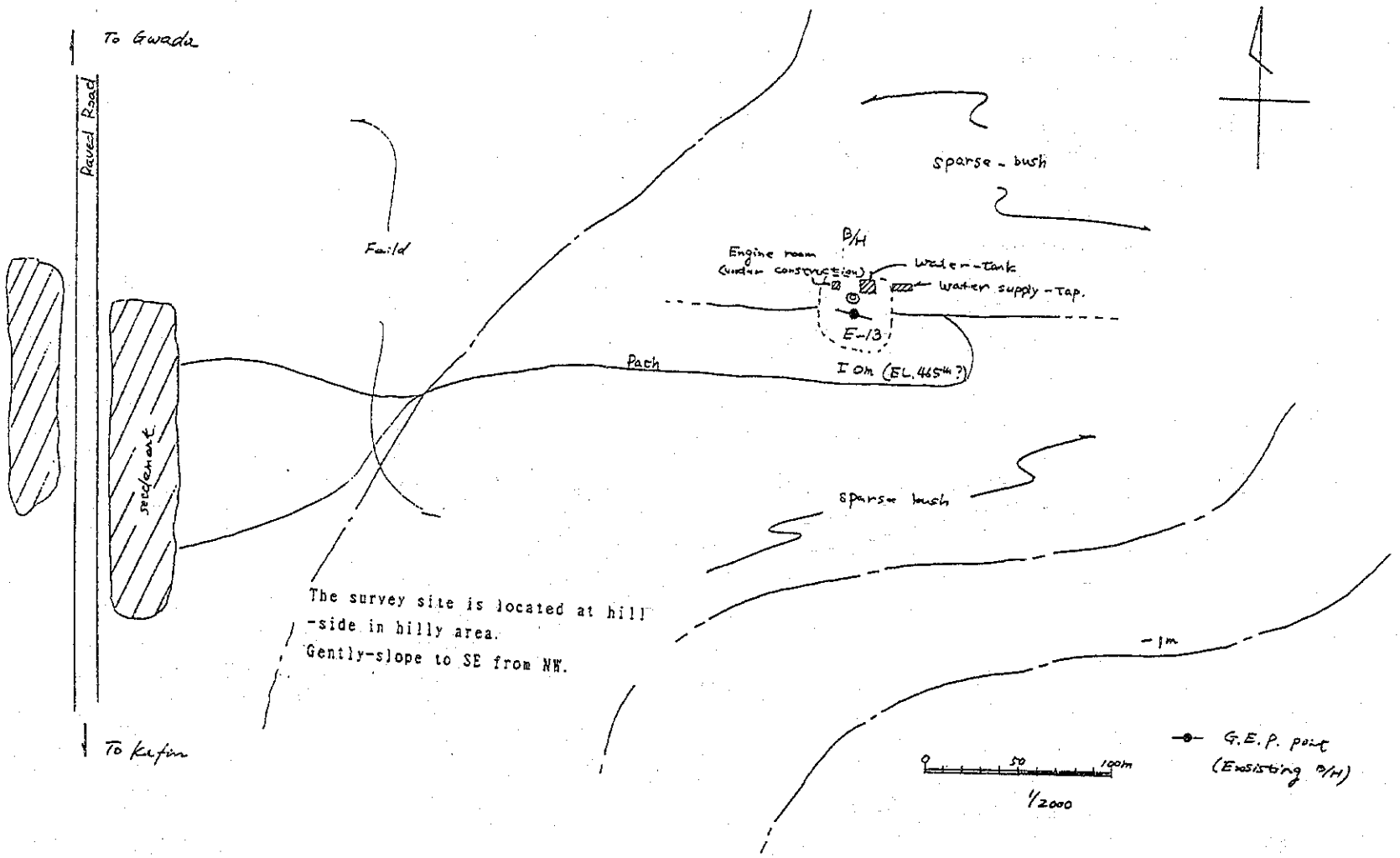


The survey point(E-1) is located at westend of Tawari village which is hilly area with gently-slope NW to SE.

The Locations of Field Survey and the Topographical Feature.

(Basement rocks area)

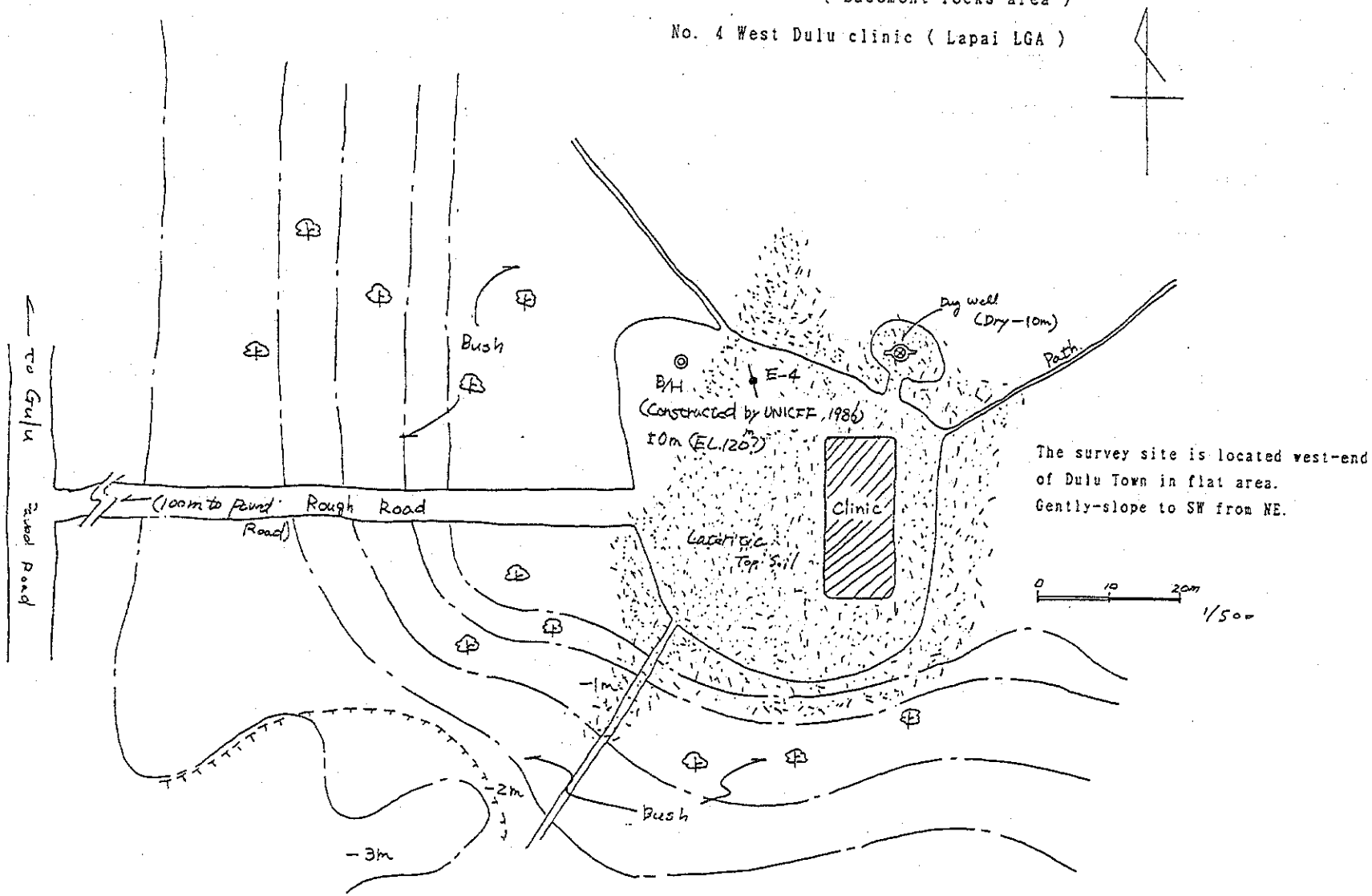
No. 14 Fuka (Shiroro LGA)



The Locations of Field Survey and the Topographical Feature.

(Basement rocks area)

No. 4 West Dulu clinic (Lapai LGA)

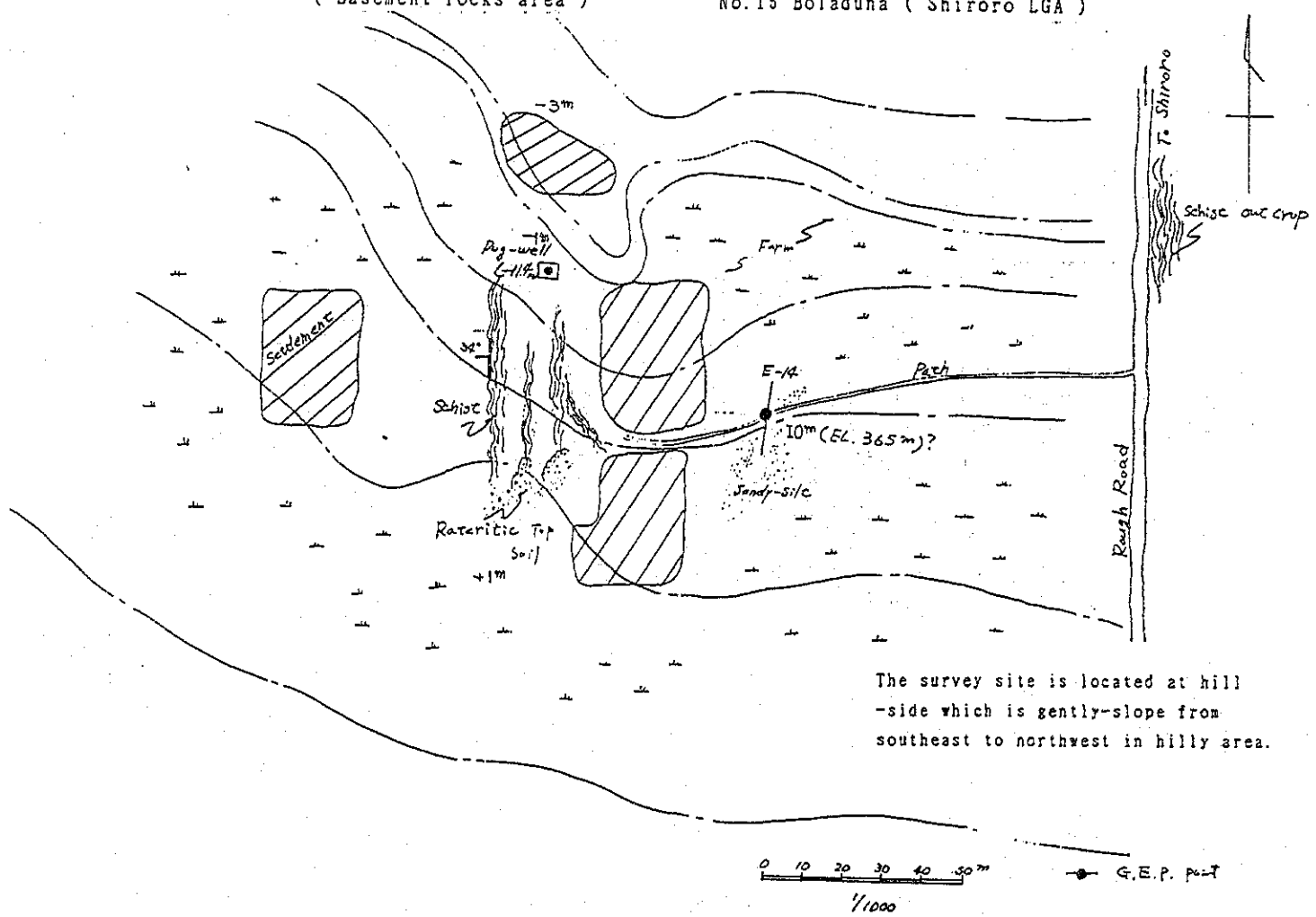


The survey site is located west-end of Dulu Town in flat area. Gently-slope to SW from NE.

The Locations of Field Survey and the Topographical Feature.

(Basement rocks area)

No.15 Boladuna (Shiroro LGA)



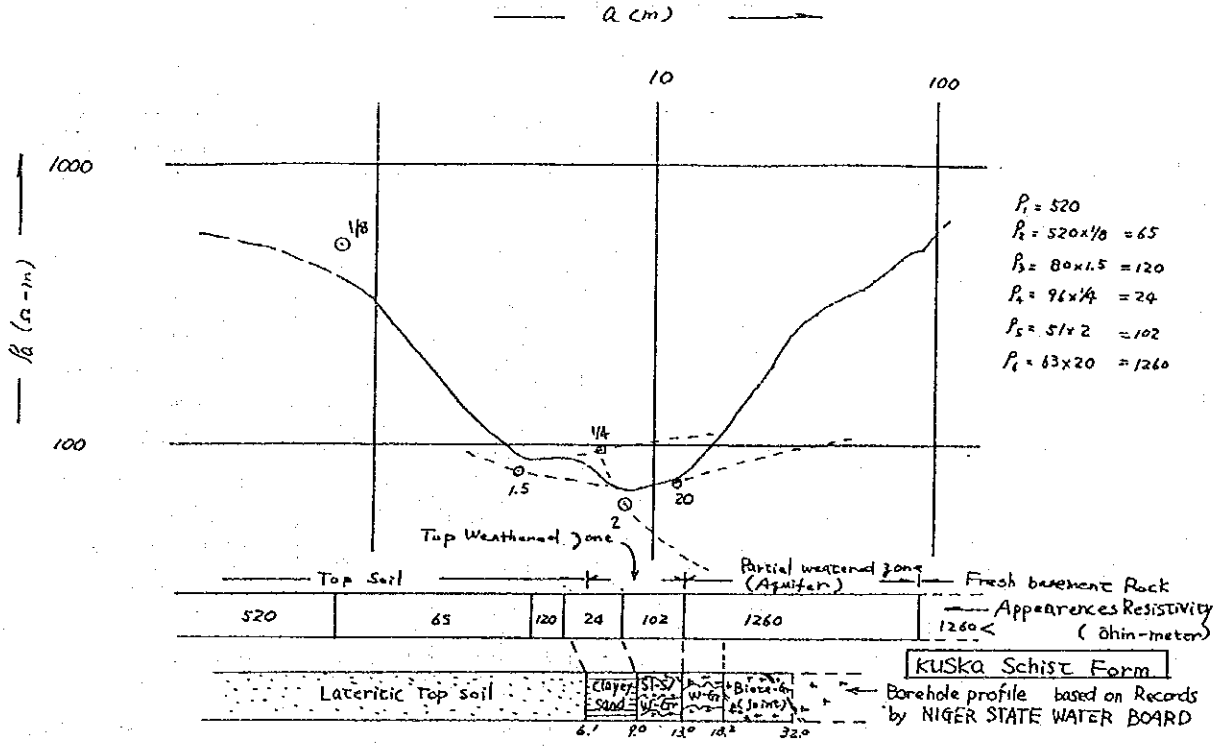
The survey site is located at hill -side which is gently-slope from southeast to northwest in hilly area.

APPENDIX 8. Selected GEP ρ-a Curves

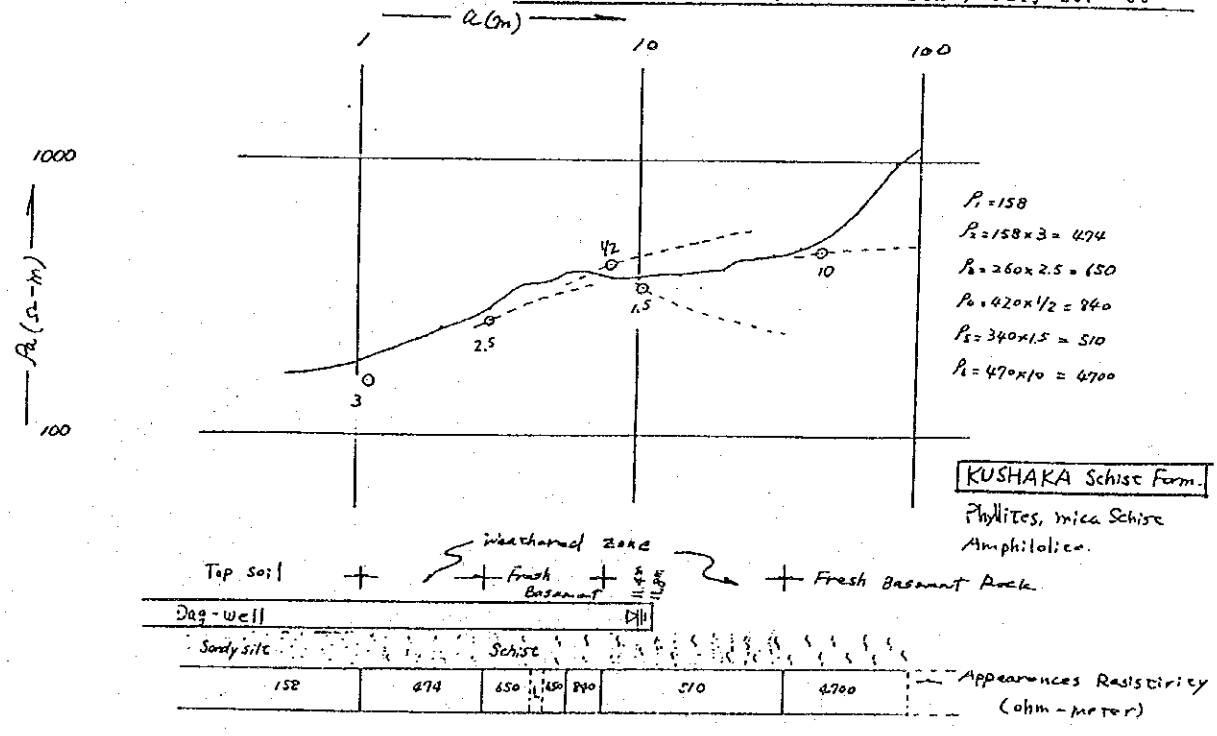
ρ-a Curves and Results of Analysis of Electric Prospecting.

(Basement rocks area)

No. E- 1. Tawali (Shiroro LGA) July 20. 189



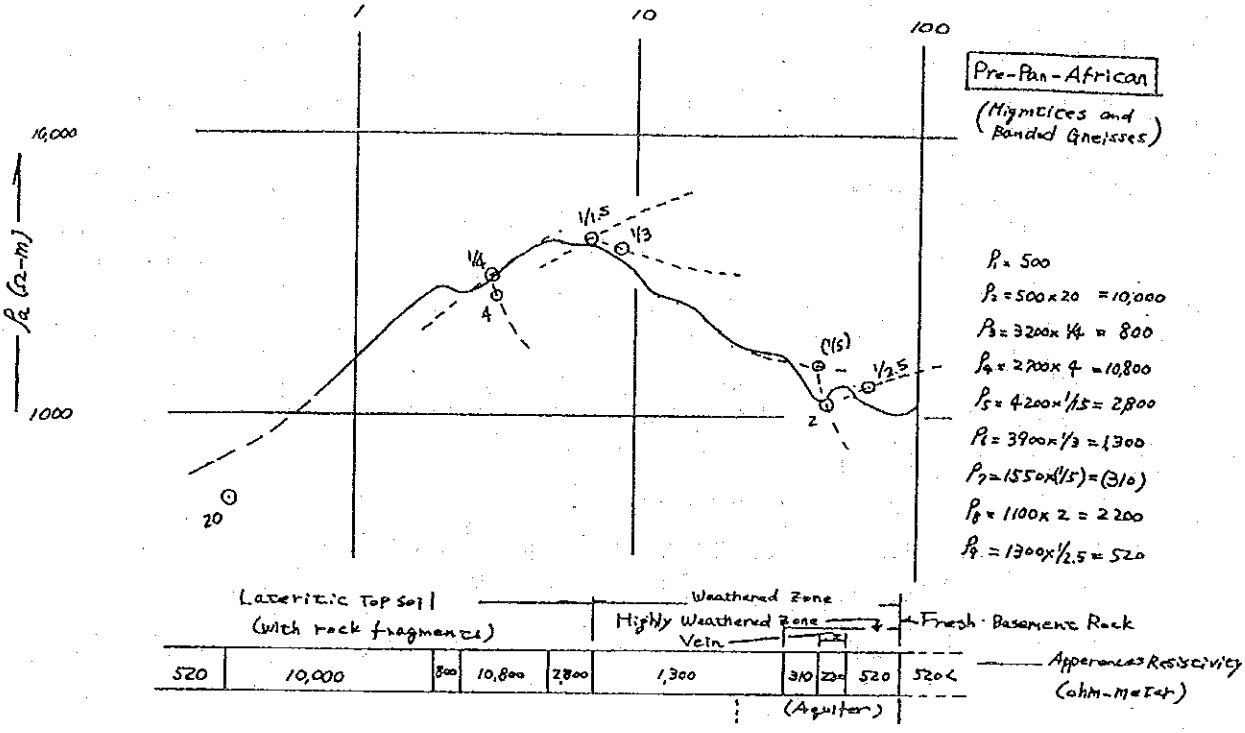
No. E-14. Boladuna (Shororo LGA) July 28. '89



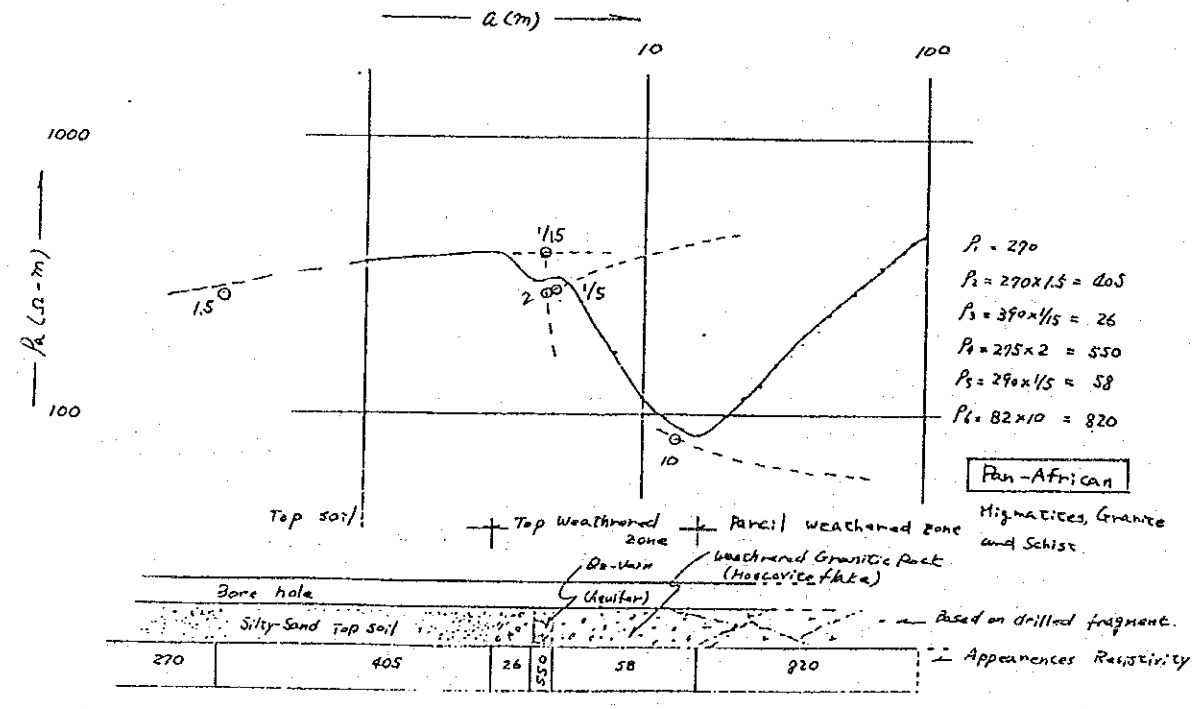
ρ -a Curves and Results of Analysis of Electric Prospecting.

(Basement rocks area)

No. E- 4. Gulu West clinic (Lapai LGA) July 21. '89



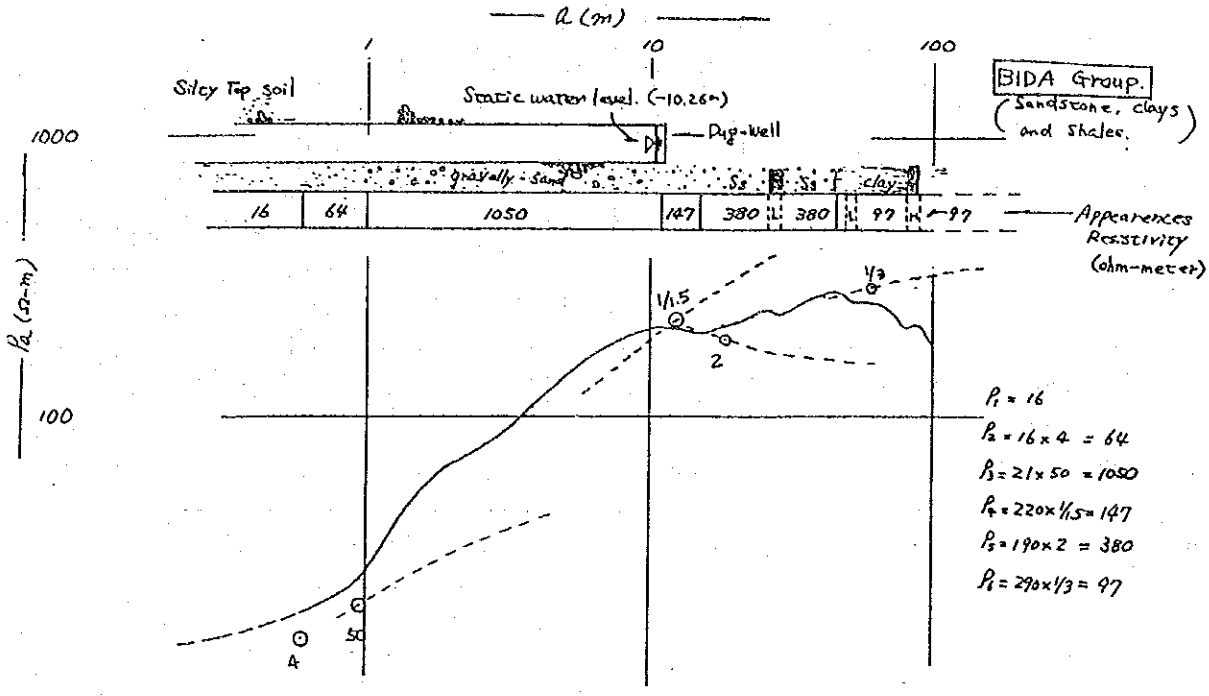
No. E-13. Fuka (Shiroro LGA) July 27. '89



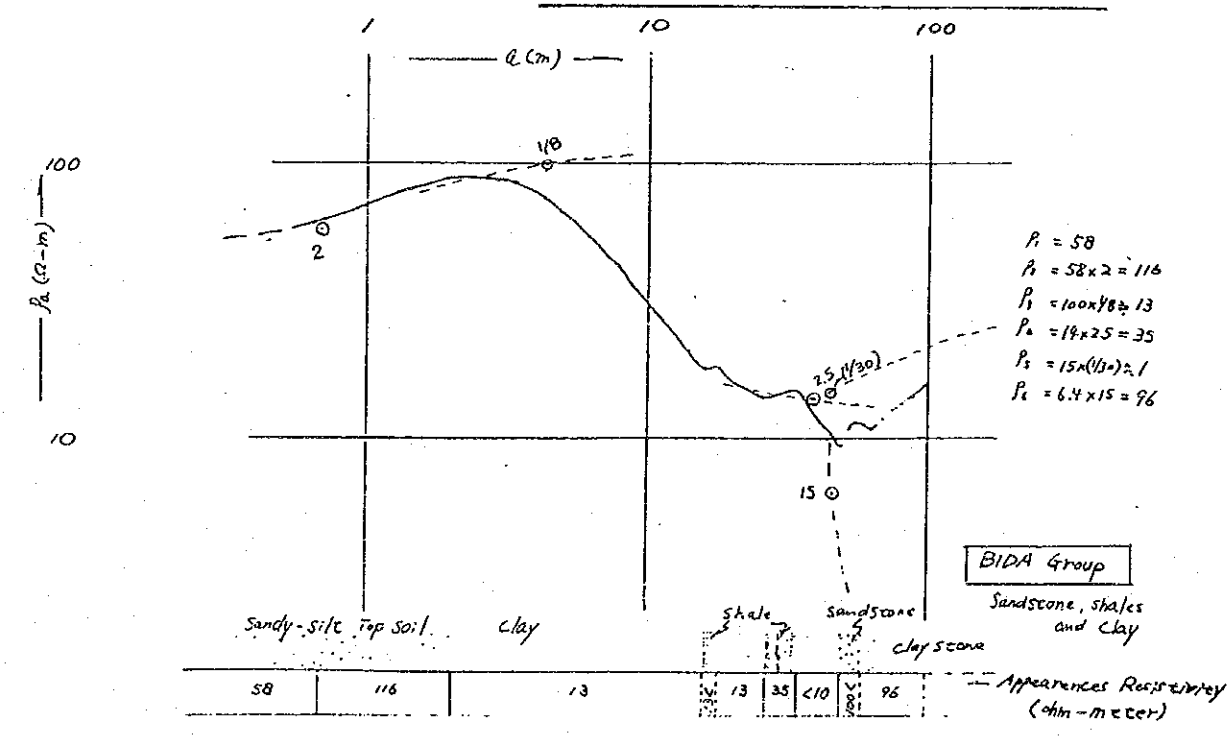
ρ -a Curves and Results of Analysis of Electric Prospecting.

(Sedimentary rocks area)

No. E- 3. Dobogi (Lapai LGA) July 21. '89



No. E- 6. Duma (Lapai LGA) July 22. '89



APPENDIX 9. Result of Borehole Construction by WATSAN Project

NIGER STATE RUWATSAN PROJECT

Water Supply Monitoring Chart, 1988

ACTIVITY	MONTH											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
No. of Boreholes Sited	13	21	12	24	4	1	30	34	28	4	19	23
No. of Boreholes Drilled	5	13	11	3	8	15	-	21	20	13	26	20
No. of Successful Boreholes	5	12	10	3	8	15	-	19	17	12	24	20
No. of Abortive Boreholes	-	1	1	-	-	-	-	2	3	1	2	-
No. of Pump Tested	-	-	-	-	-	-	-	-	-	-	-	-
No. of Pumps Installed	5	12	10	3	5	18	-	15	21	11	25	20
No. of Boreholes in Use	5	17	27	30	38	53	53	72	89	101	125	145