3-4. Present Situation of Water Supply

3-4-1. Existing water supply system and development plan

(1) Existing water supply systems

The Project areas; Nanumba, Berekum/Jaman, and Sefwi-Wiawso Districts, belong to the group of the least socio-economically developed districts with poor population density in Ghana.

Consequently, a few water supply systems are existing, and all of them are time-worn in these districts. Even boreholes with hand-pumps, which are the potable water sources for towns or communities are not prevailing. Especially in Nanumba District, only seven communities including Bimbila have boreholes with hand-pumps. The other two Districts also have relatively few boreholes facilities nevertheless these districts were included in the target area of "3000 WELLS PROJECT" German aided.

Table 3-4-1. shows a summary of existing water supply systems and facilities in the Project areas, and the location of these facilities are shown in Appendix 12.

Table 3-4-1. Existing Water Supply Systems and Boreholes

Item	Nanumba District	Berekum/ Jaman District	Sefwi-Wiawso Dist.	Total
Water Supply System	2	5	2	9
Borehole with hand-pump				
by GWSC	(7) 7	(5) 7	(10) 26	(22) 40
by 3000 wells	- -	(39) 76	(16) 50	(55) 126
Total	(7) 7	(44) 83	(26) 76	(77) 166

( ): number of communities

(2) Five Year Rehabilitation and Development Programme

The GWSC, as mentioned in previous chapter, formulated the Five Year's Programme (1985 - 1989) for the aspect of water supply, composed of (a) Rehabilitation of existing system, (b) Capacity expansion and extention, (c) Completion of existing system, and (d) New rural water supply system as major components.

According to the Programme, the objects for item (a) and (b); rehabilitation, capacity expansion and extension of existing system are 208 facilities in the country, and only 9 facilities are existing in the Project area (see Tab. 3-4-1). Among the 9 facilities, 4 facilities in Berekum/Jaman District are sourced from groundwater and the remains are surface water sourced.

Total 34 on-going projects were listed out as the object of item (c); completion of existing system. Among them, three on-going projects are located in Brong Ahafo Region and pointed out for the one of the subjects in GWSC's initial request for Japanese Aid (Scheme I-i). They are Kukuom, Dwennen, and Nkrakwanta, and only Dwennen is situated in the Project area (Berekum/Jaman District).

Item (d), new rural water supply system, means a construction of borehole with hand-pump for the communities with population more than 400 and less than 2,000, and a well digging for the communities with less than 400 of population.

Borehole construction programme intends to construct 2,245 boreholes with hand-pumps totally in 8 Regions out from 10 Regions in Ghana, including the foreign aid projects (by UNISEF, CIDA). The borehole construction programme relating to the Project areas is summarized as follows;

Region	District	Communities	Boreholes	Donator
Northern	Eastern Dagomba	100	167	CIDA
	Western Mamprusi	68	111	"
	Buipe	1	18	"
	Nanumba	54	130	(not yet)
Brong-Ahafo	- whole -	148	610	(")
	Atebubu	62	111	UNICEF
Western	- whole -	67	217	(not yet)
Total 3 Regions		500	1,364	

Three districts, each one from the three Regions which is not yet confirmed to be aided by any country or organization, are selected as the target areas for this Project by GWSC. The target communities in the Project areas are listed up in Appendix 10, and their locations are shown in also Appendix 11.

3-4-2. Existing Borehole Data

(1) Depth and yield

Table 3-4-2 shows a summary of borehole data existing in the Project areas (and some of related region); depth, static water level, yield and drawdown.

Table 3-4-2. Summary of Existing Borehole Data

Region	District	Data	Borehole	Depth (m)	SWL* (m)	Yield**	Draw*** Down (m)
Northern	Nanumba	GWSC	7	34.1	-	147.9	
	Other Dist.	GWSC	29	56.1	9.7	103.4	27.6
	total/ave.		36	51.8	9.7	112.1	27.6
Brong-Ahafo	Berekum/ Jaman	GWSC	7	80.9	4.4	182.4	34.0
	-ditto-	3,000W	76	54.0	16.8	72.9	7.6
	total/ave.		83	56.3	15.8	82.1	9.8
Western	Sefwi-Wiawso	GWSC	26	63.0	4.1	220.0	20.3
	- ditto-	3,000W	50	36.6	7.9	43.2	9.5
	total/ave.		76	45.6	6.6	103.7	13.2
Total/Average			195	51.9	11.1	96.1	14.4

Note: *... Static water level
, *... Yields and drawdown at pumping test time

As shown in the above table, the average yield of boreholes in Northern Region is larger than the ones in Brong Ahafo or Western Regions, however, an average specific yield of Northern Region's boreholes is 4.06 l/min/m, the least among the three regions, comparing to the one of Brong Ahafo's (8.38 l/min/m) and Western Region's (6.67 l/min/m).

The table indicates the total average depth of boreholes is about 52 m but it includes the deep boreholes for mechanized water supply system drilled by GWSC more than 20 years ago. Then the average depth of boreholes recently drilled is about 47 m.

(2) Groundwater quality

Groundwater quality obtained from boreholes existing in and around the Project areas are shown in Table 3-4-3. Because of the difference of data sources, the quality items are not uniform and it makes difficult to compare the data simply, but at least, the water quality in Northern Region differs from the ones in the other Regions.

Generally, groundwater in Northern Region has rather high pH value and high Erectric Conductivity (EC) but includes less cations (e.g. Fe, Mg, Ca..) and Nitrate which indicates a degree of organic pollution. While groundwater in Brong Ahafo and Western Regions show less than 7.0 of pH value and low EC comparing to the one of Northern Region, and high cations and Nitrate contents. Especially the average nitrate content is far exceeding the WHO's designation (see Table 3-4-4, which shows a standard water quality designation in Japan and WHO).

As a simple conclusion, groundwater in Northern Region has rather poor yield potential but has good water quality, while the ones in Brong Ahafo and Western Regions have high yield potential but have a little problem for water quality, especially in Western Region.

Table 3-4-4. Water Quality Designation

Item	Japan	WHO
Physical Condition		
Colour	5°	-
Taste	Unobjectionable	-
Odour	Unobjectionable	-
Turbidity	2°	-
pH range	5.8 - 8.6	6.5 - 9.2*
Chemical Condition	less than (ppm)	less than (ppm)
Total solids	500	-
Fe	0.3	0.3
Mn	0.3	0.5*
Cu	1.0	0.1
Zn	1.0	5.0
Ca	-	75
Mg	-	50
SO_4	-	200
Cl	200	200
F	0.8	1.0
NO_3	10	40
ABS	0.5	-
Total hardness (as $CaCO_3$)	200	100 - 500

*... maximum permissible

Table 3-4-3. Groundwater Qaulity

Region	Community	Temp. (°C)	E.C. (μs/cm)	pH	Alkalinity ($CaCO_3$) (mg/l)	Total Hardness (mg/l)	Total Fe (mg/l)	Niterate (mg/l)	Cl (mg/l)	Mn (mg/l)	Mg (mg/l)	Ca (mg/l)	SiO_2 (mg/l)	HCO_3 (ml/l)	SO_4 (mg/l)	F (mg/l)	T.Dissolved Solid (mg/l)	Data from	Note
NORTHERN	Nasia		400	7.2		140.0	0.06	Nil			12.2	36.0	12.0	440.0		Nil		GWSC	
	Wungu		450	7.6		80.0	0.02	0.05			2.0	28.8	6.0	260.0		Nil		"	
	Kpasemkpe		580	7.7		68.0	Nil	Nil			6.3	16.8	Nil	370.0		0.35		"	
	Yama		320	7.5		*720.0	0.04	Nil			*82.6	*152.0	7.0	490.0		Nil		"	
	Bincheratango	28.4	53	7.38														Team	Project site
	Average	——	360.6	7.48	——	252.0	0.03	Nil	----	----	25.8	58.4	6.25	390.0	——	0.09	——	———	———
BRONG AHAFO	Owenen		350	6.9	228.0	230.0	0.25	Nil	12.0	0			1600.0	CO_2 (mg/l)		Nil		GWSC	Project site
	Nkrakwanta	24.8	375	6.9	154.0	116.0	0.10	0.013	6.0	0	0.97	44.8	28.0	92.4	1.64	Nil	262.0	"	On going scheme
	Kukuom,86			7.08	277.0	292.0	*0.50	0.5	21.0	0	20.4	*83.2	8.0	166.2	1.8	Nil	39.0	"	"
	-do- ,83	26.0	480	6.3	190.0	201.0	0.25	0.4	26.0	trace	22.3	42.0	2.8	37.9	Nil	Nil	415.6	"	"
	-do- ,81			6.3	77.0	53.0	0.10	*2.0	7.0	0	1.5	10.8	40.0	46.2	1.1	Nil	203.0	"	"
	Koraso	26.7	48	6.31	30.0	25.0	0.01	*1.2	7.0	0								3000 WELLS	Project site
	Berekum	26.5	83	7.06	80.0	13.0	0.02	*1.0	12.0	*1.7								"	"
	Kato	25.0	275	6.82	60.0	52.0	0.02	*1.0	76.0	0.05								"	"
	Drobo	25.9	79	6.71	20.0	32.0	0.02	0.4	19.0	0.15								"	"
	Mperasi	24.8	362	8.43	190.0	138.0	0.01	*1.3	30.0	0.25								"	"
	Domfete	24.9	59	6.56	30.0	20.0	0.01	*1.5	10.0	0.1								"	Rehabili. scheme
	Nsapo	24.5	140	6.95	85.0	50.0	0.01	*1.1	6.0	0								"	"
	Anyimom	24.7	85	6.52	22.5	40.0	0.01	*4.5	11.0	0.1								"	"
	Jamdere		65	6.72	35.0	30.0	0.01	*3.5	8.0	0.25								"	"
	Adom	26.0	160	6.53	90.0	45.0	0.05	*3.7	17.6	*4.00								"	"
	Average	25.4	182.2	6.81	104.6	89.1	0.09	*1.47	17.9	*0.44	11.3	45.2	19.7	85.7	1.14	Nil	229.9	———	———
WESTERN	Aboduamu	24.8	123	6.54			*2.50	0.4	9.2	0								3000 WELLS	Project site
	Punikrom	26.5	130	5.98			0.08	*1.0	11.0	0								"	"
	Amhfia	27.0	171	6.48			0.22	*0.6	9.5	0.1								"	"
	Futa	26.1	453	6.84			0.25	*8.6	28.0	0.2								"	
	Bosomaoso	26.5	242	6.28			0.16	*7.1	21.0	0.1								"	
	Amafia	26.3	191	6.65			0.01	*1.2	9.4	0.1								"	
	Wenchi	25.7	572	6.67			*1.70	0.1	75.0	0.1								"	
	Datano	26.8	120	6.07			*0.70	*0.6	13.0	0.3								"	
	Kunkunso	25.9	350	6.51			*0.62	*0.6	16.0	0.2								"	
	Pataboso	27.5	169	6.06			0.08	0.4	22.5	0								"	
	Average	26.3	252.1	6.41	-----	-----	*0.63	*2.06	21.5	0.11	----	———	----	———	———	———	———	————	————

* ...Exceeding WHO standards

CHAPTER 4 OUTLINE OF THE PROJECT

4-1. Objective

The objectives of the Project are to construct some 440 boreholes equipped with manual pumps and to provide the necessary equipment for the borehole drilling in the rural area having no suitable water supply system at present, in order to develop healthy potable water supply and to improve the standard of living of the rural population, and further to contribute toward the development of the local economy and to the national economy.

The Project area is to be the following three districts;

(1) Nanumba District of Northern Region
(2) Berekum/Jaman District of Brong Ahafo Region
(3) Sefwi-Wiawso District of Western Region

4-2. Examination on the Request

The major scheme of the final request from the GWSC is to be provided the grant aid assistance of Japan on the following two items, in connection with the Project to construct total 440 borehole facilities equipped with manual pumps in the said three districts;

a) Provision of equipment necessary for the implementation of the Project, and
b) Construction of 120 boreholes, and appurtenant facilities.

For the item b) above, the Ghanaian party has expressed their strong desire that the technical personnel of the GWSC participate in the construction works to ensure technology transfer from

Japanese personnel related to the Project in the various fields of the Project implementation.

The followings are the results of examination for the Project and the request.

4-2-1. Examination on the Project

(1) Objective

Improvement in the water supply circumstances of the rural area aims at such effects as the suppression of the high occurrence rate of disease due to unhealthy drinking water, curtailment of the burden of the inhabitants medical expenses, reduction in the home labour force required for fetching water, transfer of surplus labour force to other productive activities, etc., being one of the urgent national policies.

In the conventional strategies of the GWSC which is the only responsible organization of the water supply sector and in the on-going "Five-year Rehabilitation and Development Programme (1985-1989)", the rural water supply by the hand-pump equipped borehole facilities is seriously taken up, and borehole facilities of more than 6000 sites have been constructed owing to the introduction of large-scale international cooperation and the investment of the GWSC itself. In the "Five-year Rehabilitation and Development Programme" also, borehole facilities at about 2200 sites are scheduled to be newly installed. (refer to Table 2-3-4)

The number of the scheduled facilities in the Northern Region, Western Region, and Brong Ahafo Region concerned with this Project is 426, 721, and 217, totalling to 1,364; and about 440 facilities scheduled in this Project is equivalent to 32% of it, being 20% of the total number of 2,245 throughout

the country.

This Project lies in a link of the urgent national policies which is the improvement in the water supply circumstances especially of the rural area and is significant as a project applicable to the grant aid assistance of Japan.

(2) Project areas

There districts of Nanumba, Berekum/Jaman, and Sefwi-Wiawso applicable to this Project are located most on the barrier among the districts they belonged to and most delayed in the diffusion of water supply facilities; thus the poor water supply circumstances and environmental health conditions are found beyond imagination.

Because of the three districts being situated on the border and seemingly of backwardness in the social inflastructures, they are left from the existing international cooperation projects and will not be scheduled to be taken up as a project area in the near future.

In this context, it will be reasonable to take them up as the target areas to this Project.

(3) Target communities and their population

The communities, their population (as of 1984 except Nanumba District in 1983), and allocation of boreholes applicable to the Project submitted by the GWSC are shown in Appendix 10. It shows that the number of communities is 178, population 179,000 and boreholes 445.

As seen in Appendix 10, the Project areas include some towns of more than 2000 people which fall under mechanized

water supply facilities. However, the reason that the above-mentioned villages are absent from water supply facilities at present and that they have no construction plan in the near future, they should be applicable to this Project.

The implementation period of the "Five-year Rehabilitation and Development Programme" prepared by the GWSC is 1985 through 1989, and accordingly it is not reasonable to fix the beneficial population in 1984. The design beneficial population shall be taken the value projected to 1989 when the target year of the said five year programme based on the population in 1984 (1983 for Nanumba) and population increase rate of Ghana (average 2.6%, by the population census 1984).

The figure so projected will be entered together in Appendix 10. Accordingly the design beneficial population will amount to 205,000 which is the 15% increase of that in 1984. The locations of target communities are shown in Appendix 11.

(4) Criteria of water supply and boreholes required

The water supply standard of the GWSC has stipulated that hand-pump equipped borehole facilities be installed in the communities whose population is 400 to 2000 at the rate of one site for a population of 400, and the design water demand is 22.7 lit.cd (5 gcd).

The standard says that the pumping rate per borehole is 9080 lit./d (400 persons x 22.7 lit.cd) in standard and 13600 lit./d (599 persons x 22.7 lit.cd) maximum. Since the maximum pumping capacity of the standard hand-pump is 900 lit./hr and the efficiency concerned with the pumping head and operation is usually fixed as 70% (WHO standard), the operation time T of the hand-pump per day will be as follows:

$$T \text{ (standard)} = \frac{9080}{900 \times 0.7} = 14.4 \text{ (hr)}$$

$$T \text{ (maximum)} = \frac{13,600}{900 \times 0.7} = 21.6 \text{ (hr)}$$

However, the operation time of the hand-pump is rated at 12 hours at maximum (daytime operation); therefore the said operation time is judged not realistic.

On the other hand, from the viewpoint of the transportation labor of water, if the design water demand is at 22.7 lit.cd. a 10-member family will use 227 lit. of water a day. This should require at fetching water work of more than 11 times with a 20 lit. bucket; thus the normal home labor available (2 to 3 females) cannot meet the work and use of such water rate, depending upon the transportation distance though.

The standard of the World Bank says the the standard design water demand to the rural area is 15 lit.cd, and the beneficial population per hand-pump equipped borehole is 250 to 300. The beneficial population is sometimes set to 500 from the economical background, but the operation time is generally fixed as 12 hours as the daytime hour at maximum.

Therefore, the design water demand in this Project is to be about as 15 lit.cd. In such a case, the pumping rate per borehole comes to be 6000 lit./d normal and 9000 lit./d maximum. The operation time of the hand-pump will thus come to be as follows:

$$T \text{ (standard)} = \frac{6000}{900 \times 0.7} = 9.5 \text{ (hr)}$$

$$T \text{ (maximum)} = \frac{9000}{900 \times 0.7} = 14.3 \text{ (hr)}$$

Accordingly the operation time will exceed the daytime hour at a maximum (supposed population of 599), but it comes to be within a range available for operation.

Based on these consideration, the Project fixes the allocation of boreholes for the population scale of the communities as shown in the following table.

Table 4-2-1 Allocation of Boreholes

Population	Allocation
under 399 persons	0 boreholes
400 - 599	1 "
600 - 999	2 "
1000 - 1399	3 "
1400 - 1799	4 "
1800 - 2199	5 "
2200 - 2599	6 "
2600 - 2999	7 "
over 3000 persons	8 "

The number of the boreholes fixed to the Project is shown together in Appendix 10 with the number of the existing boreholes; shown in the original plan of the GWSC, drilled by the "3000-Well Programme", or listed in the borehole inventory of Drilling Unit, and its total figures are shown in the following table.

Table 4-2-2 Communities, Population and Allocated Boreholes in the Project Areas

District	Number of Communities	Population	Number of Borehole
Nanumb	54	67,960	159
Berekum/Jama	55	66,602	143
Sefwi-Wiawso	65	70,790	164
Total	174	205,352	466

Thus the Project is fixed to apply 174 communities with total 205,352 of population, and 466 boreholes.

4-2-2. Examination on the Request

(1) Procurement of equipment

The contents and formation of the equipment required are basically limited to those necessary for the implementation of this Project. In other words, with an aim that the borehole facilities at about 440 sites to be constructed in the Project be completed within 1989 which is the target year of the "Five year Rehabilitation and Development Programme", the equipment are composed of three sets of drilling rigs as main equipment and the supporting equipment and vehicles in order to efficient and intensive construction.

The radio communication system, bulldozer for arrangement of the construction site and access road, and trucks for speed transportation of the bulldozer which were not included in the initial request were added as indispensable for the effective implementation of the Project in terms of the social inflastructure of the Project areas.

The formation, quantity and specification of these equipment are to be studied in and through the following design steps such as water supply, work plan, design of facilities etc., and be judged finally.

Most of the said equipment are durable and will not be consumable in the construction of the only 440 borehole facilities. If operated under a suitable maintenance and management after completion of this Project, they will be operative for more than ten years. Therefore, they will be enough to contribute toward the functional reinforcement of the

Drilling Unit of the GWSC which is one of the schemes included in the initial request.

The 140 manual pumps required are equivalent to those to be equipped to 120 bereholes which will be cooperated for construction by the Japan-side and their spare parts (about 15%). In connection with this manual pumps, the Ghanaian party strongly desires the furnishing of the standard types (third-country makes such as India mark II, Moyno type, etc.) which are most used at present by the GWSC, however, the type of manual pump shall be studied and selected from the view point on its ability, toughness, price and running cost, because the said standard type manual pumps are not perfectly favorable for the borehole facility.

Except those required for 120 boreholes to be constructed under the cooperation of the Government of Japan, the said request does not include the provision of import materials such as permanent casing pipes, manual pumps, mud additives, etc., and construction materials such as fuel, gravels, cement, etc. Such materials required for the implementation of the Project will be procured on the Ghana-side's own responsibility and account.

(2) Cooperation for the construction of borehole facilities

The request on the cooperation for the construction of 120 borehole facilities is not only for mere construction of the facilities but also chiefly aims at the transfer to the Ghanaian personnel the technology concerned with the drilling including the operation, maintenance, and managing of the drilling equipment and materials which will be procured by the Japanese aid.

Most of the drillers in the the Drilling Unit of the GWSC

are well skilled with the operation of percussion type drilling rigs, but a few of them have mastered the operation of high-speed rotary drilling rigs.

In addition, the upper-class staff of Drilling Unit seems to be short of experience in the operation and managing an integrated project like this one where a great number of borehole facilities are constructed systematically within a specified short time. Furthermore, though hydrogeologists who are responsible for the siting of boreholes are positioned in the Drilling Unit, the equipment for geophysical prospecting which is one of the scientific means of siting has been absent for long time.

The Drilling Unit has a workshop and parts storage, but poor in the maintenance and managing of the high-speed rotary drilling rig, its supporting equipment, hand-pump, and borehole facilities and also poor in the technique and the number of staff for the stock managing on stand-by equipment and spare parts.

These present situations suggest that the smooth and effective implementation of the Project shall not be expected by only the procurement of equipment.

In consideration of the above-mentioned status and in connection with drilling-concerned fields, that the Japanese dispatched engineers in each field work with counterparts of the Ghanaian staffs during the construction period for giving advice and corporation and for conducting on-the-job training will not only be beneficial to the smooth and effective implementation of the Project but also create an additional value that the equipment and materials procured by Japan can be operated appropriately and effectively even after completion of this Project for permanent contribution toward the improvement

in the water supply circumstances of Ghana, this being though significant.

It is thought optimum for the cooperation of Japan for the construction that, apart from a contract basis by a drilling company whose purpose is solely for the construction of facilities, the Ghana-side should furnish all personnel including labors necessary for implementation of the Project and that minimum number of Japanese engineers should be dispatched who are capable of giving advice, cooperation, and transfer technology to the Ghanaian staffs who are in charge of major fields covering the management of the Project and construction work, siting, maintenance and managing of boreholes, equipment, materials, and facilities.

The construction work of 120 borehole facilities required to Japan to cooperate will be equivalent to such work as can be completed nearly within a year making use of three sets of high-speed drilling rigs.

In other words, the transfer technology to the Ghanaian staffs will be available within one year to come and expectant of considerable outcome even it is not sufficient in all fields concerned with the implementation of this Project. So the said number of borehole facilities to be cooperated by Japan is applicable. The request of the components stipulates that, in addition to the expense incurred in the dispatch of the Japanese engineers and their stay, the procurement cost for the imports such as hand-pumps, permanent casing pipes, mud additives, etc. and local procurement materials such as fuel, cement, sand, etc. for the said 120 borehole construction shall be borne by Japan. All the cost incurred in the mobilization of Ghanaian personnel should be borne by Ghana.

The apportionment of the Ghanaian side may be applicable from a view points of their economic situation and the policy of Japanese grant aid. The construction of the 120 borehole facilities subjected to the cooperation of Japan will be conducted in the first construction year of the Project.

The Ghana-side desires that the construction be started in Nanumba District. Compared with other two districts, the said district is most remote from the capital, Accra, being subjected to worse conditions for implementation of the Project in the communication to the GWSC Head Office or the Drilling Unit, supply of fuels, etc.

Owing to such worst water supply circumstances in the district and its improvement being of the top urgency, it is reasonable that the implementation of the Project is started from this district under the cooperation of Japan.

4-3. Outline of the Project

4-3-1. Executing organization

The main body to execute the Project is to be the GWSC.

The GWSC shall secure the personnel required for the implementation of the Project, procure materials necessary for the implementation of the Project other than those procured by Japan, and bear the expense incurred therein.

Because the Project areas expand over three regions, it is desired that the direct responsibility of this Project be borne not by Regional Office of the GWSC but by the Drilling Unit. The Headquarter and each Region Offices of the GWSC shall support the Drilling Unit in connection with the implementation of this Project.

The Regional Offices shall operate the hand-pump maintenance centers which should be established at each district and be responsible for the maintenance and management of borehole facilities completed.

On the basis of the annual implementation plan of this Project, the GWSC Headquarter shall make efforts to keep on securing the annual budget including the foreign currency allowance for the procurement of import materials and to support each Regional Office concerning to coordinations between the Drilling Unit and Regional Office and between Regional Office and government agencies concerned.

Each Regional Office shall support the Drilling Unit for a communication or coordination with local councils and communities, operate a hand-pump maintenance center, and has a responsibility to O & M of the completed borehole facilities.

4-3-2. Project Planning

(1) The Project is to construct borehole facilities equipped with manual pumps for the rural people in Northern Region Nanumba District, Brong Ahafo Region Berekum/Jaman District and Western Region Sefwi-Wiawso District, aiming to provide healthful portable water to the inhabitants economically.

(2) The Project shall be planned linking with the Five Year Rehabilitation and Development Programme (1985 - 1989) of the GWSC.

(3) The target communities of the Project are to be those having more than 400 of population as of 1889; 54 communities (about 68 thousands of population) in Nanumba, 55 communities (about 67 thousands) in Berekum/Jaman and 65 communities (about 71 thousands) in Sefwi-Wiawso District, total 174 communities with

205 thousands of population.

(4) Design water demand is to be 15 lit.cd, standard and max. pumping rate per borehole are to be 6000 and 9000 lit./day respectively.

(5) Criteria of borehole allocation is as follows;

Community with 400 - 599 population : 1 borehole
" 600 - 999 " : 2 boreholes
" more than 1,000 " : added 1 borehole per 400 of exceeding population to above.
" more than 3,000 " : 8 boreholes

Numbers of borehole facility are 159 is Nanumba, 143 in Berekum/Jaman and 164 is Sefwi-Wiawso (466 sites in total).

(6) Borehole facility is to be equipped manual pump and be installed appurtenant facilities such as concrete slab, drain conduit, etc. to keep the facility clean and healthy.

(7) The construction will be commenced at Nanumba at first and followed by Berekum/Jaman and Sefwi-Wiawso.

(8) The Project is planned based on the premise that the following Japanese grant aid programme will be implemented;

a) Provision of equipment

The government of Japan procures and transports the equipment required to implement the Project, and provides them to the government of Ghana. Although the equipment include a set of equipment and tools for the workshop of the Drilling Unit, only a part of spareparts, equipment and tools for hand-pump maintenance center are included.

b) Cooperation for the construction of borehole facilities

The cooperation for the construction of 120 borehole facilities which is to be conducted at Nanumba consists of dispatchment of engineers and procurement of construction materials.

For the dispatchment, engineers of adequate number and of required sectors for the construction of 120 borehole facilities are to be dispatched. These engineers will transfer the technologies required to implement the Project to Ghanaian staffs through the actual construction work with them.

For the procurement, only materials required to construct the said 120 borehole facilities are procured under the Japanese aid.

4-3-3. Outline of construction equipment and materials

The following equipment and materials are required in the implementation of the Project.

(1) Construction equipment

a) Drilling rig,
b) Supporting equipment,
c) Vehicles for transportaion of personnel, equipment and materials,
d) Geophysical equipment for siting,
e) Borehole test equipment,
f) Earth-moving equipment for access or work site,
g) Telecommunication system
h) Camping facility, and
i) Others

All of them will be imported from Japan, and the ability, quantity, specification, etc., will be studied in detail in the chapter of basic design.

(2) Materials

Following materials are required to construct the borehole facility;

a) Manual-pumps,
b) Permanent casing pipes,
c) Bentonite and CMC,
d) Fuel and lubricants,
e) Cement,
f) Gravels, and
g) Others,

Among them, casing pipe and bentonite or CMC will be imported from Japan but the other materials are able to be procured in Ghana.

CHAPTER 5 BASIC DESIGN

5-1. Design Policy

The objective areas of the Project spread spotadically out in three regions of Northern, Brong Ahafo and Western. Among them, Northern Region situate the most remote area, and the conditions of the Region on sociology and physical environment such as climate, hydrogeology, etc, are quit different from other regions.

Furthermore, since the Project would be implemented under the Grant Aid by the Government of Japan, institutional limitations of the aid ought to be a premise for the basic design.

The basic design for the Project is, therefore, to be conducted under the following basic policy and concept taking the aforesaid particular conditions of Ghana, Project areas and system of Japanese aid into account;

(1) to meet the national policy, regulations and criteria of water supply sector as Ghana,

(2) to design the standardized and economical facility applicable for all Project areas,

(3) to make the construction plan taking the regional climatic condition and present situation and customally work system of the Drilling Unit of GWSC into account,

(4) to select the drilling rig and vehicles from views of economy and applicability for the physical conditions of not only Project areas, but all over Ghana,

(5) to provide those equipment and materials indespensable to

implement the Project in addition to those requested, provided they fit to the purpose and object of the Grant Aid.

(6) to formulate the dispatchment plan of Japanese experts based on the conception that the major tasks of those experts are to assist, cooperate and transfer technology to the Ghanaian Project staff.

5-2. Examination of Design Criteria

5-2-1. Criteria of successful borehole

As a standard of successful borehole, the GWSC has fixed it at 1,360 lit/hr (5 gpm).

The "3000-well program" has standardized the yield of successed borehole at 600 lit/hr (10 lit/min), but a borehole of yielding 300 lit/hr is equipped with a pump too.

As mentioned in the preceding section, the standard borehole in this Project is available for a pumping rate of 6,000 lit. per day (10 hours), thus it will be enough with a yield of 600 lit/hr.

However, it is not always reasonable economically and administratively to discard all boreholes whose yield is less than 600 lit/hr. This is because, if the water source is remote enough or extraordinarily unhealthy, even a borehole which fails to reach the standard yield will not be so unavailable.

In this Project, therefore, a borehole whose yield is 300 lit/hr and over available for covering a water supply population of 200 is decided to be successful. However in such case of the low yield borehole, additional borehole would be considered.

5-2-2. Successful rate of boreholes

The borehole successful rate according to the existing drilling records can be summalized as follows.

a) Actual records of NORRIP (Test borehole in Northern Region)

District	Number of drilling	Number of success	Number of dry hole	Success rate	Remark
Western Region	22	12	10	0.55	Lower Voltaian
Central Region	31	8	23	0.26	Upper Voltaian
Eastern Region	27	18	9	0.67	Middle Voltaian (including Nanumba District)
Total/Average	80	38	42	0.48	

b) Actual records of 3000-Well Program

District	Number of drilling	Number of success	Number of dry hole	Success rate	Remark
Brong-Ahafo Region	101	64	37	0.63	In case 3 gpm and over are taken successful.
Western Region	513	383	130	0.75	
Total/Average	614	447	167	0.73	

c) Actual records of Drilling Unit (all over Ghana)

Year	Number of drilling	Number of success	Number of dry hole	Success rate
1983	124	57	67	0.46
1984	133	113	20	0.85
Total/Average	257	170	87	0.66

Though the above actual records differ in such conditions as referring districts, hydrogeology conditions, successful standard, siting techniques, etc., this Project has set up the following successful rate in each Project districts as follows mainly based on the difference of the hydrogeology condition.

Table 5-2-1. Successful Rate of Boreholes
(design value)

Nanumba District	0.65
Berekum/Jaman District	0.75
Sefwi-Wiawso District	0.75

5-2-3. Number of borehole to be drilled

Taking consideration on the number of borehole facility allocated to each Project area and the successful rate of borehole drilling as examined in the foregoing section, the proposed number of borehole to be drilled in each area becomes as shown in the table below;

Table 5-2-2 Number of Boreholes

Region	District	Allocated Borehole facility	Successful rate	Boreholes to be drilled
Northern	Nanumba (Japanese coop.)	159 (120)	0.65	245 (185)
Brong Ahafo	Berekum/Jaman	143	0.75	191
Western	Sefwi-Wiawso	164	0.75	219
Total/Average		466	0.71	655

5-2-4. Borehole design depth

Borehole depth of existing borehole facilities are summarized as the Table 5-2-3 shown below.

Table 5-2-3 Existing Borehole Depth

Area		GWSC		3000 WELL		Average	
Region	District	Number	av.Depth (m)	Number	av.Depth (m)	Number	Depth (m)
Northern	-whole-	29	56.05	-	-	29	56.05
Brong Ahafo	Berekum/ Jaman	7	80.91	76	54.01	83	56.28
Western	Sefwi-Wiawso	26	63.00	50	36.58	76	45.61
Total Average		62	61.77	126	47.1	188	51.93

Although the average borehole depth is approximately 52 m, the boreholes drilled by the GWSC are mostly for mechanized borehole facilities in the late sixties.

In the Project, the average borehole depth is to be 50 m mainly referred from the actual results of 3000 Well Programme. Further the minimum depth of borehole is to be more than 30 m to prevent the facility from pollution by domestic water, and the borehole with more than 70 m of depth does not fit to the hand-pump equipped facility.

Thus, the borehole depth is designed to be 30 m or more, 70 m at most and 50 m on an average.

5-2-5. Quantities of drilling and casing

The total linear lengths of borehole drilling and casing by the area are estimated as shown in the table 5-2-4.

Table 5-2-4 Length of Drilling and Casings

Area	Total Drilling length	Casings (m)		
		Total length	Blank	Screen
Nanumba	12,250	7,950	5,565	2,385
(Japanese cooperation)	(9,250)	(6,000)	(4,200)	(1,800)
Berekum/Jaman	9,550	7,150	5,005	2,145
Sefwi-Wiawso	10,950	8,200	5,740	2,460
Total	32,750	23,300	16,310	6,990

5-2-6. Siting

The Drilling Unit of GWSC has staffed seven hydrogeologist who are chiefly in charge of siting, borehole design, supervision of drilling work, etc.

Their siting has depended chiefly on geoelectric prospecting, however, all the equipment has been age-worn and turned into no more use; therefore they have no scientific means and depend upon such traditional means as interpretation of topographical maps, geological maps, air photos, and field reconnaissance survey. The latest actual drilling records of the Drilling Unit are shown in Chapter 5-2-2. c) and the fact that they have not recorded satisfactory successful rates seems to be the outcome that scientific means are short.

Most of groundwater in Ghana, including the Project areas, is contained in a hard rock zone under comparatively a thin overburden. A prominent aquifer is mostly found in a porous covering layer, rock weathered zone, or cracks and joints in rocks; therefore the main point of the groundwater investigation is directed toward the grasp of such geological structure.

In consideration of the above-mentioned situation, this Project will introduce the following siting method applied the latest

scientific techniques, and it is expected to highly contribute toward the level-up of hydrogeological techniques of the GWSC.

a) Interpretation of Landsat Images

Since the geological structure is well projected into relief features in general, it can be roughly grasped by interpretation of topographical maps or aerial photos. However, such data show local geological structure and may lose the main structure or large scale linearment sometimes. Recently, a groundwater survey technique by means of a subject map applied with special treatment to the landsat satellite data has been developed. For example, Landsat V which was launched recently is mounted with subject mappers such as heat sensor, etc., available for analysis of the vegetation, geology, and ground surface temperature with the data. These analyses show a special power to groundwater investigation. In the implementation of this Project, therefore, subject maps (scale about 1:250,000) of ground coverage, geology, and ground surface temperature covering the Planned area will be prepared beforehand, to contribute toward the special designation of dominant groundwater basin by their interpretation as well as the existing topographical maps, geological maps, and aerial photos.

b) Geophysical prospecting

To identify a borehole site in a designated groundwater basin must be carried out by geophysical prospecting means.
One of the means effective is the conventional geo-electric survey.
However, this method requires comparatively lots of labour and time so that it is not always suitable for the

investigation covering wide areas in a short time. In such a case, electromagnetic prospecting (EM method also known as underground radar) will be effective.
Depending upon the output capacity of the equipment and geological conditions, the EM method is only effective down to 20 m from the ground surface in general, but suitable for speedy survey or extensive prospecting of overburden and fissures in the rock when it encountered in shallow depth, because it can be managed with small amount of labour and time. In this connection, the EM method should be applied to the special designation of the proposed site group within an area of a certain extent (0.25 km^2 for example) and then a geoelectric prospecting by horizontal and vertical resistivity method should be utilized about such proposed site: such a two-stepped siting method will be most effective. The siting under such method will be desirable to be executed before commencement of the borehole work, but it is supposed that the re-siting will be required letter according as the result of borehole drilling.

5-3. Design of Facilities

5-3-1. Design of borehole

The drilling depth of design borehole varies from 30 m to 70 m and is 50 m on an average.

The manual pump installed to the borehole must have a pumping capacity of 900 lit./hr according to the water supply plan, and the cylinder diameter of this class manual pump is usually 50 - 90 mm. Consequently, the minimum diameter of permanent casing shall be 100 mm, and thus, the minimum drilling diameter shall be 150 mm.

Geological condition of Ghana suggests that a decomposed and collapsible layer lie rather deep in some areas. Supposing the case to drill into these layer, the another type of borehole which needs a temporary casing to drill in shall be required. In this case, 216 mm of drilling diameter shall be needed to insert the temporary casing with more than 172 mm of diameter which can pass the 150 mm diameter bit through.

Thus, the two types of borehole are designed as shown in Fig. 5-3-1.

5-3-2. Design of appurtenant facilities

As appurtenant facilities which prevent boreholes from being polluted by wasted water, such as concrete slab, drainage conduit, cattle waters, fence, laundry, etc. are desirable.

However, the former two facilities and drain pit are planed according to the actual condition and tradion of Ghana in the Report, and the other facilities are anticipated to be provided by beneficiaries themselves in future as the necessity arises.

The concrete slab is of 2.0 m by 2.0 m, and the drain pit is set at the point about 7 m apart from the center of borehole connected by the concrete drainage conduit. Design of the facilities are shown in Fig. 5-3-2.

Fig.5-3-1. DESIGN OF BOREHOLE

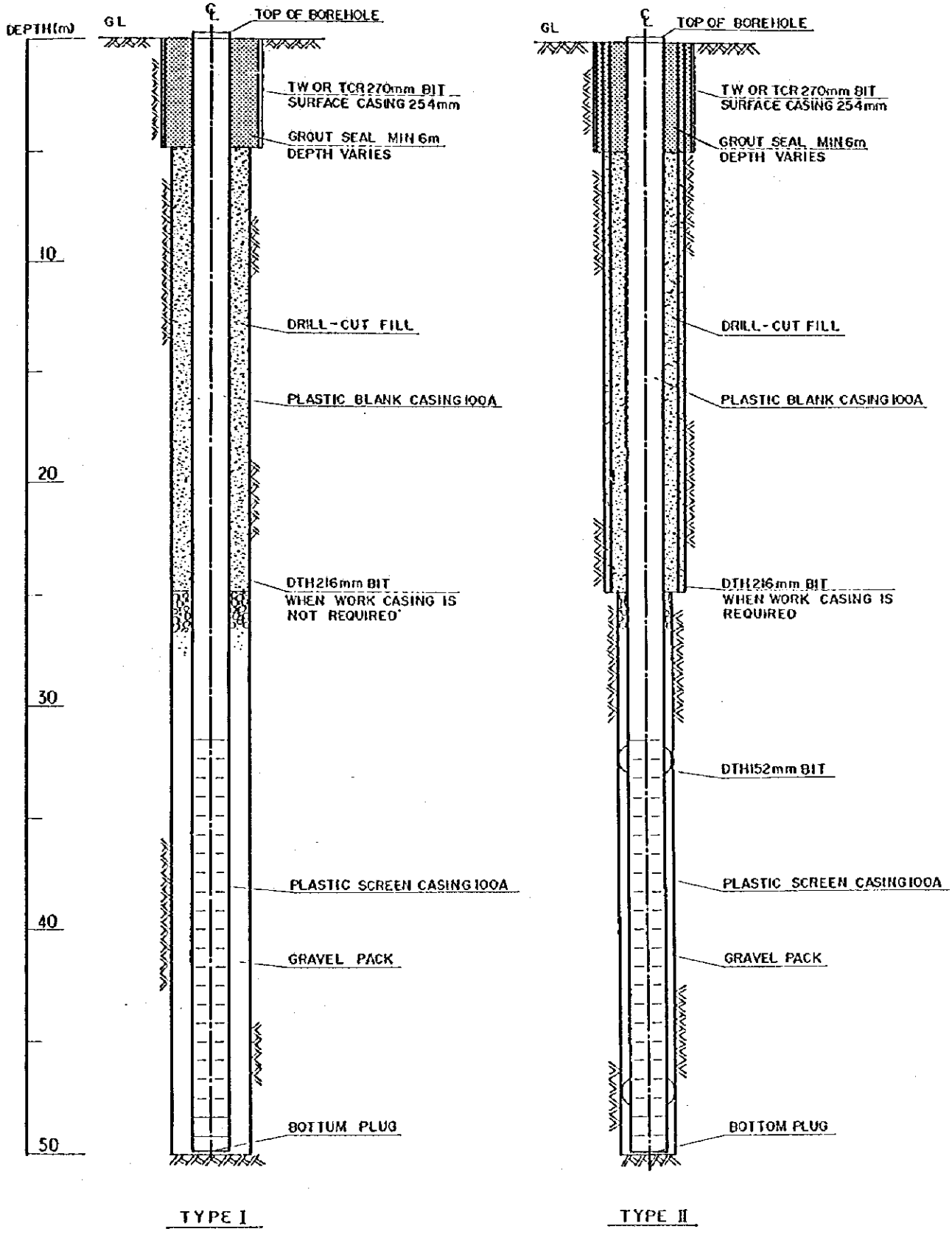
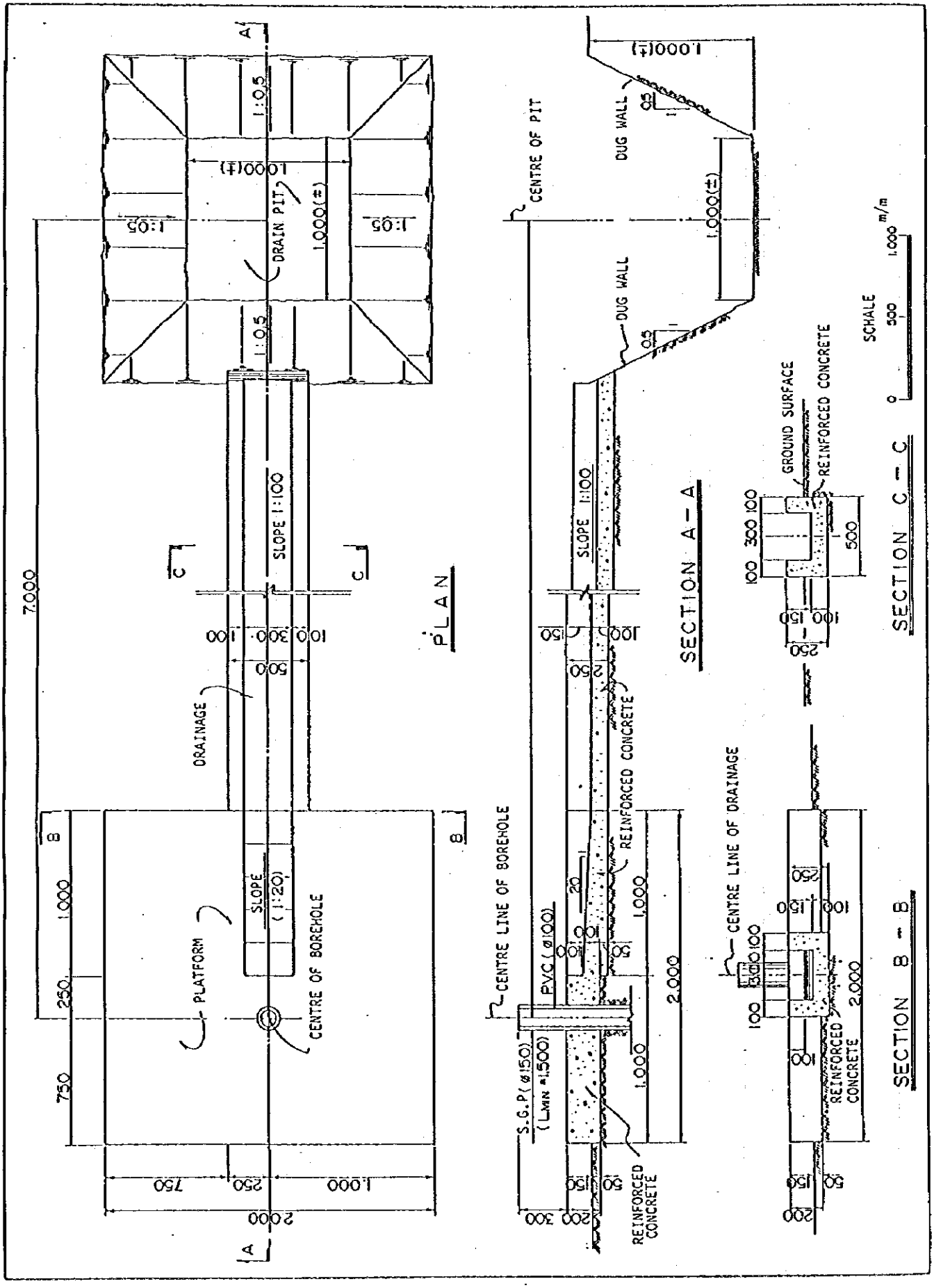


Fig. 5-3-2. DESIGN OF APPURTENANT FACILITY



5-4. Construction Plan

5-4-1. Work Plan

(1) Basic policy

The Project is to be undertaken in direct management of the GWSC. The work plan studied herein is to be smooth and efficient with considering that the target year of the Five Year Rehabilitation and Development Programme is on 1989.

(2) Quantities of Construction

The quantities of construction for the Project implementation are summarized as Table 5-4-1.

Table 5-4-1 Summary of Construction Quantities

District	Required Bore-hole	Boreholes to be drilled	Dry hole	Drilling Length (m)	Casing Length (m)
Nanumba	159	245	86	12,250	7,950
(Japanese Coop.)	(120)	(185)	(65)	(9,250)	(6,000)
Berekum/Jaman	143	191	48	9,550	7,150
Sefwi-Wiawso	164	219	55	10,950	8,200
Total	466	655	189	32,750	23,300

(3) Organization for the construction

The constructing work for hand-pump equipped borehole facilities is sub-divided into eight sectors as described below. The work of each sector shall be carried out by professional and individual working party for smooth and effective progress of the construction.

a) Project management

The sector is to conduct a general management for the Project such as;

- Coordination and communication with the government agencies concerned, both central and local,
- Supervision of the construction,
- Management/coordination of the construction schedule,
- Management of stand-by equipment and spare parts,
- Recording,
- Accounting, and others.

b) Site management

The sector is to conduct a site management consisting of following items;

- Management/coordination of actual construction sectors,
- Management of personnels,
- Supply and management of construction materials,
- Operation/management of base camp, etc.

c) Siting

The party conducts a siting of borehole site and access route. The siting shall be done by field reconnaissance and by means of geophysical prospecting as well as pre-study for the hydrogeological condition of the area.

The siting party shall instruct to the civil work party the arrangement or repairing of access route where the civil work deems to be required.

d) Earth work

The party makes arranging or repairing the access route for moving-in and out of rig-truck and other vehicles, and preparing the drilling site.

e) Drilling

Drilling party conduct following process;

- Moving-in the rig and materials, assembling the rig,
- Drilling,
- Geoelectric logging for cassing design,
- Installing casing pipes and gravel-packing,
- Developing the borehole,
- Dismantling, moving-out the rig and equipment.

Supporting parties such as water/fuel supplies, etc. accompanies to the party.

f) Borehole test

The party conducts a pumping test to confirm the yield and water quality test of the borehoile.

g) Civil work

The party constructs appurtenant facilities (concrete slab, drainage conduit and drain pit), and installs a hand-pump to complete the borehole as water supply facilities.

h) Maintenance

The party performs a daily maintenance and management of rigs, supporting equipment and vehicles.

5-4-2. Construction schedule

The section presents a construction schedule based on the work plan described in previous section.

(1) Working day

Working day in a year for the construction work is estimated as follows, in accordance with customary work condition and climatic environment of Ghana.

-	Work condition	8 hours per day 6 days per week 30 days of national holiday per year
-	Climatic condition	6 weeks of shut down per year (mid Aug - Sep.)

By the above mentioned condition, total holidays and shut down period in a year are to be 118 days as calculated below;

Weekly holiday	52 weeks x 1 day	= 52 days
National holiday		30 days
Shut down period	6 weeks x 6 days	= 36 days
Total		118 days

Thus the annual working day is estimated as 247 days (365-118 days), and it is converted to 20.6 days of monthly working day.

(2) Siting

Siting work is to be carried out by field reconnaissance survey and by the means of geophysical explorations such as electromagnetic (E.M.) prospecting, geoelectric resistivity method, etc., as well as pre-study of Landsat Image, aerial photo and topo-maps.

A hydrogeologist reconnoiters the proposed borehole sites (about 5 sites per day) including the access routes, and points out the E.M. prospecting field of about 0.25 km^2 (500m x 500m). The field is prospected by E.M. method within a half day averagely, and three detail survey points are selected out. These detail survey points are prospected by geoelectric resistivity method and the final drilling site is pointed out. It taked about one day on average.

Accordingly, the siting work takes about 1.2 days per site averagely, provided one E.M. party and two geoelectric resistivity parties.

(3) Earth work

The sites required an arrangement or a repairing of access route are to be approximately two-thirds of total drilling sites.

The earth work volume to be removed per site is presupposed as 600 m^3 (200m x 3m x 1m), and a bulldozer of GVW 10 ton class is to be adopted in the earth work.

The work capacity of bulldozer is obtained by the following formula.

$Q = (60 \times q \times E)/Cm$

herein
- Q : hourly work capacity (m^3/hr)
- q : unit remove capacity (m^3)
- E : workability
- Cm: cycle time (h)

Supposed of 10 ton bulldozer to be used and hard overburden to be removed, the work capacity per hour is calculated as follows;

$Q = (60 \times 2.19 \times 0.55)/1.36 = 53.14\ m^3/hr$

Then, work time for each site is to be approx. 11.3 hours (600 ÷ 53), and the average work time for bulldozer work is to be 7.5 hours because one-third of total site are not required the earth work (11.3 x 2/3).

In result, the total time required for the earth work is to be 9 hours, (1.2 days), including 1.5 hours for mounting/dismounting the bulldozer and moving in time besides the above mentioned work time.

(4) Drilling

Drilling time for the two types of borehole shown in Fig. 5-3-1 is calculated below, provided the drilling speed of;

- 6 m/hr for rotary drilling by 270 mm bit.
- 6 m/hr for rotary drilling by 216 mm bit.
- 8 m/hr for air hammer drill by 216 mm bit.
- 10 m/hr for air hammer drill by 152 mm bit.

° Type I

ϕ270 mm rotary drilling	6 m ÷ 6 m/hr	= 1.0 hr
ϕ216 mm air hammer drilling	44 m ÷ 8 m/hr	= 5.5 hr
Casing work (ϕ254 mm)	6 m ÷ 12 m/hr	= 0.5 hr
Total		7.0 hr

° Type II

ϕ270 mm rotary drilling	6 m ÷ 6 m/hr	= 1.0 hr
ϕ216 mm rotary drilling	20 m ÷ 6 m/hr	= 3.3 hr
ϕ152 mm air hammer drilling	24 m ÷ 10 m/hr	= 2.4 hr
Casing work (ϕ254 mm)	6 m ÷ 12 m/hr	= 0.5 hr
" (ϕ191 mm)	20 m ÷ 15 m/hr	= 1.3 hr
Total		8.5 hr
Average		7.75 hr

Since the work time in a day is 8.0 hour, the pure drilling work takes about 1.0 day providing the quantities of type-I and II are fifty-fifty.

Consequently, the work day required to complete one borehole is estimated as follows;

° moving-in, erection and preparatory work	1.0 day
° drilling	1.0 day
° casing, gravel-packing and developing	1.0 day
° dismounting, moving-out	1.0 day
Total	4.0 days

In the case of dry hole, the required work day is to be 3 days because whether it is dry or successful has been judged during the drilling and following casing, gravel-packing and developing works can be neglected.

(5) Borehole test

Borehole tests; pumping test and water quality test, take 1.5 days as estimated below.

a) Pumping test

° moving-in/out	0.5 day
° pumping test	0.5 day
Sub-total	1.0 day

b) Water quality test 0.5 day

Total 1.5 days

(6) Civil work

Civil work for completion of borehole facilities takes 3.0 days per borehole as estimated below

° moving-in/out	0.5 day
° basing, form & reinforcing	1.0 day
° concrete work	1.0 day
° pump installation	0.5 day
Total	3.0 days

(7) Total Work Plan

Total work plan is estimated based on the basic work day of each sector mentioned above.

Table 5-4-2 shows total work days for each sector to complete the quantities shown in Table 5-4-1, and the ratio compared to the presupposed construction period (3 years).

Table 5-4-2 Work days required for each sector

Sector	Q'ty	Basic Work day day site	Total required day	month	year	Ratio to 3 years
Siting	655	1.2	786	38.2	3.2	1.1
Earth Work	655	1.2	786	38.2	3.2	1.1
Drilling						
Reqd.	466	4.0	1,864			
Dry	189	3.0	567			
Total	655	3.7	2,431	118.0	9.8	3.3
Borehole test	466	1.5	699	33.9	2.8	0.9
Civil work	466	3.0	1,398	67.9	5.7	1.9

Based on the table, the work parties for each sector are decided as follows, to adjust the total work days of each sector to presupposed three years.

Siting	1 party	(but sub-divided into 3 parties for geophysical prospecting)
Drilling	3 parties	
Borehole test	1 party	
Earth work	1 party	
Civil work	2 parties	

Construction schedule for each Project area is estimated as Table 5-4-3, provided above mentioned work parties are engaged to the implementation. The item of "moving" in the table includes travel days for Kumasi - Nanumba - Berekum/Japan - Sefwi-Wiawso - Kumasi (150 km/day) and each 6 days for loading/unloading.

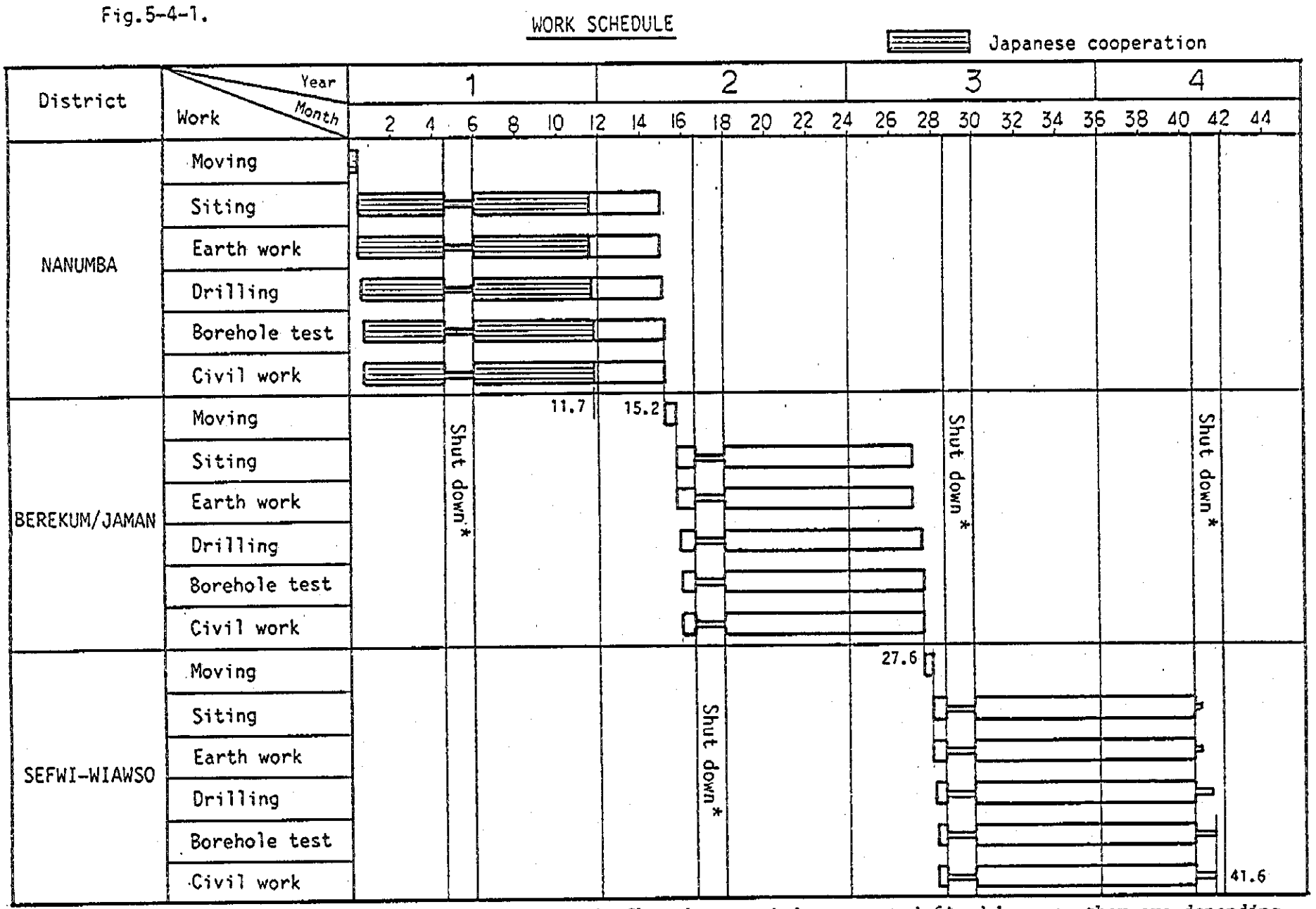
Table 5-4-3 Work period for each project area

Item	Nanumba Whole Q'ty km	Nanumba Whole Days	Nanumba Japan co-operation Q'ty km	Nanumba Japan co-operation Days	Berekum/Jaman Q'ty km	Berekum/Jaman Days	Sefw-Wiawso Q'ty km	Sefw-Wiawso Days
Moving	550	10	550	10	500	10	300	8
Siting	245	294	185	222	191	230	219	263
Earth Work	245	294	185	222	191	230	219	263
Drilling	245	298*	185	222	191	239*	219	274*
completed	159	212	120	160	143	191	164	219
dry	86	86	65	65	48	48	55	55
Borehole Test	159	239	120	180	143	215	164	246
Civil Work	159	239	120	180	143	215	164	246
Work period	314 days, 15.2 month		241 days, 11.7 month		255 days, 12.4 month		288 days, 14.0 month	

*: critical pass

As indicated in the table, the critical pass on the schedule is drilling work. The work period shown in the table consists of the said critical pass, moving and other routine works of the last one site for about 6 days; siting (1.2 days), earth work (1.2 days), borehole test (1.5 days), and civil work (1.5 days). Thus the total work period on the construction for all Project areas sums up to 857 days, 41.6 months.

Fig.5-4-1.



* Shut down periods are not defined because they are depending upon the commenced month of the construction.

Fig 5-4-1 shows the construction schedule of each Project area.

5-5. Personnel Plan

5-5-1. Ghanaian personnel plan

(1) Working parties and their tasks

Sectors of construction work and working parties required for the Project implementation as well as their major tasks are described below.

a) Project Management (One party)

- Coordination and communication with the government agencies concerned,
- Coordination/communication with the communities concerned,
- Management of the total construction programme,
- General supervision of the construction sectors,
- Siting,
- Judgement of the successful borehole,
- Recording of the Project implementation,
- Managing of the personnels,
- Stock managing of the stand-by equipment, materials and spare parts,
- Accounting, and
- Others.

b) Site Management (One party)

- Management of the base camps,
- Management of the borehole sites,
- Management and coordination of each construction sector,

- Stock management of the construction materials,
- Procurement and delivery of the local construction materials,
- Management of the personnel engaged in the construction work,
- Recording and reporting the construction work, and
- Others.

c) Siting (One party with three geophysical prospecting crews)

- Pre-studying the borehole sites,
- Geophysical prospecting and analysis,
- Judgment of the proposed site and reporting to the Project Manager,
- Selection of the access route,
- Judgement of the earth work quantities,
- Instruction the borehole sites and access routes to the earth work party, and etc.

d) Earth work (One party)

- Arrangement/repairing of the access routes and borehole sites.

e) Drilling (Three parties)

- Drilling the boreholes,
- Casing, gravel-packing and developing the boreholes.

f) Borehole test (One party)

- Electric logging of the drilled boreholes,
- Conducting the pumping test and water quality test for the casing design,

- Analysis of the borehole tests above mentioned and reporting of the result to the Project Manager.

g) Civil work (Two parties)

- Construction of appurtenant facilities for the completed boreholes,
- Installing the manual pump.

h) Maintenance of equipment (Two parties)

- Daily maintenance of equipment and vehicles,
- Repairing the equipment and vehicles.

i) Operation and maintenance (One party for each district)

- Regular check of the borehole facilities,
- Repairing the troubled facilities.

j) Stock managing

- Managing of the stand-by equipment and the stock of spare parts in the warehouse of Drilling Unit, Kumasi.

(2) Ghanaian personnel plan

Ghanaian personnel to be engaged in the Project implementation sums up 100 persons (89 persons are fully assigned to the field work), covering through the all construction sectors mentioned above. The remuneration and wages for the Ghanaian are to be borne by the GWSC.

The allocation of personnel to the each construction sector is shown in Table 5-5-1.

Table 5-5-1. Ghanaian Personnel Plan

Item	Profession / Sector	Base camp	Siting	Drilling	Borehole test	Earth work	Civil work	Maintenance	Total
	Project Manager	(1)							- (1)
	Site Manager	1							1
	Hydrogeologist		3		1				4
GWSC	-ditto- Assistant		3		1				4
	Mech. Engineer			1				(1)	1 (1)
Staff	-ditto- Assistant			2				(1)	2 (1)
	Civil Engineer					2	1		3
	Driller Chief			3					3
	Assistant Driller			3					3
	Stock clerk	(2)							- (2)
	Accounter	1							1
	Sub-Total	2 (3)	6	9	2	2	1	(2)	22 (7)
	Foreman					2	1		3
	Driver (heavy)			6			2		8
Employee	Driver (light)	2							2
	Typist/secretary	1							1
	Cook	2							2
	Guard/watcher	2		3	1	1	1		8
	Labour	2	12	12	4	8	5	(4)	43 (4)
	Sub-Total	9	12	21	5	11	9	(4)	67 (4)
T O T A L		11 (3)	18	30	7	13	10	(6)	89 (11)

5-5-2 Dispatchment plan of Japanese Engineers

Japanese engineers join with the Ghanaian staffs to cooperate the construction for the first one year of the construction period under the Grant Aid System. Dispatched Japanese engineers transfer the technology, especially for the following items, to the Ghanaian personnel through the actual work, as well as advicing and assisting them for smooth and effective Project implementation.

a) Project management
b) Borehole siting
c) Design of borehole facilities
d) Site management
e) Drilling by rotary rig
f) Borehole test
g) Maintenance and management of rigs, supporting equipment and vehicles
h) Stock management of equipment and materials
i) Installation, maintenance and management of manual pump

To achieve the above mentioned objectives, the Government of Japan dispatches the engineers shown in Table 5-5-2 by his own expenses.

Scopes of work for the Japanese engineers dispatched are to be as follows.

A. Design and Supervising Group

a) Project Manager (Team leader of dispatched Japanese engineers)

- Meeting and reporting with/to the GWSC and JICA,
- Controlling and managing the Japanese personnel,
- Controlling and managing the tasks of Japanese team,

Table 5-5-2 Japanese Engineers and their profession

Field	Profession	Sectors in charge of	person
Design & Supervision	Project Manager	Project management	1
	Hydrogeologist	Siting	1
	Supervising Engineer	Supervising, Design of borehole	1
Sub-total			3
Cooperation for construction	Site-managing Engineer	Site management, Civil & Earth work	1
	Hydrogeologist	Borehole test	1
	Drilling Engineer	Drilling	3
	Mechanical Engineer	Maintenance & management of Equipment, Stock management	2
Sub-total			7
Total			10

- ° General management of the technology transfer,
- ° Advicing, assisting and transferring knowledge to the Ghanaian Project Manager for the items concerning to Project management such as;
  - Coordination/communication with the government agencies and communities concerned,
  - Management of the implementation schedule,
  - Supervision of the construction,
  - Selection of the borehole sites,
  - Judgement of the successful boreholes,
  - Recording the Project implementation,
  - Managing the personnel engaged, and etc.
- ° Others

b) Hydrogeologist

- ° Advicing, assisting and transferring technology to the Ghanaian staff in charge of borehole siting for the items such as;

- Selection of borehole sites,
- Geophysical prospections and their analysis,
- Judgement of proposed borehole site and reporting technique,
- Selection of access routes,
- Judgement of earth work quantity for the drilling site and access,
- Instruction of earth work to the work party concerned, and etc.

c) Supervising Engineer

° Advising, assisting and transferring technology to the Ghanaian Site Manager for the items concerning to borehole construction and supervising such as;

- Design of borehole,
- Supervision of borehole test,
- Supervision of appurtenant facility construction and installation of hand-pump, etc.

° Supervising the tasks of Japanese engineers concerned to the construction work.

B. Engineering Group

a) Field Manager

° Controlling and managing the Japanese engineering group.

° Controlling, accounting, managing, recording and reporting for the Japanese cooperation to the construction.

° Advicing, assisting and transferring technology to the Ghanaian Site Manager for the items concerning to site managing such as;

- Managing the base camp,
- Managing the borehole site,
- Coordination and management of the construction work,
- Stock management of the construction materials
- Procurement of local materials and delivery to the borehole site,
- Management of the personnel engaged to the construction work,
- Recording and reporting the work record, and etc.

° Advicing, assisting and transferring technology to the Ghanaian staffs in charged of earth work and civil work.

b) Hydrogeologist

° Advicing, assisting and transferring technology to the Ghanaian Hydrogeologist for the items concerning to borehole test such as;

- Borehole logging,
- Pumping test,
- Water quality test, and etc.

° Assisting the Field Manager

c) Drilling Engineer

° Advicing, assisting and transferring technology to

the Ghanaian staff for the items concerning to drilling such as;

- Handling and operation of the drilling rig and supporting equipment,
- Drilling technique,
- Casing and gravel-packing,
- Developing of borehole, etc.

d) Mechanical Engineer

° Advising, assisting and transferring technology to the Ghanaian staff for the items concerned to maintenance of the equipment and stock management such as;

- Daily maintenance and management of the rigs, supporting equipment and vehicles,
- Stock management of the stand-by equipment and spare parts,
- Maintenance and managing of the manual pumps.

5-6. Equipment and Material Plan

5-6-1. Selection of major equipment and materials

The following major equipment and materials are necessary to implement the Project;

(1) drilling rig,
(2) high pressure air-compressor,
(3) vehicles,
(4) earth-moving equipment,
(5) camping facility,
(6) radio telephone system,

(7) geophysical equipment,
(8) borehole test equipment,
(9) water analysis kit,
(10) permanent casing pipes,
(11) manual pumps,
(12) equipment and tools for workshop,
(13) engine welder, and
(14) concrete mixer.

The said equipment and materials are selected in the following selections:

(1) Drilling Rig

Considering from the hydrogeological condition of the Project areas, the most boreholes involved in the Project are to be drilled hard rock formations through. And, as per such project to construct a lot of boreholes under various physical conditions and within a particular short period, the type of drilling rig is to be those could keep high drilling performance with economical construction cost.

To meet those requirement, only type of rig which is top-head drive rotary and capable of both mud-circulation and air-hammer (Down-The-Hole, DTH) drills is best adoptable. This type of rig is to be capable to apply pressured air as well as mud-water for drilling fluid in order to chill the drill bit and to exhaust drill-cut materials from the borehole so as to response those sires where water is not easily available. The rig is to be mounted on a carrier truck so as to move speedily. Though the designed maximum depth of borehole of the Project is 70 m, the capacity of the rig is, taking some allowance into account, to be upto 150 m depth with 150 mm drill bit.

As already stated in the section of construction plan, three units of rig are necessary for the Project.

(2) High pressure Air-Compressor

The air-compressor is necessary to drive air-hammer and air-circulation. As per air-hammer drive, the capacity of compressor is to be of 17 kg/cm^2 or more air-pressure and 21 m^3/min or more air delivery.

The compressor is to be allocated one each to the drilling rig, and total number of compressor becomes three units.

(3) Vehicles

The vehicles to support the Project implementation are as below:

a) Cargo truck

Cargo truck of eight-ton payload capacity is necessary to transport drilling tools such as drill pipes, casing, drill bit, etc. A crane of three-ton capacity is to be mounted to the truck to handle heavy steel pipes during works. This tool truck is to be allocated one each to the drilling rig, and total number of the truck becomes three.

Cargo truck of four-ton payload capacity with two-ton crane is necessary to transport equipment and materials for civil works of appurtenant facility of borehole and installation of manual pump. Two units of the truck are to be procured for two civil work parties.

One truck of 12-ton capacity with auto-loader system is necessary for the bulldozer carrier.

b) Lorry

Two water lorries of 6.5 m^3 capacity are needed to supply the drilling water for three drilling rigs at least. Then, a fuel lorry is indispensable for the drilling work in consideration to the fuel consumption per day, the road condition, and the actual condition of fuel supply system.

c) Light vehicles

Light vehicles are required to transport the personnel and materials for the drilling and other works incidental to the borehole construction.

A station wagon type and a pick-up type 4WD vehicles are suitable for the transportation of personnel and for the transportation of equipment and/or materials respectively. They are to be a long-body type from a view point of transportation capacity.

Total numbers of vehicles required from each working sector and working parties are shown in the Table 5-6-1.

Table 5-6-1 Type and numbers of Vehicles required

		Truck (ton)			Lorry		Light Vehicle		
Sector	Party	4	8	12	Water	Fuel	Wagon	Pickup	Total
Supervising	2						2		2
Siting	3						3		3
Drilling	3		3		2	1	3	3	12
Borehole test	1							2	2
Civil work	2	2							2
Earth work	1			1				1	2
Total	12	2	3	1	2	1	8	6	23

(4) Earth-moving equipment

As before mentioned, the present road condition is very poor, and no existing road which can pass and bear a heavy truck is expected apart from the major road system. Even in the community along the major road, the selected borehole site is not always accessible for rig truck or other heavy equipment. Beside this, about 3000 m^2 of flat yard is necessary for the rig itself, going in and out of the vehicles, and stocking the equipment and the construction materials during the construction of borehole.

Earth-moving equipment for these earth works; arranging or repairing the access route and working yard, is inevitably needed, so a bulldozer is to be procured.

The bulldozer is to be a mass production type from a view point of spare parts supply and maintenance services, and be about 10-ton class angle-dozer from a view point of earth work efficiency and hauling capacity.

(5) Camping facility

During the Project implementation, total 98 personnel; 89 Ghanaian and 9 Japanese excepting Project Manager respectively, are to be stationed in the field.

Since no lodging facility enough capacious for these big group is anticipated in the rural area of Ghana, an own lodging facility is to be procured. Furthermore, several points of base camp are needed in the construction period because the target communities are widely scattered in each Project area.

Accordingly, a mobile camping facility consisting of trailer camp houses for engineers, tents for other staffs and labours, and appurtenant facilities and materials such as submergible pump,

engine generator, elevated water tank, temporally shower bath, toilet, etc., is to be procured including a set of wiring and piping materials.

(6) Radio telephone system

Telecommunication between the base camp and each borehole site, Regional Office, Drilling Unit and farther the Headquarter of GWSC for a regular reporting, an operational contact or an emergency is indispensable for the Project implementation. While the telephone system has not yet prevailed in the rural area, therefore, a set of radio telephone system is to be procured.

Since the telecommunication system of the GWSC between Headquarter and each Regional Office is completed fortunately, the communication between the remote Project site and Accra or Kumasi via Regional Office is possible, if the contact from the site to a certain Regional Office is held on.

Based on these considerations, two fixed stations at Regional Office and base camp, and total five mobile stations on each rigs and vehicles for the Project Manager and for the Site Manager.

Output of fixed station of about 100 W is enough to communicate with each mobile station.

(7) Geophysical prospecting equipment

Two kinds and total three set of geophysical prospecting equipment; an electromagnetic prospecting equipment effective to cover an extensive area quickly and two geoelectric prospecting equipment effective for detail exploration, are to be procured.

The geoelectric equipment is to be alternative D.C. type and capable to prospect more than 100 m of depth. The electromagnetic

(EM) equipment is to have an output of 850 W or more.

(8) Borehole test equipment

The following equipment for borehole tests; an electric logging for a screen design and a pumping test to confirm an yield, are to be procured:

a)	Auto-recording electric logger (resistivity and S.P., 100 m cable)	1 set
b)	Submersible motor pump (ϕ 50 mm pipe)	1 set
c)	Diesel generator	1 set
d)	Water-meter (needle senser)	4 sets

(9) Water analysis kit

Water analysis is to be capable for the 18 items designated by WHO, and the kit is to be a portable type for field measurement.

(10) Permanent casing pipe

The casing pipe for boreholes being used by the GWSC are of PVC-made with diameter of 140 mm or 100 mm, both 6 m long.

In the Project, the same kind of plastic pipe (PVC or FRP pipe) is to be adopted but 4 m unit length. The GWSC used to adopt 140 mm diameter's pipes to mechanized pump borehole and 100 mm dia's pipes to hand-pump installed borehole, and then, so called 100 mm (4') PVC pipes are to be procured, as a rule.

(11) Manual pump

The type of pump to be equipped to the boreholes in the Project is to be a manual pump of deep-borehole-type, from the view points

of price, operation cost, easiness of maintenance, as well as the criteria of water supply.

Types of manual pump generally used in Ghana at present (and therefore requested by the GWSC as the type of manual pump to be provided under the grant aid) are hand-pumps such as India Mark II, Moyno, etc., and the parts supply system for the pumps by import agencies has been completed.

The type of manual pump (hand- and foot-pump) is subdivided into major three types functionally; plunger type (e.g. India Mark II, Moyno), diaphragm type (e.g. Vergnet), and bellows type. Table 5-6-2 shows a comparison of these manual pump types.

Table 5-6-2 Comparison of Manual Pump Types

	Plunger	Bellows	Diaphragm
I. Specification			
1. Withdrawing	Plunger	Bellows	Diaphragm
2. Driving	rod drive	cable drive	hydraulic drive
3. Operation	hand	hand	hand or foot
4. Cylinder dia.	75 mm	89 mm	92 mm
5. Min. borehole dia.	100 mm	100 mm	100 mm
6. Withdrawal pipe	50 mm steel-pipe	32 mm steel-pipe	26 mm x 2 plastic tubes
7. Yield	15 lit/min (25 m)	18 lit/min (30 m)	20 lit/min (30 m)
II. Price			
1. Price index*	100	170	291
2. Operation cost index*	100	90	164
III. O and M			
1. Operation	fair-heavy touch	light	light
2. Maintenance		easy	easy
IV. Manufactured	India, Japan	Japan	France, Japan Ivory Coast

*: plunger type = 100

Although each type of manual pump has both merit and demerit, as shown in the table, the bellows type manual pump may be superior than the others from a total view point (light operation, easy

maintenance and low operation cost). However, if the manual pump except above mentioned GWSC's standard was adopted in the Project, the after-care system such as constant parts supply or maintenance services, etc., must be established by the first supplyer.

(12) Equipment and tools for workshop

The Government of Ghana requested the provision of equipment and tools for the workshop of Drilling Unit and the hand-pump maintenance centers which will be settled in each target district.

The required equipment and tools for the workshop of Drilling Unit is shown in the Table 5-6-3.

Equipment and tools to be procured for the workshop under the Project is to be selected as enough minimum based on the existing equipment and tools, and on the type and quantity of procured rig and supporting equipment or vehicles. The equipment and tools for the hand-pump maintenance centers are also to be selected as enough minimum, according to the type of manual pump procured.

(13) Engine welder

Engine welders, one each for rigs, are to be procured for a temporally casing work at borehole site and an installing of manual pump.

(14) Concrete mixer

Quantity of the concrete work required for the borehole facility is about 1.5 m^3 per site, and it is exceeding the capacity of manual mixing of concrete. Therefore, mobile (or portable) engine concrete mixers; one each for two civil work parties, are to be procured.

Table 5-6-3 Equipment and Tools for Workshop required by GWSC

No.	Items	Quantity
1	Tool box with complete tool sets	6 boxes
2	Socket spanners with wrench, 0"-1"	2 boxes
3	Stock and disc, 3/8"-1" BSF	2 boxes
4	Stock and disc, 1/8"-1" BSW	2 boxes
5	Stock and disc, 1/8"-1" UNF	2 boxes
6	Taps, 0"-3/4" BSF, with stock	1 box
7	Taps, 0"-3/4" BSW, with stock	1 box
8	Taps, 0"-3/4" UNF, with stock	1 box
9	Torque wrench, 0-1000 ft 16	4 nos.
10	Pipe threading machine with dice, 0"-4" dia.	1 no.
11	Bench vice, medium size	4 nos.
12	Bench vice, small size	2 nos.
13	Bench pillar drill machine with drill bits	1 no.
14	Electric chest drill with bits	2 nos.
15	Battery charger, 0-10 amps	1 no.
16	Portable battery charger, 0-5 amps	1 no.
17	Pressing machine, 0-5 ton-capacity	1 no.
18	Gas welding kit, acetylene and oxygen	4 sets
19	Tachometer, 0-3000 rpm	2 nos.
20	Ignition tining light unit	2 units
21	Cylinder compression gauge	2 sets
22	Stud extractor	8 nos.
23	Chain block, 0-5 tons	4 nos.
24	Garage jack, 0-5 tons	2 nos.
25	Hydraulic jack, 2 tons	2 nos.
26	Engine lift crane, 0-2 tons	1 no.
27	Pipe wrench, 18"	6 nos.
28	Pipe wrench, 12"	4 nos.
29	Battery cell tester	2 nos.
30	Hydrometer	6 nos.
31	Universal arometer, 0-600A 440V range	1 no.
32	Amp-Volt clip-on meter	1 no.
33	Mobile grease unit	1 no.
34	Liner tape measure, 50 m	2 nos.
35	Pocket size tape measure, 1 m	6 nos.
36	Puller, 0-4"	2 nos.
37	Puller, 0-8"	2 nos.

5-6-2. Specifications

Specifications and quantities of equipment and construction materials to be procured are described below, based on the examinations mentioned before:

(1) Drilling rig 3 sets

1) Borehole specification

Drilling diameter: 270 mm - 152 mm

Drilling depth : ave. 50 m, max. 150 m

Casing diameter : 100 mm (4')

2) Drilling type

Both mud-circulate rotary drill and air-hammer drill

3) Rig

Truck-mounted type

Truck : Water-cooled diesel engine, left handle

Drilling capacity: 3-1/2' drill pipe x 150 m

Mud-pump : 500 lit/min

4) Standard accessory and consumables

Drill pipes, shock absorbers, bits, drill color, stabilizer, handling tools, water swivel, manifolds, wire ropes, fishing tools,
down-the-hole-hammer and bit: 6' - 8'
tools, work casings, portable water tanks, and others

(2) High pressure air-compressor 3 sets

Trailer-mounted

Capacity : 17 kg/cm^2 x 21 m^3/min or more

Accessory : line-oiler, injector, high pressure delivery hose, etc.

(3) Cargo-truck with crane 3 sets

1) Truck

Engine : Water-cooled diesel engine

Type : Left handle

Loadage : 8 ton

2) Crane

Loading : 3 ton

(4) Cargo-truck with crane — 2 sets

1) Truck

Engine : Water-cooled diesel engine

Type : Left handle

Loadage : 4 ton

2) Crane

Loading : 2 ton

(5) Cargo-truck with auto-loader — 1 set

Engine : Water-cooled diesel engine

Type : Left handle

Loadage : 12 ton

(6) Fuel-lorry — 1 set

1) Tank capacity : 6.5 m^3

2) Truck

Engine : Water-cooled diesel engine

Type : Left handle

(7) Water-lorry — 2 sets

1) Tank capacity : 6.5 m^3

2) Truck

Engine : Water-cooled diesel engine

Type : Left handle

(8) Light vehicles — 8 sets

Engine : Water-cooled diesel engine

Type : Station wagon type, 4 x 4, left handle, long body

(9) Light vehicles — 6 sets

Engine	:	Water-cooled diesel engine
Type	:	Pickup type, 4 x 4, left handle, long body

(10) Bulldozer — 1 set

Engine	:	Water cooled diesel engine
Dozer type	:	Angle
Plate width	:	500 mm ±
Tonage	:	9 - 11 ton

(11) Camping facility — 1 set

1)	Trailer camp unit (with air conditioning)	(4 sets)
	- Office/sleeping (2 beds) 1	
	- kitchen unit (for 10 men) 1	
	- Sleeping unit (4 beds) 2	
2)	Tent (for 6 men)	(12 sets)
3)	Camping bed	(72 sets)
4)	Camping table set	(60 sets)
5)	Temporary shower bath, toilet unit	(19 sets)
6)	Submergible pump (50 mm)	(1 set)
7)	Elevated tank (2 m^3, 3 m)	(1 set)
8)	Engine generator (20 KVA)	(1 set)
9)	Wiring/piping materials	(1 L.S)
10)	Others	(1 L.S)

(12) Radio telephone system — 1 set

1)	Output	:	100 W or more
2)	Stations	:	Fixed 2, mobile 5

(13) Geophysical prospecting equipment — 3 sets

1) Geoelectric prospecting equipment (2 sets)

Alternative D.C. type

Prospecting depth 100 m

Standard accessory

2) Electromagnetic prospecting equipment (1 set)

Output 800 W or more

Standard accessory

(14) Electric logger 1 set

Measurement: Resistivity and S.P

Record : Auto-recording

Cable : 100 m with cable-dram

Standard accessory

(15) Pumping test equipment 1 set

1) Submergible pump (500 lit/min, 80 m H, 50 mm pipe)
2) Diesel engene generator (50 Hz, 220 V, 20 KVA)
3) Water-meter (100 m cable, 4 sets)
4) Standard accessory

(16) Water analysis kit (for 150 samples) 1 set

1) Type : Portable type for field measurement
2) Items of analysis

Turbidity, colour, odour, taste, consumption of $KMnO_4$, pH, niterate, ammonium N, nitrite N, Cl, Cr, total Fe, Cu, Zn, total hardness, chloride, bacterias, colon bacillus.

(17) Permanent casing pipe 1 L.S

1) Material : Polyvinyl Chloride
2) Diameter : Outer 114 mm, inner 100 mm

3) Connection : Socket and paste

4) Unit length : 4 m

5) Screen : Slit type, perforation 5%

6) Quantity

Blank pipe: 4,480 m (1,120 pcs)

Screen pipe: 2,120 m (530 pcs)

Socket : 1,700 pcs

Paste : 140 cans

(18) Manual pump 140 sets

1) Type : Manual type

2) Yield : 15 lit/min, 40 m Head

3) Diameter of borehole casing: 100 mm

4) Accessory : Pump head, withdrawal pipe, etc.

(19) Equipment and tools 1 L.S

A. For workshop of Drilling Unit

1. Tool box with complete tool set	1 box
2. Socket spanner with wrench	1 box
3. Screw plate set	1 set
4. Torque wrench	1 no
5. Bench vice	1 no
6. Electric bench drilling machine	1 no
7. Electric hand drilling machine	1 no
8. Battery charger	1 no
9. Pressing machine, 5 tons	1 no
10. Gas cutting set	1 set
11. Ignition timing light	1 no
12. Stud extractor	1 set
13. Chain block, 5 tons	1 no
14. Garage jack, 5 tons	1 no
15. Hydraulic jack, 2 tons	1 no
16. Battery hydrometer set	1 set
17. Circuit tester	1 no
18. Grease gun	1 no

B. For hand pump maintenance center 1 L.S

1. Vice	1 no

2.	Wrench set (Hexagonal)	1 set
3.	Driver set	2 sets
4.	Pipe wrench	1 pair
5.	Spanner set	1 set
6.	Hammer	1 set
7.	Chisel	1 set
8.	Wood hammer	3 nos
9.	Portable pipe thresding machine	1 set
10.	Pipe cutter	1 set
11.	Monkey wrench	1 set
12.	Calipers	1 no
13.	Steel scale	1 no
14.	Tape measure	2 nos
15.	Portable electric drill	1 set
16.	Saw	2 sets
17.	Pliers	1 no
18.	Wire brush	10 nos
19.	Brush	10 nos
20.	Sling wire	2 nos
21.	File	1 set
22.	Oiler	3 nos
23.	Sand paper	1 set
24.	Handing grinder	1 set
25.	Bar	2 nos
26.	Bolt clipper	1 no
27.	Water pump pliers	2 nos
28.	Tool box	2 nos

(20) Engine welder 3 sets

Diesel engine

D.C. max. 250 A

A.C max. 10 KVA, 200 V/50 Hz

with Welding bars (4 mm) 10 kg, tools and accessory

(21) Concrete mixer 2 sets

Portable

Capacity : 0.25 m^3 $\pm$

Diesel engine

Tools and accessory

CHAPTER 6 PROJECT IMPLEMENTATION PROGRAMME

6-1. Implementation System

(1) Executive agency

The executive body for the Project is to be the GWSC, and the construction work shall be undertaken by the GWSC force account basis.

The GWSC shall construct the borehole facilities by/with the personnel mobilized under their own responsibility, equipment and materials both procured by their own expenses and provided under the grant aid assistance of Japan. Further the GWSC shall establish hand-pump maintenance centers, strengthen the repairing function of the Drilling Unit, and operate and maintain the borehole facilities completed and equipment appropriately.

Besides those, the GWSC shall make a necessary measures for the grant aid programme of Japan such as Exchange of Notes (E/N), Bank Arrangement, tax exemption, etc. in cooperation with the Government agencies concerned.

(2) Consultant services

The Consultant will make a contract with the GWSC for following consultant services immediately after the Exchange of Notes for the grant aid assistance to the Project.

a) Preparation of detail design and tender documents for the procurement of equipment and materials and for the construction work to be cooperated by the Japanese Government,
b) Tendering and evaluation of the tender offer,

c) Witnessing and advising on the negotiation between the Government of Ghana and the successful bidders,

d) Procurement and transport the equipment and materials and supervision of dispatched Japanese engineers,

e) Transfer of technology including siting technique, and

f) Others.

(3) Suppliers

The contracted supplyer shall procure the equipment and materials specified in the contract, transport them to the site designated by the GWSC, dispatch the engineers to Ghana for the contracted period, and procure the local materials required to construct the said 120 borehole facilities.

6-2. Apportionment of the Governments of Ghana and Japan

(1) Undertaking of the Government of Japan

a) Procurement, transport and hand-over of the major equipment and materials described in the procurement plan (Chapter 5, Para 5-5).

b) i. Dispatch of the construction engineers and transfer of technology to the Ghanaian staff, and

ii. Procurement of the local materials,

in connection with cooperation for the construction of 120 borehole facilities.

c) Design and supervising services covering the items mentioned above including a dispatchment of concerned engineers.

(2) Undertakings of the Government of Ghana

a) To complete the Project thoroughly.

b) To provide necessary number of Ghanaian personnel for the Project implementation and to bear all the expenses.

c) To bear all expenses necessary for the Project other than those to be borne by the Japanese grant.

d) To acquire land space and the right-of-way for the Project works.

e) To ensure the tax exemption and customs clearance at a port in Ghana to import equipment and materials supplied under the Japanese grant for the Project.

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

g) To do everything possible to secure safety of Japanese personnel related to the Project during their stay in Ghana.

h) To accord Japanese personnel related to the Project such facilities as may be necessary for their entry and/or re-entry into Ghana and stay therein for the Project.

i) To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement;

   (1) advising commission of the Authorization-to-Pay,

   (2) payment commission.

j) To maintain and use properly and effectively the equipment and borehole facilities provided under the Japanese grant and to arrange and secure necessary budgets and personnel for the maintenance and operation, after the takeover of those equipment and facilities.

6-3 Implementation Schedule

The Project will actually start when the Exchange of Notes is mutually confirmed by the Governments of Japan and Ghana. Then the GWSC should make immediately contract with Japanese consulting firm

for services of designing and supervising of the Project. After the contract is signed, the Consultant should prepare the detailed design and the tender documents for Japanese suppliers regarding to procurement and transport of the equipment and materials, and for dispatch of the Japanese engineers. The Consultant, based on the approval by both Governments, shall make a tendering in Japan or in Ghana, on behalf of the GWSC. After opening the tenders, the Consultant shall evaluate the biddings, recommend the successful bidder to the GWSC, and witness in the negotiation and the contract between the GWSC and the successful bidder.

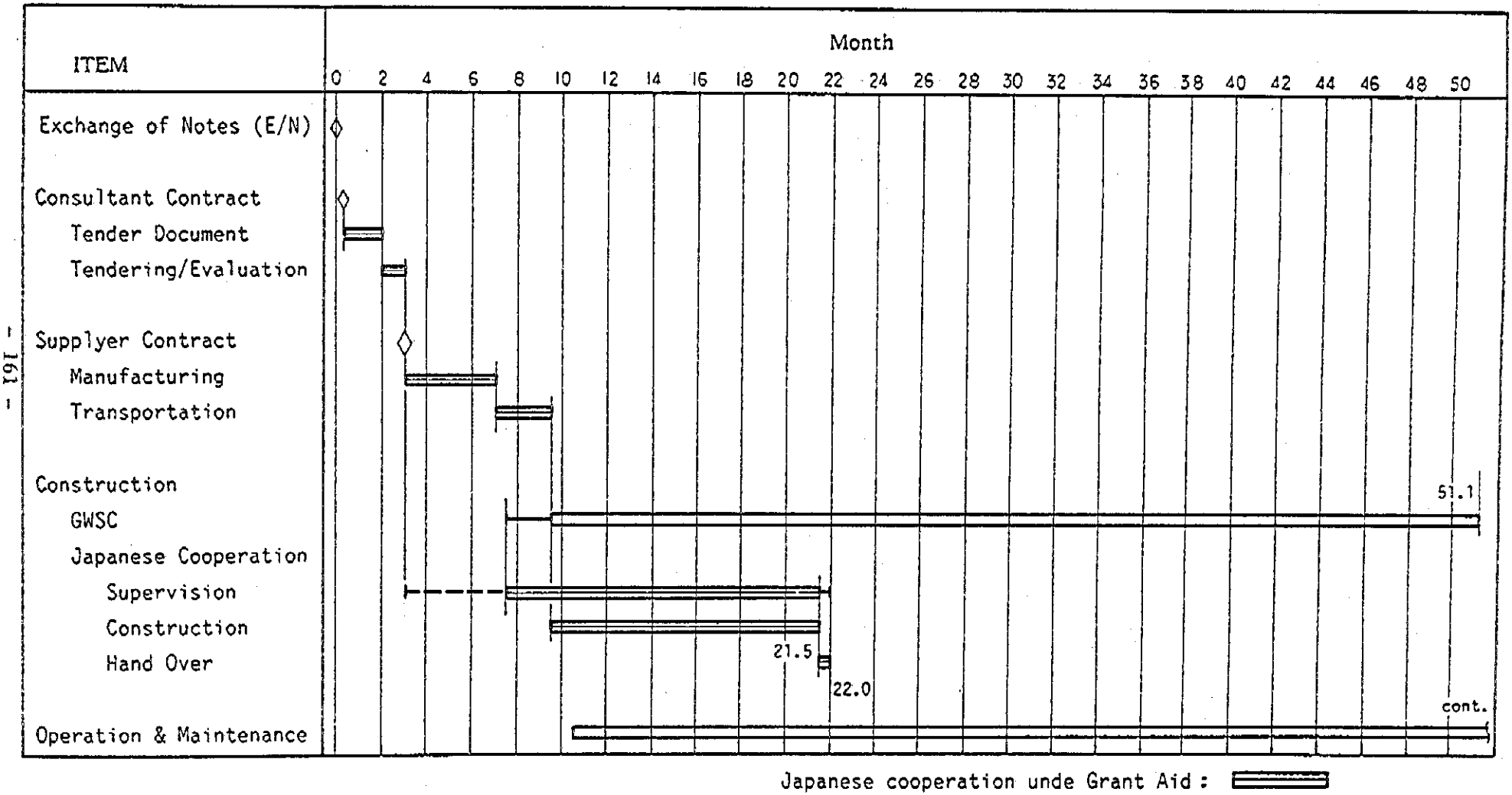
It will take about three months from the E/N to the supplyer contract, while about 4 months for procurement of equipment and materials and 2.5 months at least for ocean and inland transport will be necessary. In other words, 9.5 months after the E/N will be required to import and to transport the equipment and materials to the site designated by the Government of Ghana.

According to the work schedule, the construction works for the 466 facilities will require 41.6 months to complete, so that the implementation period of the Project will be about 51.1 months after the E/N. The Government of Japan shall cooperate to the construction of 120 borehole facilities in Nanumba District by the dispatchment of Japanese engineers for 12 months. The re-arrangement and handing-over of the equipment provided under the grant aid assistance will need a period of 0.5 month. Consequentially, it will take 22 months to implement the grant aid assistance programme of Japan in connection with the Project, after E/N and by the handing-over of the equipment.

The operation and maintenance of the borehole facilities will be continued after completion of the Project implementation.

The implementation programme of the Project mentioned above is shown in Figure 6-3-1.

Tab.6-3-1. IMPLEMENTATION SCHEDULE



6-4. Procurement of Equipment and Materials

The equipment and materials provided under the grant aid assistance of Japan shall be of made in Japan or Ghana in accordance with institutional rule of the grant aid, therefore, most of them except those can be procured in Ghana are to be procured in japan and be imported to Ghana.

Ghana can produce PVC pipe utilizing an imported raw material but the supply of raw material is unstable due to the shortage of foreign exchange, so that the PVC pipe required in the Project are also to be procured in Japan.

For the manual pumps, the GWSC desires to provide the pumps of GWSC's standard types such as India Mark II, Moyno, etc., and if these types were finally selected for the Project, the exceptional procedure for procurement of the third country's production should be taken.

The additional equipment and materials required to implement the Project after the period defined in the E/N shall be procured under the responsibility and expenses of the Government of Ghana.

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

7-1. Operation and Maintenance System

In the Project, the operation and maintenance services will be rendered to the borehole facilities, drilling rigs and the related supporting equipment/vehicles. The GWSC shall be responsible for carrying out the O & M services as it has been practising at present.

(1) O & M for borehole facilities

The O & M services for the respective borehole facilities in the Project Area shall be under the responsibility of each Regional Offices of the GWSC and the hand-pump maintenance centers shall be established at each Project District. The hand-pump maintenance centers shall be responsible for O & M services for the hand-pumps of the boreholes, and the Drilling Unit of the GWSC shall carry out the repair works of serious troubles of the borehole facilities in replying to the request from the each center through Regional Offices.

The staffs of the hand-pump maintenance centers should be employed as following way, but it is desirable to assign those people who would be engaged in the construction works of the borehole facilities as the members of the civil work party.

a)	Chief of the Center (corresponding to Assistant Engineer)	1
b)	Head of maintenance crew (Foreman)	1
c)	Crew member (Labour)	3
	Total	5

The chief of the center should be responsible for general administration of the center, regular inspection patrol for the facilities especially their exposed portion, the operations of them, and the claims made by beneficiaries, etc. And when any troubles are found with facilities, the chief should dispatch the repair group to the site along with his judgement of the troubles, and furthermore, should practise the inventory of the spare parts to make successful stock control.

The maintenance crew should repair troubles and replace the parts for maintaining effective water supply according to the instructions given by the chief of the center.

The maitenance center should provide the workshop for repairing mainly the hand-pumps and warehouse to store the spare hand-pumps as well as the necessary spare parts, and also two light vehicles should be deployed with the center for regular patrol and inspection.

The center should equip with the following building, equipment and vehicles in the extent of the basic design.

a)	Building of the Center ($40m^2$) (including office; $10m^2$, workship; $15m^2$ and warehouse; $15m^2$)	1 building
b)	Vehicles (pickup type)	2 cars
c)	Stand-by hand-pumps	abt. 20 units
d)	Spare parts for pumps	Lump Sum

(2) O & M of the drilling rigs and supporting equipment

The Drilling Unit. of the GWSC is fully responsible for operation and maintenance of the drilling rigs, their supporting equipment and vehicles that will be supplied for the Project implementation by the Government of Japan.

The equipment/tools and spare parts for workshops provided by Japan in the Project shall be delivered to the workshop or warehouse of the Drilling Unit and the Drilling Unit should carry out adequate stock control and utilization of them with its responsibility.

In other respect, since the provision of the spare parts as Japanese aids in the Project will be limited in their kinds and quantity, those which will be required additionally for the successful completion of the Project and for effective operation and maintenance after completion of the Project shall be procured and supplied by the GWSC at its own expenditure.

7-2. Operation and Maintenance Cost

(1) Remuneration

(Annual cost per objective district)

	No. of persons	¢/month*	Months	Amount
Chief of Center	1	x 17,210 x	12 =	206,520.-
Head of crew	1	x 13,000 x	12 =	156,000.-
Crew member	3	x 7,200 x	12 =	259,200.-
Total	5 persons			¢621,720.-

*: shown in Tab. 8-2-1

When the whole Project with three districts is completed, the necessary direct salary will be ¢1,865,160. per annum.

(2) Construction cost (per one repair center)

	Space		¢/cm^2		
Office Building	10m^2	x	28,600	=	286,000.-
Workshop	15m^2	x	22,900	=	343,500.-
Warehouse	15m^2	x	22,900	=	343,500.-
Total					¢973,000.-

Total ¢2,919,00 will be required to construct the three hand-pump maintenance centers.

(3) Equipment and materials cost (per one repair Center)

The equipment and materials to be ready for use should be spare hand-pumps, spare parts covering about 20 units of pumps and two vehicles.

Hand-pumps	20 sets	x	¥211,000	=	¥4,220,000
				=	¢1,267,270.-
Spare Parts	10%	x	¥4,220,000	=	¥422,000.-
				=	¢126,730.-
Vehicles	2 units	x	¥3,144,000	=	¥6,288,000.-
				=	¢1,888,290.-
Total					¥10,930,000
				=	¢3,282,300.-

Note: (i) The prices quoted include the freight.

(ii) Conversion rate

¢1.0 = ¥3.33

US$1.00 = ¢60.0 US$1.00 = ¥200.00

The total amount required will be

¢3,282,300 x 3 = ¢9,846,900.-

(4) Contingency

The physical contingency should include the price escalation in the future. Since the O & M cost is required even after completion of the Project, the definite period for the O & M cannot be decided. And consequently, the O & M costs to be required up to the completion of the Project (early half of 1990) are allocated in local currency to each year, and the amounts obtained by multiplying the yearly O & M costs by average escalation rate for the latest six months are included in the contingency. (Ref. to Fig. 8-2-1)

Years	Total of L/C	Escalation Rate	Contingency Equip.
1st Yr.	-	(29.2) (%)	-
	(1,000¢)		
2nd Yr.	1,594.0	45.6	727.2
3rd Yr.	2,216.4	61.9	1,371.9
4th Yr.	2,838.1	78.3	2,222.2
			(1,000¢)
Total	6,694.2	(av.65.0)	4,321.3

(5) Maintenance Cost

The maintenance cost after the completion of the three maintenance centers is estimated with those maintaining cost of building and equipment/materials.

(a) Buildings

The maintenance costs of the buildings are estimated by five percent of the construction cost of the buildings.

¢2,929,000. x 0.05 = ¢145,950/year

(b) Vehicles

The amount by 10 percent to the total cost of the procurement of the vehicles is counted as the vehicle maintenance for regular checking, repair and other maintaining services for every year.

¢5,664,900 x 0.1 = ¢566,400/year

(c) Hand-pumps and spare parts

The maintaining costs of the hand-pumps and spare parts are estimated on the basis that the necessary equipment and materials with 20 units, equivalent for one maintenance center, should be completely supplemented every year.

Hand-pumps	20 units x ¥211,000	= ¥4,220,000.-	
		= ¢1,267,300./year	
Spare Parts	Lump Sum ¥422,000	= ¢126,700./year	
Total	¥4,642,000./year	= ¢1,394,000./year	

(Freight Charges included)

(6) Total of O & M costs

(a) O & M costs till completion of construction

Renumeration	¢3,730,200.-	
Construction costs	¢2,919,000.-	
Equip./Materials costs	¢9,946,900.-	(¥32,790,000.-)
Contingency	¢4,321,300.-	
	¢20,917,400.-	

(b) O & M Costs after completion

Remuneration		¢1,865,100.-
Mainte. Costs for Build., Equip./Materials		¢2,106,400.-
	(L/C 145.9, F/C 1,960.5)	
Contingency		¢1,574,600.-
	(Equip. to Escalation in 4th Yr.)	
Sub Total		¢5,546,100.-
		(L.C ¢3,585,600.- / F.C ¢1,960,500.-)

CHAPTER 8 COST ESTIMATION

8-1. Rough Estimation of the Project Cost

The project implementation cost is roughly estimated as follows:

1)	Remuneration	¢36,524,100.
2)	Materials	¢17,631,400.
3)	Contingency	¢28,610,900.
	Sub-total	¢82,766,400.
4)	Foreign Materials	¢76,508,700.
	Total	¢159,275,000.

The total cost corresponds to about ¢280,400. per borehole (or ¢5,600 per meter) without the contingency for price escalation. Then the cost is equivalent to about ¢344,400. per borehole including the equipment cost which shall be provided by Japanese Grant, if the expected life span of the equipment is considered.

8-2. Bases of the Cost Estimation

8-2-1. General

The construction works shall be carried out on the GWSC force account basis, and the Government of Japan shall assist the GWSC in construction works for 120 boreholes out of the total 466 boreholes in the first construction year.

The basic costs adopted for the cost estimation are released from the GWSC as shown in Tab. 8-2-1 (Remuneration and Labour cost) and Tab. 8-2-2 (Unit costs of Materials).

Tab.8-2-1. REMUNERATION AND LABOUR COST

(1985) (¢)

Profession	Unit Cost	Profession	Unit Cost
Project Manager	17,400.*	Work Manager	13,000.
Site Manager	17,300*	Driver (heavy duty)	8,900.
Hydrogeologist	17,210.*	Driver (light)	8,450.
Civil Engineer	17,210.*	Typist	8,900.
Driller Chief	17,000.*	Driller Asst.	15,450.*
Mech. Engineer	17,400.*	Accounter	13,000.
Labour (skilled)	7,200.	Labour (unskilled)	6,800.

Note: based on Drilling Unit Data,
Gross Salary including overtime, various allowance and overhead expenses.
*: 22 days/month, others 28 days/month

Tab.8-2-2. UNIT COST OF MATERIALS

(1985, June)

Item	Specification	Unit	Unit Cost
1. Construction Materials			(¢)
1-1. Cement	Portland, 50 kg/bag	bag	400.
1-2. Sand	aggregate	m^3	2,620.
1-3. Iron rod	1/2 inch	ton	120,000.
1-4. -ditto-	1/4 inch	ton	75,000.
1-5. Nail	1 - 2 inch	kg	330.
1-6. Boards	Wawa	lbs	50.
2. Borehole Materials			
2-1. Sandgravel	river sand	m^3	3,000.
2-2. Casing	4" PVC, 6m length	pieces	4,100.
2-3. Screen	-ditto-	-ditto-	7,000.
2-4. Socket	4" PVC	-ditto-	600.
2-5. Paste for socket	Tangit, 500 gr can	can	3,500.
3. Fuels			
3-1. Gasoline		liter	23.
3-2. Diesel Fuel		liter	19.
3-3. Lub. Oil		liter	88.
3-4. Grease		kg	110.
4. Others			
4-1. Hand pump	India MK II	set	US$1000.
4-2. Test pump	Submersible	set	US$3000.
4-3. Water Tanker Service		trip	500.

Based on GWSC H.Quarter and D.Unit

General provision for the cost estimation is as follows;

(1) Personnel

Total 100 personnel shall be engaged in the implementation of the Project as shown in the personnel plan. And 10 Japanese engineers shall cooperate with them during the first construction year.

(2) Construction Period

As described in the work schedule, the total construction period shall be about 42 months, however, a Project Manager and personnels in charge of siting work shall be assigned for 44 months because the siting shall start about two months ahead to the construction work.

(3) Work Volume

- Construction of Borehole 466 holes
- Drilling of Borehole 655 holes
- ditto (linear length) 32,800 meters

Details are shown in Tab. 8-2-3.

8-2-2. Calculation of consumables

(1) Basic running distances of vehicles

a) Rig-truck and Cargo-truck

Each rig-truck and cargo-truck shall move simply one drilling point to the other. Since each target community has more than three of drilling points (655 holes/174 communities) on an average, all rig and cargo trucks shall pass through the all target communities. An average

Tab. 8-2-3 BOREHOLE DRILLING WORKS

Item	Partial Charge	Borehole type	No.of borehole	Drilling Work									Casing Work		
				Ø270 m/m Rotary Drill.		Ø216 m/m Rotary Drill.		Ø216 m/m Air-hammer		Ø152 m/m Air-hammer		Total	Ø254 m/m Surface Casing	Ø191 m/m Work Casing	Total
				Ave. depth	Length	Ave. depth	Length	Ave. depth	Length	Ave. depth	Length				
Complete Borehole	Ghana	I	173	6(m)	1038(m)	–(m)	–(m)	44(m)	7612(m)	–(m)	–(m)	8650(m)	1038(m)	–(m)	1038(m)
		II	173	6	1038	20	3460	–	–	24	4152	8650	1038	4498	5536
		total	346		2076		3460		7612		4152	17300	2076	4498	6574
	Japan	I	60	6	360	–	–	44	2640	–	–	3000	360	–	360
		II	60	6	360	20	1200	–	–	24	1440	3000	360	1560	1920
		total	120		720		1200		2640		1440	6000	720	1560	2280
	total		466		2796		4660		10252		5592	23300	2796	6058	8854
Dry Borehole	Ghana	I	62	6	372	–	–	44	2728	–	–	3100	372	–	372
		II	62	6	372	20	1240	–	–	24	1488	3100	372	1612	1984
		total	124		744		1240		2728		1488	6200	744	1612	2356
	Japan	I	33	6	198	–	–	44	1452	–	–	1650	198	–	198
		II	32	6	192	20	640	–	–	24	768	1600	192	832	1024
		total	65		390		640		1452		768	3250	390	832	1222
	total		189		1134		1880		4180		2256	9450	1134	2444	3578
Grand Total			655		3930		6,540		14,432		7,848	32,750	3,930	8,502	12,432
Ghana-side total			470		2820		4700		10340		5640	23500	2820	6110	8930
Japanese Cooperation			185		1110		1840		4092		2208	9250	1110	2392	3502

distance between the communities and total distance passing through all communities are as follows;

- Nanumba District	av. 7.57 total 410 km
- Berekum-Jaman District	av. 6.66 total 370 km
- Sefwi-Wiawso District	av. 7.71 total 500 km
General average/distance	av. 7.31 Total 1,280 km

In addition to the community to community distance, about 2.0 km of short moving or access within each community shall be needed for the trucks, and it sums to about 350 km totally (174 communities x 2.0 km).

Besides, the trucks must run through about 1,500 km to make a round trip between Kumasi and the Project sites.

Thus the rig-trucks and cargo-trucks will run through the total distance of 3,130 km (1280+350+1500 km), and the averag basic running distance of these trucks for a borehole can be calculated as follows:

$$(3130^{km} \times 3\ ^{trucks})/655\ ^{holes} = \text{approx. } 14.3 \text{ km}$$

Practically, the basic running distance of these trucks is estimated at 21.0 km/drilling hole with 50% of allowance, taking the unfavorable road condition into consideration.

b) Tank-truck

Tank-trucks of two water-trucks and a fuel truck shall run through another distance equivalent to the total communities distance additionally to the rig-truck's running distance mentioned above, for water or fuel supply.

The basic running distance of the tank-trucks can be, calculated as follows;

- total communities distance ($1280^{km} \times 3^{cars} \times 2)/655^{holes}$	$=12^{km}$
- rig-truck's running distance (mentioned above)	21^{km}
Total	33 km

c) Other supporting vehicles

The supporting vehicles such as pick-up trucks and wagons etc. will go between the base camp and the drilling sites every day. The averaged distance between the base camp and the drilling site is estimated as follows, when the base camp is settled in each district cital;

- Nanumba District	20 km
- Berekum-Jaman District	35 km
- Sefwi-Wiawso District	35 km
Average	30 km (for one way)

Since the drilling period for one borehole (average through completed boreholes and dry hoes) is 3.71 days, the running distance of these vehicles per one borehole is;

$60^{km} \times 3.71^{days}$ = approx. 223 km, on an average.

Then, these vehicles also will travel round about 1,500 km (Kumasi-Project sites-Kumasi), and the distance can be allocated to each vehicle as about 7.0 km per drilled hole.

As a result, the basic running distance of the supporting vehicles will be at 230 km per drilling a hole (223 + 7 km).

(2) Running time of equipment

a) Bulldozer

The running time of the bulldozer (GVW 10 ton class) is about 12 hr, as mentioned in the work schedule.

b) Air compressor

The air compressor shall run for air hammer drilling, and about two hours for washing out and developing of the borehole.

- air hammer drilling $(5.5+2.4^{hrs})/2$	3.95^{hrs}
- washing and developing	2.0^{hrs}
Total	approx. 6 hours

c) Other equipment

- Generator (for pumping test)	approx. 5.0 hours
- Welder (for casing work)	" 1.5 "
- Concrete Mixer (a half of concrete work)	" 4.0 "

(3) Volumes of consumables for one borehole

a) Fuel (Diesel)

- Rig	1	set x 12 hrs x 21 a/h	= 252 lit.
- Compressor	1	" x 6 " x 60 "	= 360 "
- Rig-truck	1	" x 21 km ÷ 3.5 km/l	= 6 "
- Cargo-truck	1.33	" x 21 " ÷ 4.0 "	= 7 "
- Tank-truck	1	" x 33 " ÷ 4.0 "	= 8.3"
- Bulldozer	1	" x 12 hrs x 15 l/h	= 180 "
- Right vehicles	5	" x 230 km ÷ 5 km/l	= 230 "
- Generator	1	" x 5 hrs x 4 l/h	= 20 "
- Welder	1	" x 1.5 " x 3 "	= 4.5 "
- Concrete Mixer	1	" x 4 " x 1.5"	= 6 "
Total			1,074 lit.

b) Lubricants

- Mechanical oil	diesel x 0.05	54 lit.
- Grease	(diesel x 0.01) x 0.8	9 kg

c) Gravel (for gravel packing)

° Type I

$$Q = \frac{\pi}{4}(0.216^2 - 0.114^2) \times 25 = 0.887 \text{ m}^3$$

° Type II

$$Q = \frac{\pi}{4}(0.152^2 - 0.114^2) \times 25 = 0.425 \text{ m}^3$$

Average required volume with 30% allowance is

$$(0.887 + 0.425) \div 2 \times 1.3 = 0.853 \text{ m}^3$$

d) Concrete materials

Volume of the concrete work for each borehole is

- platform	0.7625 m^2
- drainage	0.405 m^2
Total	1.1675 m^2

The required concrete volume will be 1.52 m^3 including 30% of allowance (1.1675 x 1.3). The materials for 1.0 m^3 of concrete (W:C:S:G = 1:1.7:4.5:5.4) are 310 kg of cement and 1835 kg of sandgravel. Then, the iron bars by 16 m in the platform and 16 m in the drainage are required for reinforce.

Thus, the volumes of materials to be required for the concrete work are calculated as below.

- Cement $310^{kg/m^3} \times 1.52^{m^3} = \underline{471\ kg}$
- Sand gravel $1835^{\ "} \times 1.52^{\ "} = \underline{2790\ kg}$
- Iron bar $(16 + 16^{m}) \times 0.5^{kg/m} = \underline{16\ kg}$

e) Grout sealing materials

The uppermost space between casing and ground of the borehole shall be sealed by cement mortar of C:S:W = 1:3:0.75 conpornent for 6 m span on an average.

The calculated sealing volume is 0.282 m^3, and required volume of grout mortar including 30% of allowance is about 0.367 m^3 (0.282 x 1.3 = 0.367). The materials for 1.0 m^3 of mortar are 455 kg of cement and 1364 kg of sand, so that the required volume of each material is;

- Cement $455^{kg/m^3} \times 0.367^{m^3} = \underline{167\ kg}$
- Sand $1364^{\ "} \times 0.367^{\ "} = \underline{500\ kg}$

f) Oxygen and Acetylene

Both of these welding materials will be consumed by approximate 30% of cylinder (7 m^3 cylinder for oxygen and 7 kg cylinder for acetylene) for casing work of one borehole.

8-2-3. Estimation of construction cost

(1) Remuneration

The remuneration and labour cost are calculated below. As shown in the calculation talbe, the remuneration of the Project Manager and Stock Managers are not summed up because they will serve concurrently with their own job, as Chief Engineer and workshop engineers of the Drilling Unit, GWSC.

Profession	personnel	term*	unit-cost	amount
Project Manager	(1)	(44)	-	-
Site Manager	1	42	17,300.	726,600.
Hydrogeologist (siting)	3	44	17,210.	2,271,720.
Asst, - do -	3	44	15,450	2,039,400.
Hydrogeologist (test)	1	42	17,210.	722,820.
Asst. - do -	1	42	15,450.	648,900.
Mech. Engineer	1	42	17,400.	730,800.
Asst. - do -	2	42	15,450.	1,297,800.
Civil Engineer	3	42	17,210	2,168,460.
Driller Chief	3	42	17,000.	2,142,000.
Asst. Driller	3	42	15,450.	1,946,700.
Stock Manager	(2)	(42)	-	-
Accounter	1	42	15,450	648,900.
sub-total	22	-	-	15,344,100.
Foreman	3	42	13,000.	1,638,000.
Heavy Eq. Driver	8	42	8,900.	2,990,400.
Driver	2	42	8,450.	709,800.
Typist/secretary	1	42	8,900.	373,800.
Cook	2	42	7,200.	604,800.
Guard/watcher	8	42	7,200.	2,419,200.
Labour (siting)	12	44	6,800.	3,590,400.
Labour (others)	31	42	6,800.	8,853,600.
sub-total	67	-	-	21,180,000.
Total	89			¢36,524,100.-

(* : month)

(2) Materials

Diesel	471 hole	x 1074 l/hole	x 19 ¢/l	= 9,611,226.
Oil	471 "	x 54 "	x 88 "	= 2,238,192.
Grease	471 "	x 9 kg/hole	x 110 ¢/kg	= 466,290.
Packing gravel	346 "	x 0.853 m^3/hole	x3000 ¢/m^3	= 885,414.
Cement	346 "	x 638 kg/hole	x 8 ¢/kg	= 1,765,984.
Sandgravel	346 "	x 2790 "	x 1 "	= 965,340.
Iron bar	346 "	x 16 "	x 120 "	664,300.
Oxygen	471 "	x 0.3 pcs/hole	x 800 ¢/pcs	= 113,040.
Acetylene	471 "	x 0.3 "	x3550 "	= 501,615.
Miscellaneous		' 42 months	x1000 ¢/month	= 410,000.
Total				¢17,631,421.-

(3) Contingency

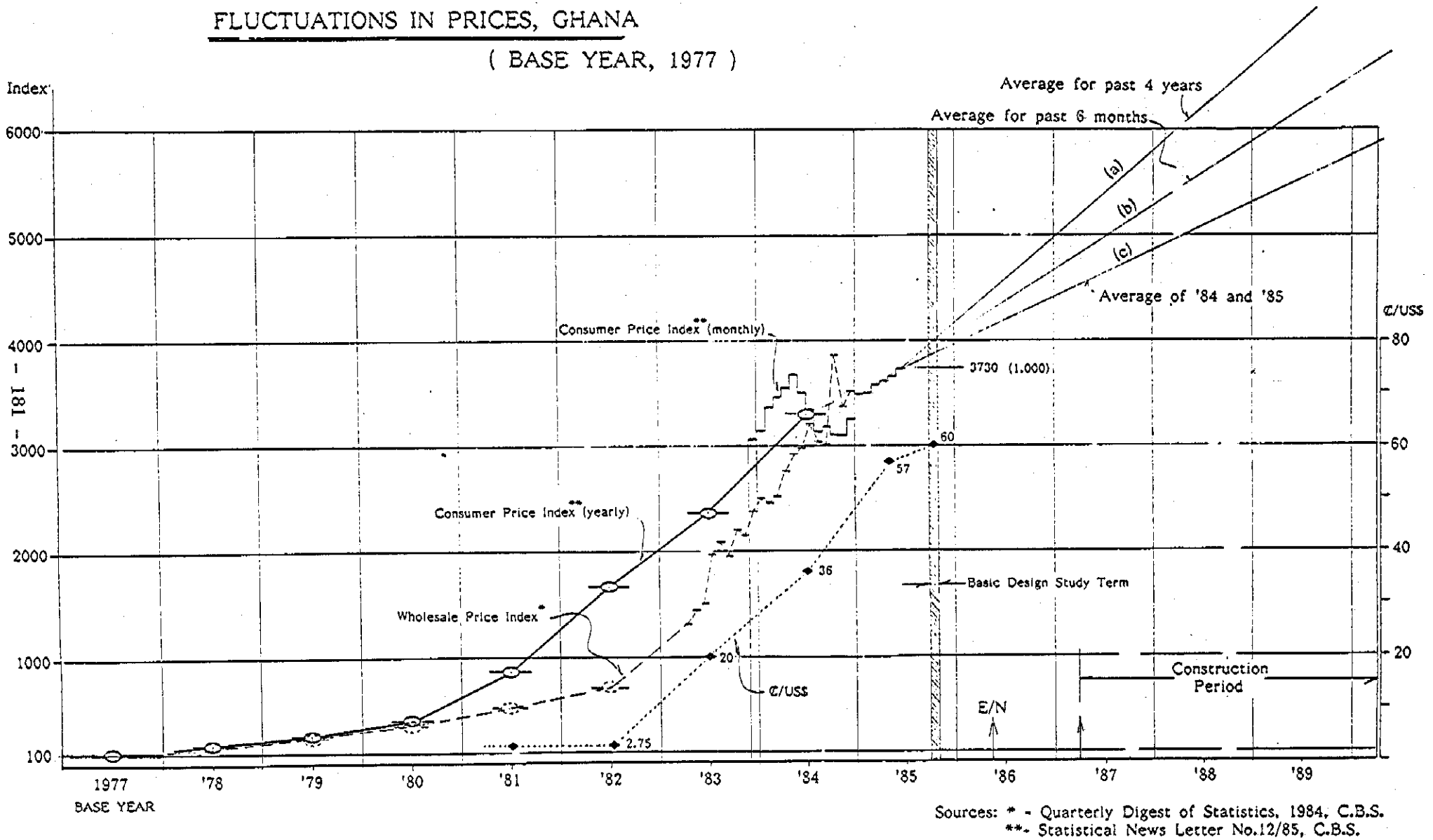
Fig. 8-2-1 shows fluctuations of price indiex in Ghana and exchange rate of Cedi (¢) to US$. As shown in the figure, the consumer price escalation which jumped up for past four years from 1981 to 1984, seems to be mitigated recently (after the middle of 1984). Forecsting the future, roughly three tendencies for price escalation; a) returns to heavy escalation rate as past four years, b) goes along the moderate escalation rate as for last six months, and c) genly escalates along the average escalation rate for last two years, are predictable.

Although it is very difficult, the contingency is estimated as an allowance for the price escalation during the construction period based on the estimated cost in this basic design. In the Report, the price escalation is pressuposed to be along the average escalation rate for the last six months; case b) mentioned above and shown in Fig. 8-2-1.

FIG .8-2-1

FLUCTUATIONS IN PRICES, GHANA

(BASE YEAR, 1977)



Sources: * - Quarterly Digest of Statistics, 1984, C.B.S.
**- Statistical News Letter No.12/85, C.B.S.

Thus, the price escalation rate and the amount of contingency are estimated as follows;

Year	Base*	Rate	Contingency
The 1st	10,844,900	29.2 %	3,166,700.
The 2nd	17,161,200	45.6	7,825,500.
The 3rd	17,415,900	61.9	10,780,400.
The 4th	8,733,400	78.3	6,838,300.
Total	54,155,400	-	¢28,160,900.

* : Remuneration + Materials cost

(4) Foreign Materials

Foreign materials, both of consumables enough for the construction of 120 boreholes and spareparts for two years, are provided by Japan, and the materials and spareparts listed below are to be procured by Ghanaian responsibility and expenses so as to be smooth and not to interrupt the progress of the construction work.

a) Materials and equipment

Work casing & tools	3 sets	x 5,000,000	= 15,000,000.
PVC Casing pipes	3,250 pps	x 5,870	= 19,077,500.
PVC Screen pipes	1,530 pcs	x 15,420	= 23,592,600.
Centralizers	1,530 pcs	x 9,600	= 14,688,000.
Paste for socket	L.S		4,563,000.
Hand-pump	400 sets	x 195,000	= 78,000,000.
Sub-total			¥154,921,100.

Spare parts for Rigs	(for two years)	22,620,000.
" for Compressor	"	5,310,000.
" for Cargo-trucks	"	7,086,000.
" for Tank-trucks	"	2,552,000.
" for Other vehicles	"	4,871,000.
" for Camping facilities	"	2,280,000.
" for Generator & Pump	"	305,000.
" for Radio System	"	684,000.
" for Bulldozer	"	900,000.
" for Hand Pumps	"	3,908,500.
" for Concrete Mixer	"	396,000.
" for Welder	"	135,000.
Sub-total		¥51,057,500.
Total		¥205,978,600.

b) Freight

Packing	611.1 FT	x 3,820	= 2,945,500.
Transportation	611.1 FT	x 283$ x 200	= 34,588,200.
Insurance		L.S	3,600,000.
Managing expense		L.S	6,179,900.
Total			¥48,795,600.
Grand total of Foreign materials (a) + b))			¥254,774,200.
			= ¢76,508,700.*

* : 1.0 US$ = 60 ¢, 1.0 US$ = ¥200,0 then
1.0 ¢ = ¥3.33

8-3. Financial Schedule

The financial schedule of the total Project implementation cost including the operation and maintenance cost is prepared as shwn in Table 8-3-1 covering the local and foreign currencies portions.

Difference in numbers of annually completed boreholes except for the last year, result from the difference in borehole successful rate between Nanumba and other two Districts.

The operation and maintenance cost is estimated and allocated on the supposition that the maintenance centers will be installed one by one in each district for three years from the second construction year.

Table 8-3-1 FINANCIAL SCHEDULE

(unit 1000 ¢)

Year / Item	The 1st Year		The 2nd Year		The 3rd Year		The 4th Year		Total		After the 4th year	
	L.C *	F.C *	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C
CONSTRUCTION												
1. Remuneration	10,692.0	-	10,332.8		10,332.8		5,166.4		36,524.1	-	-	
2. Materials	152.9		6,828.4		7,038.1		3,567.0		17,631.4	-	-	
3. Foreign Materials		0		30,293.9		30,736.2		15,478.6		76.508.7	-	-
4. Contingency	3,166.7		7,825.5		10,780.4		6,838.3		28,610.9		-	-
sub-total	14,011.6	0	24,986.7	30,293.9	28,196.3	30.736.2	15,571.7	15,978.6	82,766.4	76,508.7	-	-
O AND M												
1. Remuneration	-	-	721.7		1,243.4		1,865.1		3,730.2	1,865.1		
2. Construction	-	-	973.0		973.0		973.0		2,919.0		145.9	
3. Vehicles	-	-		1,888.3	1,888.3		1,888.3		5,664.9		566.5	
4. Materials	-	-	1,394.0		1,394.0		1,394.0		4,182.0		1,394.0	
5. Contingency	-	-	727.2		1,371.9		2,222.2		4,321.3		1.574.6	
sub-total	0	0	2,321.9	3,282.3	3,588.3	3,282.3	5,060.3	3,282.3	10.970.5	9,846.9	3,585.6	1,960.5
TOTAL	14,011.6	0	27,308.6	33.576.2	31.684.6	34,018.5	20,632.0	18,860.9	93,736.8	86,355.6	3,585.6	1,960.5
No. of borehole												
by Ghana		3		134		139		70		346		
by Japan		120		-		-		-		120		

* L.C: Local Currency, F.C: Foreign Currency

CHAPTER 9 JUSTIFICATION

The Project will be implemented linking up with two major national programmes of Ghana; the Five Year Rehabilitation and Development Programme (1985 - 89) and the NORRIP, aiming to ensure the healthy drinking water supply for the rural people who are directly engaged in agricultural production which is the primary occupation and the fundamental industry of Ghana. The objective population of the Project is about 205, 000 in the 174 local communities.

The direct benefits to be generated from the Project are as follows:

(1) The stable and healthy drinking water can mitigate such a high occurrence rate of water-borne disease as 44/1000 person, especially the infant mortality rate by disease at digestive system, as well as alleviation of the heavy burden of medical expenditure of the rural people.

(2) The effective allocation of borehole facility can remarkably alleviate the home labour wasted in water fetching work.

(3) The stable and healthy drinking water supply can stabilize and level up the living standard of the rural inhabitants.

And in addition, the following ripple effects can be expected.

(4) The surplus labour forces created from (1) and (2) as above can be re-allocated to the productive activities like agriculture and it can contribute to the development of the local economy or the national economy finally.

(5) The communication of inhabitants and the solidarity of

community can be strengthen through and centering the borehole facility.

Furthermore, the durable equipment such as drilling rigs, supporting equipment and vehicles to be supplied under the Japanese grant aid assistance, can contribute to the construction of more than 2000 borehole facilities even after completion of the Project, if they are effectively operated and maintained by Ghanaian staffs. These construction work, as well as the latest technology to be transferred to the Ghanaian staffs through the Project, will be quite helpful and effective for early realization of improvement the rural water supply condition.

The Project is deemed quits feasible as the grant aid assistance programme of Japan in due consideration of the above human and socio-economic benefits and effects as well as the Project implementation will strengthen the relationship between two countries.

CHAPTER 10 CONCLUSION AND RECOMMENDATIONS

10-1. Conclusion

The consultative meetings between the Government of Ghana and the Study Team have come to the conclusion as follows.

(1) The Project should exclude the completion of the on-going three projects and the rehabilitation of the time-worn facilities of the 37 water supply systems which had been originally proposed by the Ghanaian Government, in taking into consideration the fact that these proposed projects would not successfully function even if the equipment and materials required are supplied, and further detailed studies and project formulation are necessary to make another request to the Japanese Government for meeting the grant aid conditions.

(2) The Project aims to construct 440 borehole facilities with hand-pumps in the three proposed areas so as to supply the hygenical and healthy drinking water with the rural inhabitants, and procure/supply the necessary equipment and materials for successful implementation of the Project.

The Project areas are as follows.

° Nanumba District, Northen Region
° Berekum/Jaman District, Brong Ahafo Region
° Sefwi-Wiawso District, Western Region

(3) The requests to the Government of Japan by Ghanaian party for realization of the Project are as follows:

° Provision of the necessary equipment and materials
° Construction of 120 boreholes facilities with hand-pumps

(4) When implementing the Project, the Ghanian Government should take the following measures;

- ° To exempt the import taxes of the equipment and materials supplied from Japan
- ° To ensure the security of the Japanese staffs in the country and to exempt any taxes and duties from them.
- ° To ensure mobilization of the Ghanian staffs and bear the necessary costs for their employment.
- ° To bear any other costs required for the Project implementation than the grant aid assistance by Japanese Government.
- ° And others

As a result of the study and examination on the request and the plan as home office works, the Study Team has made a basid design of the Project. The major scheme of the Project is as follows.

(1) The total 446 borehole facilities shall be constructed in 174 communities in three Districts for about 205,000 inhabitants predicted at 1989.

(2) The designed boreholes should have the casing diameter of 100mm, 50m depth on an average and manual pump equipped.

(3) The Japanese Government shall provide the necessary equipment for the construction of the said borehole facilities as well as cooperate with the GWSC in installation of 120 boreholes with manual pumps in Nanumba District. The total 10 Japanese staffs consisting of three supervising engineers and seven construction engineers should be assigned to the Project for successful implementation, and these Japanese staffs should transfer the knowledge and technology to the Ghanaian staffs through 12 months of the cooperation period.

(4) The major items of the equipment and materials to be provided

by Japanese grant aid are as follows:

° Truck-mounted rotary drilling rigs	3 units
° High pressure Air-Compressors	3 units
° Heavy Vehicles	9 units
° Light Vehicles	14 units
° Bulldozer	1 unit
° Camping Facility	1 set
° Radio Communication System	1 set
° Geophysical Prospecting Equipment	1 unit
° Borehole Test Equipment	1 unit
° Casing Pipes	6,600 m
° Manual Pumps	140 units
° Workshop Equipment/tools	Lump Sum
° Others	Lump Sum

Throughout the Project implementation, the Ghanaian authorities concerned should make measures required by the Japanese grant-aid system, ensure to recruit staffs and workers as many as about 100 (excepting Japanese staffs), take responsibility to carry out the construction works from the second implementation year, procure and supply the materials for the works after the second implementation year, and practise effectively the O & M of the total Project facilities after completion of the construction works.

The Project costs to be borne by the Government of Ghana are 159 million Cedis including 77 million Cedis as foreign currency component.

In addition, the Ghanaian authorities concerned should bear the O & M cost for the borehole facilities during the construction period by 21 million Cedis (including 10 million Cedis as foreign currency at 33 million yen equivalent), and thereafter 6 million Cedis (two million Cedis as foreign currency at seven million yen equivalent) every year.

The direct benefits are expected as follows, when the Project is realized.

° The heavy burden of medical expenditure by inhabitants can be alleviated by reducing suffering ratio of water-borne diseases at 44 cases to 1,000 inhabitants and furthermore, the infants mortality ratio can be decreased as well.
° The heavy burden of home labour by water fetching can be remarkably alleviated.
° The stable and healthy water supply can stabilize the rural life and level up the standard of living.

In other respect, the ripple effects can be expected as follows.

° The surplus labour forces resulting from saving water-fetching can be allocated to the other more productive labour so as to contribute to the development of the local and even the national economy.
° Communication opportunity will be increased among villagers and the solidarity in the rural community can be strengthened.

Besides the aforesaid both direct and indirect benefits to meet the human needs and socio-economic requirements, it can be considered that the friendly relationship between two countries will be strengthened and firmly established, and such being the case, the Project is sound and feasible for implementation under the Japanese grant aid assistance.

10-2. Recommendations

The Study Team recommends to the Ghanaian authorities concerned to pay due attention on the following matters for successful implementation of the Project.

(1) The materials required in/latter the second construction year such as manual pumps, casing pipes, spare parts, etc. should be procured in full responsibility of the Ghanaian authorities concerned and supply without any undue delay to the schedule with appropriate budgetary support including foreign exchange allocation. The foreign exchange to be required for such procurement is about 255 million yen for construction works and about 32 million yen for O & M services for the facilities, and it is urgently required to reserve the necessary amount of the foreign exchange in view of the international cooperation as well. It is desirable to make an agreement with the suppliers for supplemental supply of the materials, when the authorities concerned concludes the contract for the supply of the equipment/materials.

(2) The equipment and materials to be procured for the Project by the Government of Japan should be exclusively used throughout construction period for the earliest completion of the Project.

(3) As many staffs as possible to be assigned to the O & M services of the boreholes facilities should be engaged in the borehole construction works. And one of these civil engineers of the civil work party should be selected as the chief of Manual Pump Maintenance Center to be provided in the Project.

(4) The rural inhabitants are to be educated on the environmental preservation and public health not by GWSC but by Ministry of Health or other adequate organization at present. The GWSC, however, should take necessary and appropriate measures as early as possible for public education to the beneficiaries of the Project in close cooperation with the aforesaid authorities and agencies.

(5) The boreholes facilities are essentially the public properties in close relate with health and daily life of the rural people,

and can keep the benefit for long time by careful and effective maintenance with reasonable expenditure. For the beneficiaries to have full understanding on the matter, it is considered as the best way that the beneficiaries practise the routine maintenance works of the facilities by themselves. In such consideration, it is recommended to establish the community basis "Borehole Committee" (provisional name) which shall consist of several number of the mutually elected beneficiaries. The Committee shall function to practise routine maintenance and cleaning works of the facilities and make a quick contact with the related Maintenance Center if emergency or troubles occur with facilities.

In other respect, the Study Team will refer to the difficulties of beneficiaries served from time-worn water supply system in urban towns, reported and observed by the Team also.

Most of these people have been suffering from heavy burden of lavour to keep the drinking water which is not healthy. Such situation is deemed not merely as a matter of living standard of the water consumers but as losses in the national economy. Consequently, the rehabilitation of these facilities in troubles should be taken up as a matter of urgence.

Although the rehabilitation scheme proposed initially by the Government of Ghana has been excluded from the Project due to the reasons explained previously, it can be said that the rehabilitation of these old facilities will bring about considerably large benefit and favourable effect in terms of socio-economy and human needs, when realized in the future providing the basic project formulation.

Attached Documents

APPENDIX

1. Member List of the Survey Team
2. Itinerary of the Field Survey
3. Organizations and Related Officials Contracted by the Study Team
4. Minutes of Discussions on the Rural Water Supply Project in the Republic of Ghana
5. Collected Data and Information
6. Population in March 1970 and 1984 and Average Annual Growth Rated by Region
7. Rural and Urban Population 1984 by Region
8. The Public Finance of Ghana (1984/85)
9. Country Data of Ghana
10. Target Communities and Planed Boreholes
11. Location Map of Target Communities
12. Location Map of Existing Boreholes
13. Inventory of Existing Production Boreholes
14. Data of Three On-going Project Scheme
15. Data of Rehabilitation Scheme
16. Location Map of Scheme - I Sites

APPENDIX 1. Basic Design Study on the Rural Water Supply Project in the Republic of Ghana

Member List of the Survey Team

Position	Name	Firm
Team Leader	Yukitoshi SUZUKI	Industrial Water Supply Division, Bureau of Water Supply, Yokohama City
Project Coordination	Yoshihide TERANISHI	First Basic Design Study Division, Grant-Aid Planning and Survey Department, Japan International Cooperation Agency (JICA)
Groundwater Development/Water Supply Facilities	Mitsuru YOSHIKAWA	Sanyu Consultants Inc.
Drilling Equipment/ Hydrogeology	Ryoichi KAWASAKI	Sanyu Consultants Inc.

APPENDIX 2. Basic Design Study on the Rural Water Supply Project in the Republic of Ghana

Itinerary of the Field Survey

Date	Day	Work Schedule
Sep. 30	Mon.	Trip (Tokyo to Amsterdam)
Oct. 1	Tue.	- do - (stop over)
2	Wed.	Arrival at Accra. Meeting for schedule with Mr. Sunagawa, Officer of Japanese Embassy.
3	Thu.	Courtesy call to Japanese Embassy. Meeting with Mr. Ariga, Councilor of Japanese Embassy. Courtesy call to MFEP and MWH. Submitted Inception report and Meeting for schedule in the GWSC.
4	Fri.	Explanation of inception report at the GWSC.
5	Sat.	Conference with Drilling Unit, GWSC. Inspection of facilities.
6	Sun.	Inspection of existing facilities in Brong Ahafo regeon and field inspection in Berekum/Jaman district.
7	Mon.	Inspection of existing facilities and drilling site in Northern region. Meeting with officer in charge of NORRIP and the chief of Northern Regional Office, GWSC.
8	Tue.	Inspection of site in Nanumba district. Courtesy call to Secretary of Northern Region and chief of Nanumba tribe.
9	Wed.	Taking explanation for the project in NORRIP office. Return at Accra by air.
10	Thu.	Discussion about the scope of the Grant Aid in the GWSC.
11	Fri.	- do - . Conference about a draft of minutes of discussions.
12	Sat.	Preparation of final draft for the minutes of discussions.

13	Sun.	Team meeting.
14	Mon.	Signning of the minutes of discussions; Report on the said minutes to ambassador Arichi. Mr. Suzuki, team leader and Mr. Teranishi left for Japan by KL584.
15	Tue.	Procedure of Visa extention at the embassy of Japan. Data collection in the GWSC.
16	Wed.	Data collection in the GWSC, meteological services, Survey department, and MH.
17	Thu.	Data collection in the GWSC, Survey department, and IGIP.
18	Fri.	Data collection in OCP, Meteological services, and Noguchi memorial institute, Ghana University. Meeting for facility of workshop in the GWSC.
19	Sat.	Arrangement of data collected
20	Sun.	Meeting with the chief of Western Regeonal Office, GWSC.
21	Mon.	Inspection of existing facilities in Western Region and sites in Sefwi-Wiawso district.
22	Tue.	Inspection of existing facilities. Meeting with the Secretary of Sefwi-Wiawso District.
23	Wed.	Inspection of existing facilities in Western region and the sites in Sefwi-Wiawso District.
24	Thu.	Data collection in GWSC and CBS.
25	Fri.	Final meeting with Managing Director, Vice Managing Director of GWSC. Courtesy call to Ambassador. Leaving for Amsterdom.
26	Sat.	Arrival at Copenhagen via Amsterdam. Stop-over in Copenhagen depend on repairing the airplane.
27	Sun.	Leaving for Japan
28	Mon.	Arrival at Tokyo (Narita, 15:00)

APPENDIX 3 Organizations and Related Officials Contacted by the Study Team

Embassy of Japan in Accra

H. E. Mr. K. Arichi	Ambassador
Mr. A. Ariga	Counsellor
Mr. A. Iyama	Secretary
Mr. S. Sunagawa	Information Officer

Ministry of Finance and Economic Planning (MFEP)

Mr. Sam Daisie	Chief Economic Planning Officer
Ms. I. D. Hervie	Assistant Economic Planning Officer

Ministry of Works and Housing (MWH)

Mr. S. F. Kwaku	Technical Director (Works)

Ghana Water and Sewerage Corporation (GWSC)

Head Office (Accra)

Mr. T. B. F. Acquah	Acting Managing Director
Mr. E. F. Quashie	Deputy Managing Director (Operations')
Mr. E. K. Y. Dovlo	Acting Deputy Managing Director (Technical Services)
Mr. S. Owusu	Principal Hydrogeologist (Planning)
Mr. F. C. Lukko	Civil Engineer
Mr. E. Nkrumah	Assistant Hydrogeologist
Mr. F. K. Brew	
Mr. B. Ladgekpo	
Dr. Z. Shalew	Consultant (Tahal Consulting Engs.)

Drilling Unit (Kumasi)

Mr. N. A. Amoh	Acting Drilling Engineer
Mr. I. C. Acquah	Chief Driller
Mr. R. K. Van Ess	Hydrogeologist

Regional Office (Brong Ahafo Region, Sunyani)

Mr. K. Akator	Regional Manager
Mr. B. Frimpong	Project Engineer
Mr. E. F. K. Boateng	Mechanical Engineer

Regional Office (Northern Region, Tamale)

Mr. S. G. O. Lamptey	Regional Manager

Regional Office (Western Region, Takoradi)

Mr. Adu-Pokn	Project Engineer
Mr. A. L. Gyeduh	Surveyer
Mr. F. E. Couduah	District Manager, Sefwi-Wiawso

IGIP/GWSC Maintenance Unit (Accra)

Mr. T. K. Sarpocty	Co-manager
Mr. C. Riexinger	Supervisor, IGIP

Northern Region Rural Integrated Development Project (NORRIP)(Tamale)

Mr. R. A. I. Mahama	Programme Manager
Mr. D. Ngula	Head, Agriculture Sector
Mr. B. Anamoh	Project Analyst
Mr. A. Abubakari	Head, Water Sector
Mr. A. Nantogma	Finance Officer
Mr. H. Imoru	Public Relation Officer
Mr. S. Abdullah	Assistant Accountant
Mr. M. Issifu	Senior Animator
Mr. D. Amuah	Community Development and Adult Education

Brong Ahafo Regional Council (Sunyani)

Col. A. Antwi	Regional Secretary

Northern Regional Council (Tamale)

Mr. A. H. Yahaya	Regional Secretary
Mr. D. Zakaria	Regional Under-secretary

Nanumba District Council, Northern Region (Bimbilla)

Mr. J. I. Adam	District Secretary
Mr. A. Attah	Parmanent Chief, Nanumba (Bimbilla)

Meteorological Service Department (Accra)

Mr. A. K. E. Ussher	Acting Deputy Director

Survey Department (Accra)

Mr. I. Atzu	Acting Director (Surveys)
Mr. J. Sampah	Assistant Chief Cartographer

Ministry of Health (MH)

Environmental Health Division (Accra)

Mr. H. Noye Nortey	Principal Public Health Engineer

National Onchocerciasis Secritariat (Accra)

Mr. D. Oinsu Sarfo	Senior Economic Planning Officer

University of Ghana

Noguchi Memorial Institute for Medical Research (Accra)

Dr. E. Ido

Dr. S. Torigoe

Dr. T. Rikimaru

Western Region

Mr. S. Donkor	District Secretary, Sefwi-Wiawso

Appendix 4

MINUTES OF DISCUSSIONS
ON
THE RURAL WATER SUPPLY PROJECT
IN
THE REPUBLIC OF GHANA

In response to the request made by the Government of the Republic of Ghana for a grant aid on the rural water supply project (hereinafter referred to as "the Project"), the Government of Japan has decided to conduct a basic design study on the Project (hereinafter referred to as "the Study"). The Japan International Cooperation Agency which is an official agency implementing the international cooperation programmes of the Government of Japan (hereinafter referred to as "JICA") has sent a team led by Mr. Yukitoshi Suzuki to Ghana to carry out the Study (hereinafter referred to as "the Study Team") for 28 days from 30th September to 27th October, 1985.

The Study Team performed field inspection, held a series of discussions and exchanged views with the related officials headed by Mr. E. K. Y. Dovlo of the Ghana Water and Severage Corporation of the Government of the Republic of Ghana (hereinafter referred to as "GWSC").

Both parties have agreed upon to recommend to their respective Governments to examine the results of the discussions attached herevith towards the realization of the Project.

At Accra, 14th October, 1985

鈴木幸敏

Yukitoshi Suzuki
Leader,
The Study Team,
J I C A

T. B. F. Acquah
Acting
Managing Director,
G W S C

A T T A C H M E N T

1. The objectives of the Project are to construct some 440 boreholes equipped with manual pumps and to provide the necessary equipment for borehole drilling in the rural area in order to develop healthy potable water supply and to improve the standard of living of the rural population.

2. The Project area is to be the following three districts;

(1) Nanumba District in the Northern Region,
(2) Berekum/Jaman District in the Brong Ahafo Region,
(3) Sefwi-Wiawso District in the Western Region.

The location of the Project area is shown in Appendix I attached hereafter.

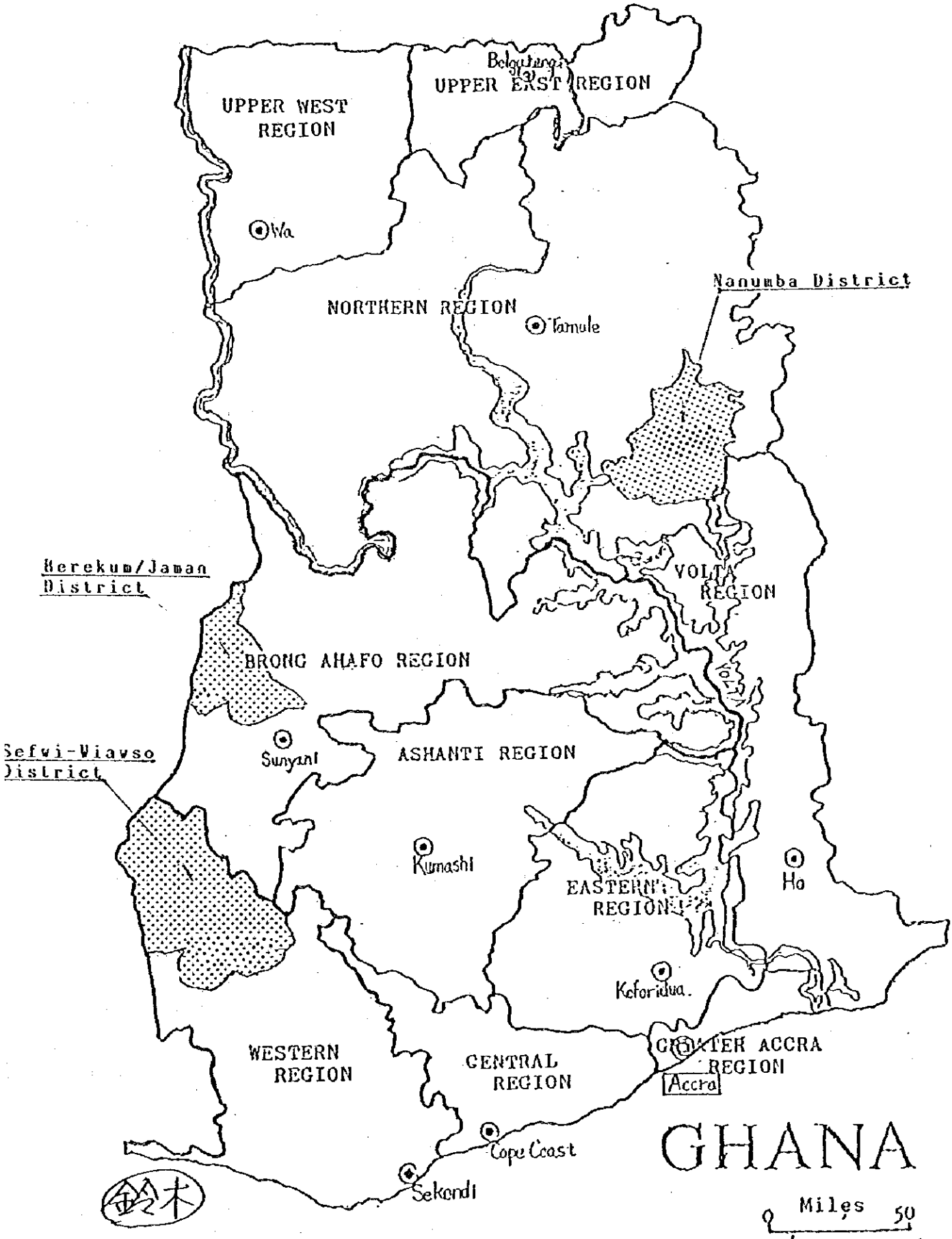
3. The executing agency responsible for the implementation of the Project is GWSC.

4. The Study Team would convey to the Government of Japan the request of the Government of the Republic of Ghana that the former takes necessary measures to cooperate in implementing the Project and bears the cost of the items requested by the latter shown in Appendix II attached hereafter within the scope of Japan's economic cooperation in grant form.

5. The Government of the Republic of Ghana would take necessary measures stipulated in Appendix III under the condition that the grant aid by the Government of Japan is extended to the Project.

6. Both parties confirmed that the Study Team has explained the framework of Japan's grant aid programme and the Ghanaian party has understood it.

APPENDIX I LOCATION MAP OF THE PROJECT AREA



A P P E N D I X II

The items requested by the Government of the Republic of Ghana are as follows:

1. Provision of equipment necessary for the implementation of the Project;

(1) three (3) units of truck-mounted drilling rig inclusive of standard accessory and tools,

(2) three (3) units of high-pressure air compressor,

(3) four (4) units of cargo truck with crane,

(4) three (3) units of water lorry,

(5) six (6) units of pick-up type light vehicle,

(6) six (6) units of station-wagon type light vehicle,

(7) one (1) lot of camping facilities,

(8) one (1) lot of geophysical instruments for borehole siting,

(9) one (1) lot of borehole test equipment,

(10) one (1) lot of water analysis kit,

(11) one (1) lot of radio telephone system,

(12) one (1) lot of equipment and tools for workshop,

(13) one (1) lot of equipment and tools for manual pump maintenance centers,

(14) one (1) unit of earth-moving equipment for the preparation of site and access,

(15) 140 units of manual pump set,

(16) one (1) lot of spare parts for the above equipment.

Note:

The Ghanaian party has expressed their strong desire that manual pumps to be provided be of GWSC's standard types.

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2. Construction of 120 boreholes and appurtenant facilities inclusive of supply of construction materials and installation of manual pump sets.

Note:

The Ghanaian party has expressed their strong desire that the technical personnel of GWSC participate in the Project works to ensure technology transfer from Japanese personnel related to the Project in the various fields of the Project implementation such as project management; borehole siting, drilling and testing; manual pump installation; and maintenance of equipment, manual pump and borehole facility.

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A P P E N D I X III

The necessary measures to be undertaken by the Government of the Republic of Ghana for the Project are as follows:

1. To ensure the tax exemption and customs clearance at a port in Ghana to import equipment and materials supplied under the Japanese grant for the Project.

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

3. To do everything possible to secure safety of Japanese personnel related to the Project during their stay in Ghana.

4. To accord Japanese personnel related to the Project such facilities as may be necessary for their entry and/or re-entry into Ghana and stay therein for the Project.

5. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement;
   (1) advising commission of the Authorization-to-Pay,
   (2) payment commission.

6. To acquire land spaces and the right-of-way for the Project works.

7. To provide necessary number of Ghanaian personnel for the Project implementation and to bear all their expenses.

8. To provide convenience to allow Japanese personnel related to the Project to use workshops, facilities and equipment of GWSC other than those supplied under the Japanese grant, when necessary for the purpose of the Project.

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9. To use the equipment supplied under the Japanese grant properly and exclusively for the Project during the Project period.

10. To maintain and use properly and effectively the equipment and borehole facilities provided under the Japanese grant and to arrange and secure necessary budgets and personnel for the maintenance and operation, after the takeover of those equipment and facilities.

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

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Appendix 5

COLLECTED DATA AND INFORMATION

A. GENERAL

(1) CBS (1984): 1984 Population Census of Ghana, Preliminary Report

(2) MFEP (1983): Economic Recovery Programme 1984-1986, Vol.I & II

(3) MFEP (1985): The PNDC Budget Statement and Economic Policy for 1985

(4) UNDP/GRG (1984): Review of the Third Country Programme for Ghana, 1983-1986

(5) GWSC (1985): Five-year Rehabilitation and Development Programme, 1985-1989

(6) GWSC (1985): Five-year Development Plan for Groundwater -based Water Supplies (1985-1989)

(7) GWSC (1985): Public Expenditure Review, Water Sector

(8) ISD (1983): Decentralization in Ghana

(9) WEDC (1985): Water and Sanitation in Africa, 11th WEDC Conference, Dar es Salaam 1985

(10) GWSC (1978): Rapid Assessment of On-going Drinking Water and Sanitation Programme, Ghana

B. WATER SUPPLY

(11) GRG (1965): GWSC Act

(12) GRG (1969): Ammendment Decree of GWSC Act

(13) GWSC (1969): Water and Severage Regulations

(14) WHO/UNDP (1978): Rural Water Supply and Environmental Health, Ghana, Vol.6, Standard Design Manual

(15) NORRIP (1983): The Northern Region, Ghana,
Vol.1 (A Descriptive Overview)
Vol.2 (Regional Development Strategy)
Vol.3 (Development Programmes and Projects)

(16) NORRIP (1984): Proposed Integrated Development Packages, IDA 2 & 3, Northern Region, Ghana

(17) GWSC (1984): 3000 Well Drilling Programme, Vol.1 (Principal Technical Report)

(18) GWSC/CIDA (1980): Upper Region Water Supply Project, Well Construction Programme, Final Report

C. METEOROLOGY AND HYDROLOGY

(19) MSD (1985): Monthly Records of Rainfalls, Air-temperatures and Humidities, (1965-1984)

(20) MSD (1974): Climatic Maps of Ghana for Agriculture

(21) MSD (1974): Mean Monthly and Annual Rainfall Maps

(22) MSD (1974): Maximum Rainfall Intensity, Duration and Frequencies in Ghana

(23) MSD (1975): Annual Summary of Climatological Observations in Ghana, 1972, 1973, 1974

(24) MSD (1973): Probability Distribution of Annual Rainfall in Ghana

D. PUBLIC HEALTH

(25) OTATUME, S. (1974): Viruses isolated from drinking water and severage in Ghana, Medicine & Biology,88

(26) OTATUME, S. (1974): Recent trend of infectious deseases in Ghana, Tropics,8

(27) MH (1985): Annual Regional Incidence of Guinea Worm in Ghana

(28) MH (1970): Water Supplies and Water-borne Deseases in Ghana, Environmental Health Series, 1970 No.1

(29) OCP (1984): Onchocerciasis Control Programme in the Volta River Basin Area

(30) OCP (1983): ONCHO

D. OTHERS

(31) CBS (1985): Consumer Price Index, Statistics News, 12/85

(32) CBS (1985): Quarterly Digest of Statistics

E. MAPS

(32) SD (1972): Catalogue of Maps

(33) SD (1983): Topographic Maps,
1:500,000 series,
1:250,000 series,
1:50,000 series.

(34) CSIR (1969): National Atlas (1:1,500,000)
Physical,
Vegetation Zones,
Agricultural Products,
Mineral Deposits,
Annual Rainfall,
Isogonic,
Great Soil Groups,
Geology,
Population (1960).

Appendix 6

POPULATION IN MARCH 1970 AND 1984 AND AVERAGE ANNUAL GROWTH RATES BY REGION

REGION	POPULATION		% Increase	GROWTH RATE #
	1970	1984		
ALL REGIONS	8,559,313	12,205,574	42.6	2.6
1. Western	770,087	1,116,930	45.0	2.7
2. Central	890,135	1,145,520	28.7	1.8
3. Greater Accra	903,447	1,420,066	57.2	3.3
4. Volta	947,258	1,201,095	26.8	1.7
5. Eastern	1,209,828	1,679,485	38.8	2.4
6. Ashanti	1,481,698	2,089,683	41.0	2.5
7. Brong Ahafo	766,509	1,179,407	53.9	3.1
8. Northern	727,618	1,162,645	59.8	3.4
9. Upper West	319,865	439,161	37.3	2.3
10. Upper East	542,858	771,584	42.1	2.5

Average compound rate of increase per year

Appendix 7

RURAL AND URBAN* POPULATION 1984 BY REGION

REGION	TOTAL	RURAL	URBAN	AS PERCENTAGE OF TOTAL POPULATION	
				RURAL	URBAN
ALL REGIONS	12,205,574	8,380,185	3,825,389	68.7	31.3
Western	1,116,930	862,275	254,655	77.2	22.8
Central	1,145,520	841,505	304,015	73.5	26.5
Greater Accra	1,420,066	234,612	1,185,454	16.5	83.5
Eastern	1,679,483	1,230,706	448,777	73.3	26.7
Volta	1,201,095	951,989	249,106	79.3	20.7
Ashanti	2,089,683	1,419,308	670,375	67.9	32.1
Brong Ahafo	1,179,407	865,842	313,565	73.4	26.6
Northern	1,162,545	876,085	286,560	75.3	24.7
Upper West	439,161	391,726	47,435	89.2	10.8
Upper East	771,584	706,137	65,447	91.5	8.5

* Towns with population 5,000 and over

Appendix 8

The Public Finance of Ghana (1984/85)

(¢M)

	1984 (Settled)	1985 (Budget)	Increment Amount	Increment Rate (%)
Income	22,641	39,900	17,259	76.2
Expenditure	27,485	48,510	21,025	76.5
Ordinary	22,700	36,535	13,835	61.0
Capital expenditure	4,785	11,975	7,190	150.3
Balance	-4,844	-8,610	-3,766	77.7
Compensation funds	4,844	8,610	3,766	77.7
Foreign	1,816	5,360	3,544	195.2
Local	3,028	3,250	222	7.3
Defict/GDP (%)	1.5	2.0		

(MFEP, 1985)

Transition of Exchange-rate of Ghanaian Cedi (¢) to US$:

1981	2.25 ¢/$
1982	2.25 ¢/$
1983	20.00 ¢/$
1984	36.00 ¢/$
1985.4	57.00 ¢/$
1985.10	60.00 ¢/$

Appendix 9

Country Data of Ghana

Land :	236,600 sq.km		
	1970	1980	1984
Population :	8.6	11.8	12.2
Increasing rate			2.6 %
Average future lifetime :	50	55	50
Infant mortality	121	101	137
	1970		1983
School attendance % :	64		70
Farming population rate (%) :	58		53

Financial Index :

	1978	1980	1982	1983	1984*
GNP (1975, ₵M)	5654	5428	4849	4884	5212
Chage rate	-	0.3	-7.7	0.7	+6.7
Income per capita (₵) :	538	489	414	407	427
Change rate	-	-2.8	-10.2	-2.7	+4.1
Minimum wages index**	26	15	13	11	12
Mining production index***	87.1	73.8	59.9	50.2	56.7
Grain production (1000 ton) :					
Maize	218	382	346	172	574
Rice	108	78	36	40	66
Cassava	1895	2322	2470	1729	3283
	77/78	79/80	81/82	82/83	83/84
Cocoa production (1000 ton) :	271	296	225	197	157

*: predict, **:1974=100, ***:1977=100

Appendix 10 TARGET COMMUNITIES AND PLANED BOREHOLES

NANUMBA DISTRICT

(1)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1983	1989*	Existing	GWSC Original	Plan
1	MAKAYILI	3,426	3,996	1	8	7
2	NAKPAYILI	3,263	3,806	0	7	8
3	LUNGNI	2,884	3,364	1	6	7
4	BINCHERATANGA	2,552	2,977	0	6	7
5	LIPUHI	2,466	2,877	0	5	7
6	GULINYAASI	1,997	2,330	0	4	6
7	DAKPAM	1,849	2,157	1	4	4
8	KPALISOGU	1,814	2,116	0	4	5
9	KUKOU	1,699	1,982	1	4	4
10	GBEENI	1,594	1,859	1	4	4
11	GUNDOO	1,447	1,688	0	3	4
12	GBUNGBALIGA	1,444	1,684	1	3	3
13	OLD LUNGNI	1,304	1,521	0	3	4
14	BAKPABA	1,237	1,443	0	3	4
15	PUSUGA	1,150	1,340	0	3	3
16	KABULIYA	1,103	1,286	0	3	3
17	BAADUR	1,012	1,179	0	3	3
18	TAALI	1,012	1,179	0	3	3
19	BURI	1,012	1,179	0	3	3
20	NAABAAYILI	882	1,028	0	2	3
21	KPABI	882	1,028	0	2	3
22	NASAMBA	874	1,019	0	2	3
23	LABINJA	870	1,014	0	2	3
24	GILSINAAYA	854	995	0	2	2
25	KPAGDURI	835	973	0	2	2
26	DUUNI	823	959	0	2	2
27	KPACHEYA	823	959	0	2	2
28	NEW TAGNAMO	820	956	0	2	2
29	TIKPILANI	815	950	0	2	2
30	TAMPOAYA	809	943	0	2	2
31	JILOO	798	930	0	2	2
32	KANJOO	786	916	0	2	2
33	JUALE	763	889	0	2	2
34	KUKOZIBAGA	712	830	0	2	2
35	MONTANA	702	818	0	2	2

NANUMBA DISTRICT

(2)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1983	1989*	Existing	GWSC Original	Plan
36	GUNGUNI	683	796	0	1	2
37	NYAMANYAMA	671	782	0	1	2
38	CHAMBA	669	780	0	1	2
39	CHIFERE	669	780	0	1	2
40	JOO	638	743	0	1	2
41	OPIJUA	621	724	0	1	2
42	KPAYANSE	621	724	0	1	2
43	KPALIGA	610	711	0	1	2
44	NANLEYILI	608	709	0	1	2
45	GAMBUGA	571	666	0	1	2
46	OLIYILI	565	658	0	1	2
47	DANAAYILI	544	634	0	1	2
48	KARAGA	530	618	0	1	2
49	TONG	524	611	0	1	2
50	MANCHONI I	519	605	0	1	2
51	DIPAL DABOYA	510	594	0	1	1
52	YAPALA	477	556	0	1	1
53	MONCHONI II	474	552	0	1	1
54	MOBA	469	547	0	1	1
TOTAL	54 COMMUNITIES	58,277	67,960	6	130	159

* ... Estimated, Based on 1983

BEREKUM/JAMAN DISTRICT

(3)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1984	1989*	Existing	GWSC Original	Plan
1	ABRIKASA	758	862	0	2	2
2	BUOBUNU	500	568	0	2	1
3	KOMFORKROON	725	824	1	1	1
4	KONSIA	1,220	1,387	0	4	3
5	DODOSUO	1,188	1,351	0	4	3
6	BAANO I	651	740	1	1	1
7	BAANO II	679	772	1	1	1
8	KWAMESEIKROM	1,478	1,680	0	4	4
9	SEBRENI	910	1,035	0	2	3
10	GUNASUA	2,201	2,502	0	5	6
11	BAABIANEHA	2,542	2,890	1	4	6
12	OROBO	1,496	1,701	1	4	3
13	KOFIKO	586	666	0	2	2
14	ASEMPANAYE	986	1,121	1	2	2
15	FAOMAN	1,189	1,352	0	4	3
16	JENJEMIREJA	954	1,085	0	4	3
17	MEREMANO	1,025	1,165	1	2	2
18	DAWIRI	790	898	0	2	2
19	BUNI	1,235	1,404	0	4	4
20	GYANKUFA	943	1,072	0	3	3
21	ASIRI	2,341	2,662	0	5	7
22	TAINANO I	507	576	0	2	1
23	TAINANO II	545	620	0	2	2
24	ZEZERA	1,993	2,266	0	5	6
25	ASUOKOR	1,892	2,151	3	2	2
26	BODAA	693	788	0	2	2
27	NSONSOMEA	570	648	0	2	2
28	SEKETIA	1,084	1,234	1	2	2
29	MAYERA	1,162	1,321	1	2	2
30	KOKOA	2,002	2,276	1	2	5
31	MORLE	852	969	1	1	1
32	KOKOSUA I	902	1,026	0	2	3
33	KOKOSUA II	495	563	0	2	1
34	BONAKYIRE	689	783	0	2	2
35	ADADIEM	920	1,046	0	2	3

BEREKUM/JAMAN DISTRICT

(4)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1984	1989*	Existing	GWSC Original	Plan
36	KABILE	1,302	1,480	0	3	4
37	BUADASO I	1,116	1,269	1	2	2
38	BUADASO II	2,184	2,483	1	4	5
39	JAMERA	1,509	1,716	0	4	4
40	ADIOKOR I	435	495	0	2	1
41	BAANO III	365	415	1	2	0
42	ABUOKRON	448	509	0	2	1
43	ASUOGYA	466	530	0	2	1
44	ASANTEKROM	476	541	0	2	1
45	ASORE	444	505	0	2	1
46	NKYENKYEMAM	622	707	0	2	2
47	NENESUANO	499	567	0	2	1
48	NKANRANKA	611	695	0	2	2
49	KATO	2,041	2,320	2	3	4
50	KORASO	3,018	3,431	2	3	6
51	NANTEASEM/HENEKROM	944	1,073	0	3	3
52	TWUMASIKROM	444	505	0	2	1
53	BOBOKUROM	929	1,056	0	3	3
54	MPARASE	1,112	1,264	0	3	3
55	DORNEABRA/AMPENKRO	482	548	0	2	1
56	BODOA	430	489	0	2	1
TOTAL	55 COMMUNITIES	58,580	66,602	18	144	143

* ... Estimated, Based on 1984

SEFWI-WIAWSO DISTRICT

(5)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1984	1989*	Existing	GWSC Original	Plan
1	ADU AKURAA	1,097	1,247	0	3	3
2	AKWANTAMBRA	1,767	2,009	0	5	5
3	KWAME ABRAHAM	932	1,060	0	2	3
4	AHIBENSO	1,176	1,337	0	3	3
5	APRUTU	690	784	0	2	2
6	TIKOBO	583	663	0	2	2
7	BOKABO	690	784	0	2	2
8	AMOYAW	1,378	1,567	0	4	4
9	KWASIKROM	979	1,113	0	3	3
10	SANTAASE	766	871	0	2	2
11	PATAKRO	760	864	0	2	2
12	ANTOBIA	984	1,119	0	3	3
13	JUABESO	1,692	1,924	1	4	4
14	SUIANO	602	684	0	2	2
15	KWAFUKAA	780	887	0	2	2
16	SEFWI-ACHIACHEM	624	709	0	2	2
17	SEFWI-NKWANTA	825	938	0	2	2
18	SEFWI-KOFIKROM	597	679	0	2	2
19	SEFWI-PRASO	770	875	0	2	2
20	KWASI AKRUMAH	529	601	0	2	2
21	BENKASA	1,614	1,835	0	4	5
22	ADJUAFRA	1,851	2,104	4	5	1
23	MAFIA ROMAN	873	993	0	2	2
24	KANTANKRUBO	515	586	0	2	2
25	KOJINA	663	754	0	2	2
26	ETESO	579	658	0	2	2
27	ASEMPANAYE	812	923	0	2	2
28	ELLUOKROM	735	836	0	2	2
29	NEW TECHIMAN	775	881	0	2	2
30	PAMPRAMASE	893	1,015	0	2	3
31	SIF SIKAFREMOGYO	756	860	0	2	2
32	KOJO FOSUKROM	989	1,124	0	3	3
33	NEW BREKUM	659	749	0	2	2
34	OLD DEBISO	879	999	0	2	2
35	ESSEM	1,911	2,173	3	5	2

SEFWI-WIASO DISTRICT

(6)

No.	COMMUNITY	POPULATION		BOREHOLES		
		1984	1989*	Existing	GWSC Original	Plan
36	KWAME BIKROM	1,284	1,460	0	3	4
37	KOJO ABA	882	1,003	0	2	3
38	KAASE	731	831	0	2	2
39	ABABOKROM	1,350	1,535	0	3	4
40	KWAM TAWIAKROM	1,067	1,213	0	3	3
41	PAPASE	833	947	0	2	2
42	KWASAREKROM	772	878	0	2	2
43	ASANTEKROM	555	631	0	2	2
44	NAFIADU	708	805	0	2	2
45	BOPA	711	808	0	2	2
46	SEFWI-EWIASE	808	919	0	2	2
47	AMHWIA	1,075	1,222	5	3	0
48	KOFIKROM	551	626	0	2	2
49	KOJOKROM	602	684	0	2	2
50	ASANTEMAN	539	613	0	2	2
51	EDUMAFUA	1,031	1,172	0	3	3
52	AKWADUM	770	875	0	2	2
53	ASAMOAKROM	525	597	0	2	2
54	KOFI AKAAKROM	966	1,098	0	3	3
55	NKONYA DONKORKROM	581	661	0	2	2
56	KOKOKROM	1,032	1,173	0	3	3
57	ABODUAM	1,139	1,295	4	3	0
58	PABOASE	587	667	0	2	2
59	DANTANO	1,098	1,248	4	3	0
60	PUNIKROM AYEBOOSO	1,371	1,559	0	3	4
61	BUAKO	1,958	2,226	0	5	6
62	SEFWI CAMP	676	769	0	2	2
63	NKWADUMU	754	857	0	2	2
64	SUI	945	1,074	0	2	3
65	ENYINABRIMU	1,410	1,603	0	4	4
66	BEKYIMA	849	965	0	2	2
67	AHOKWAA	800	910	0	2	2
68	ADIEMBRA	579	658	0	2	2
TOTAL	65 COMMUNITIES	62,264	70,790	21	171	164

* ... Estimated, Based on 1984

GRAND TOTAL

(7)

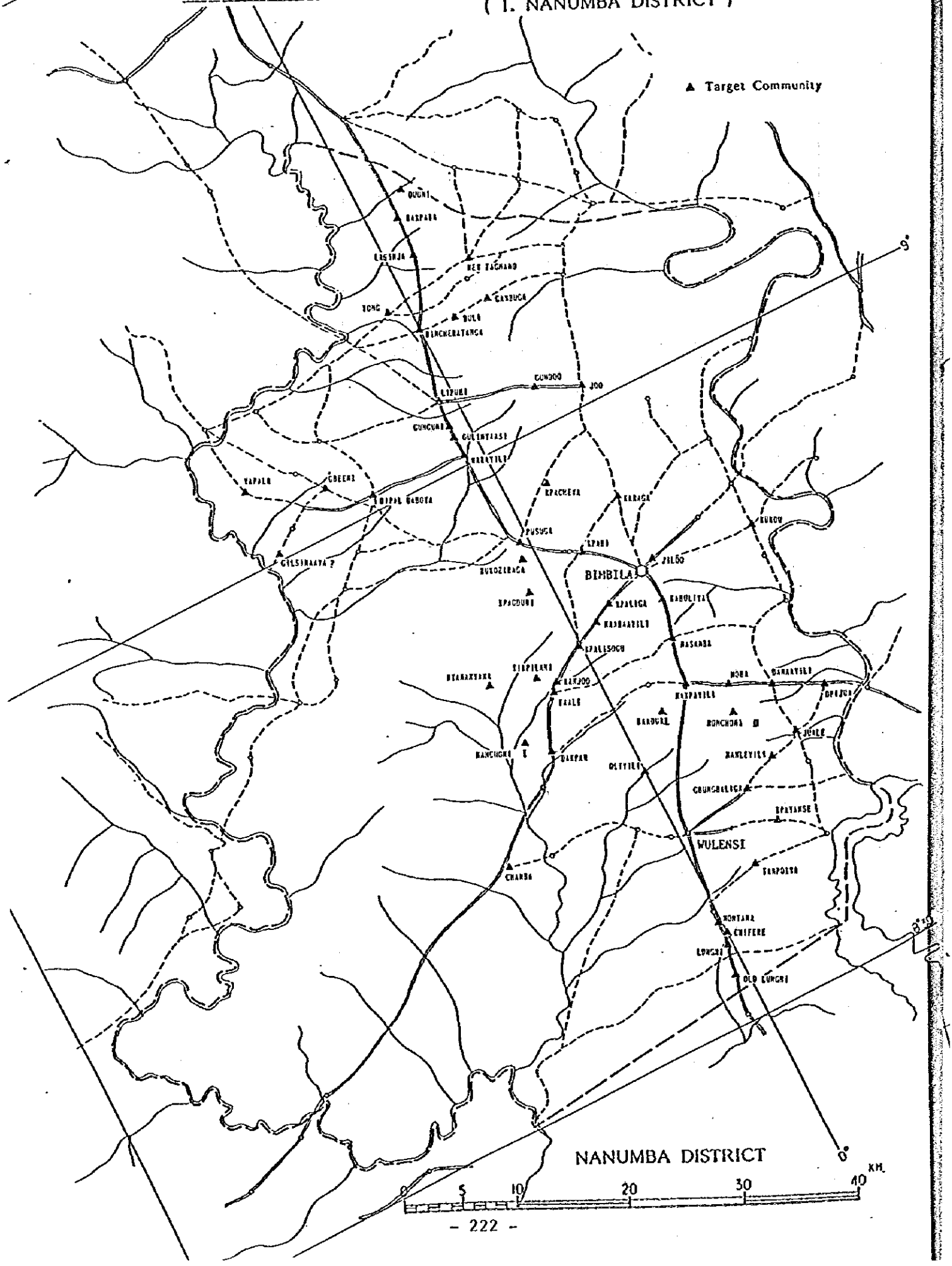
No.	DISTRICT	POPULATION		BOREHOLES		
		1984	1989	Existing	GWSC Original	Plan
	NANUMBA DISTRICT	58,277	67,960#	6	130	159
	BEREKUM/JAMAN DISTRICT	58,580	66,602 *	18	144	143
	SEFWI-WIAWSO DISTRICT	62,264	70,790 *	21	171	164
	GRAND TOTAL 174 COMMUNITIES	179,121	205,352	45	445	466

...Estimated, Based on 1983

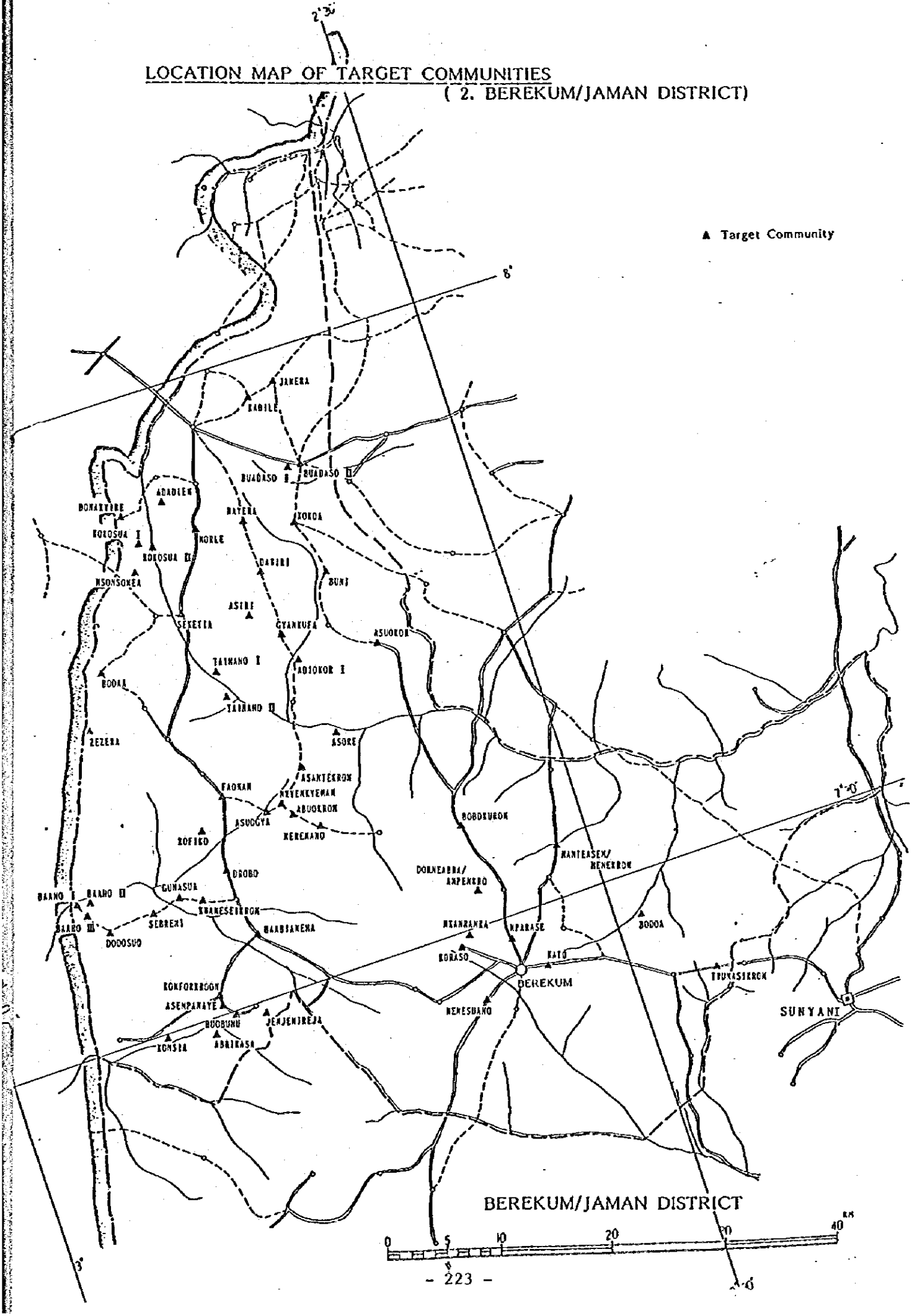
* ...Estimated, Based on 1984

Appendix 11

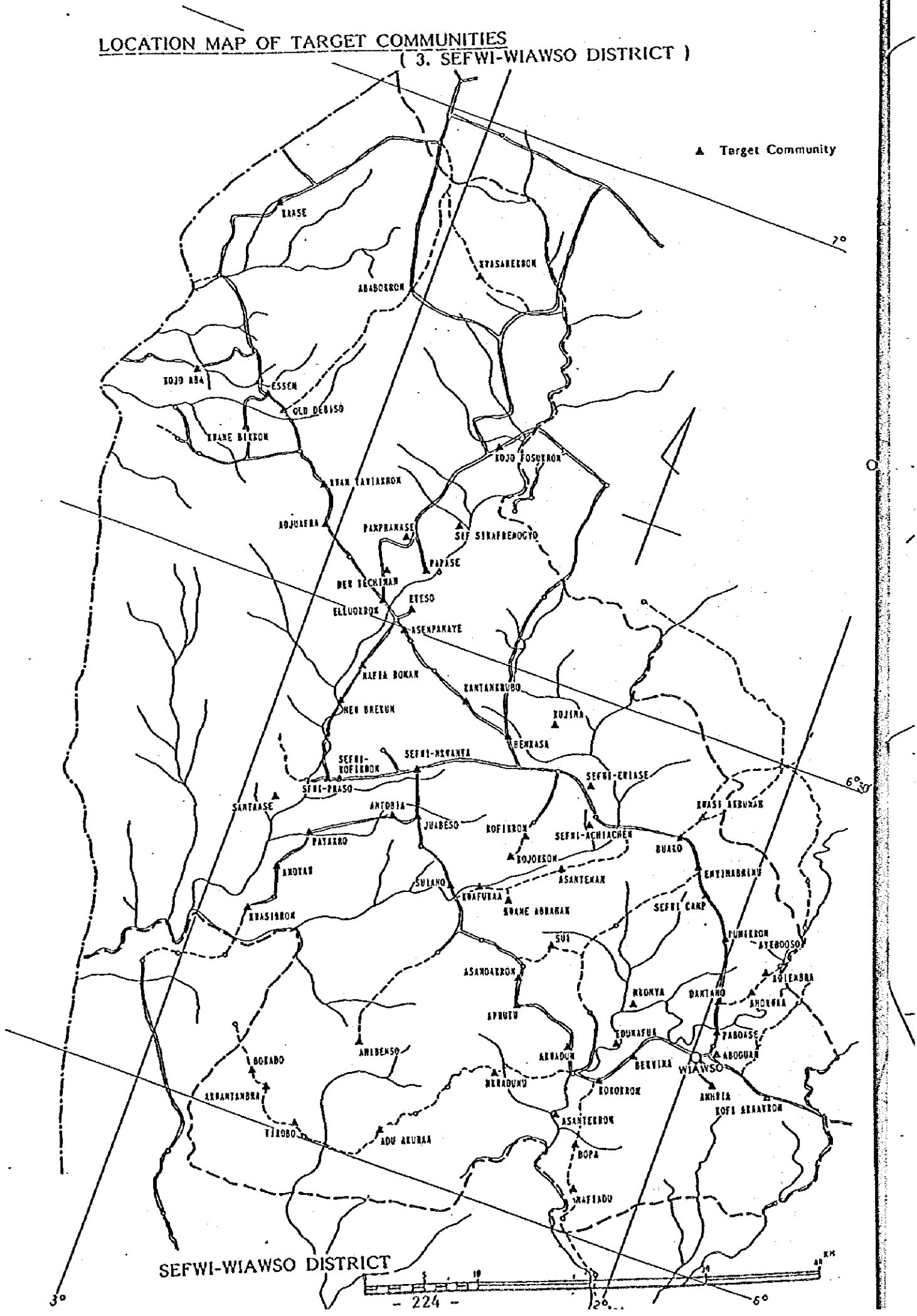
LOCATION MAP OF TARGET COMMUNITIES
(1. NANUMBA DISTRICT)



LOCATION MAP OF TARGET COMMUNITIES
(2. BEREKUM/JAMAN DISTRICT)

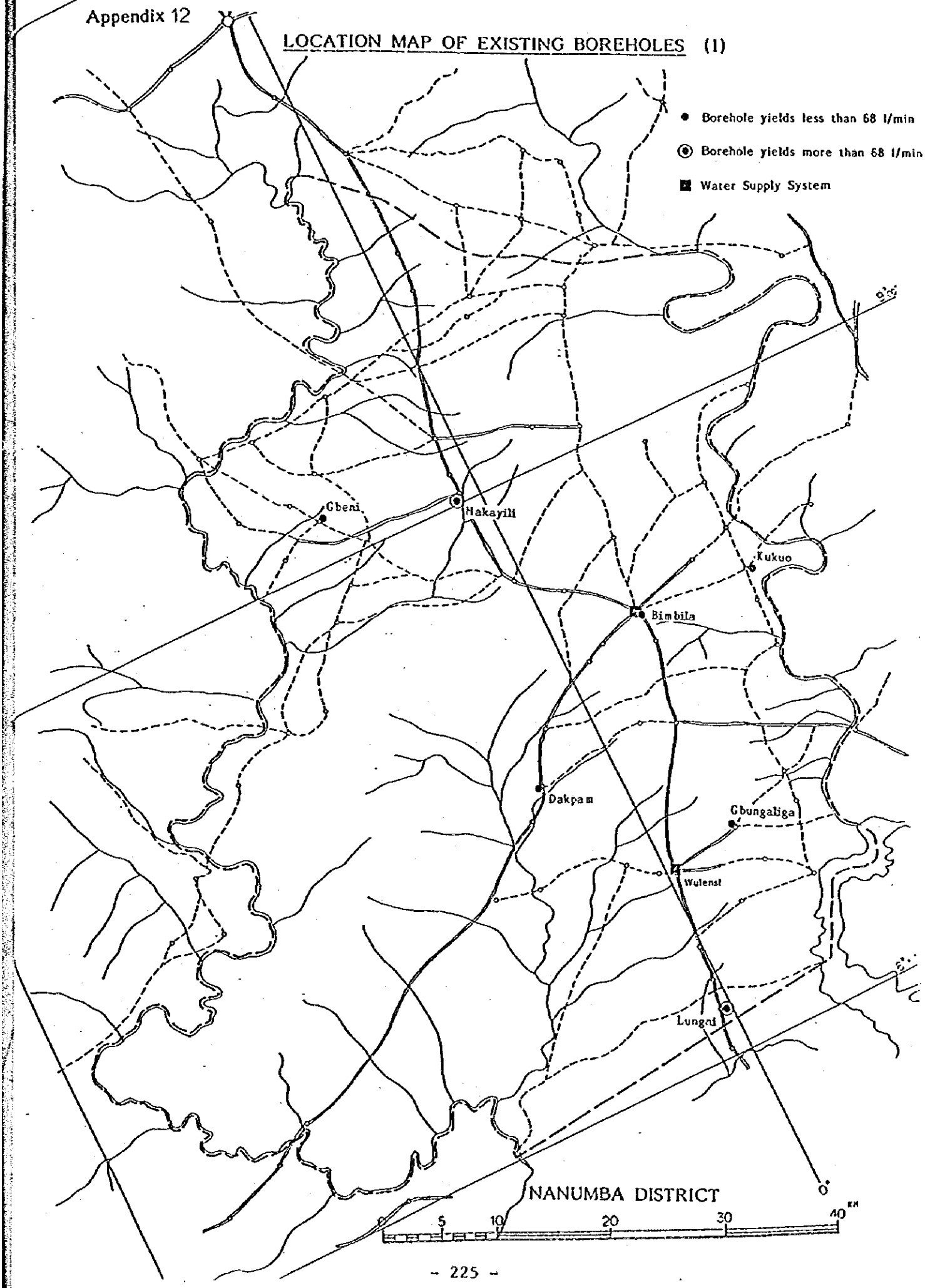


LOCATION MAP OF TARGET COMMUNITIES
(3. SEFWI-WIAWSO DISTRICT)

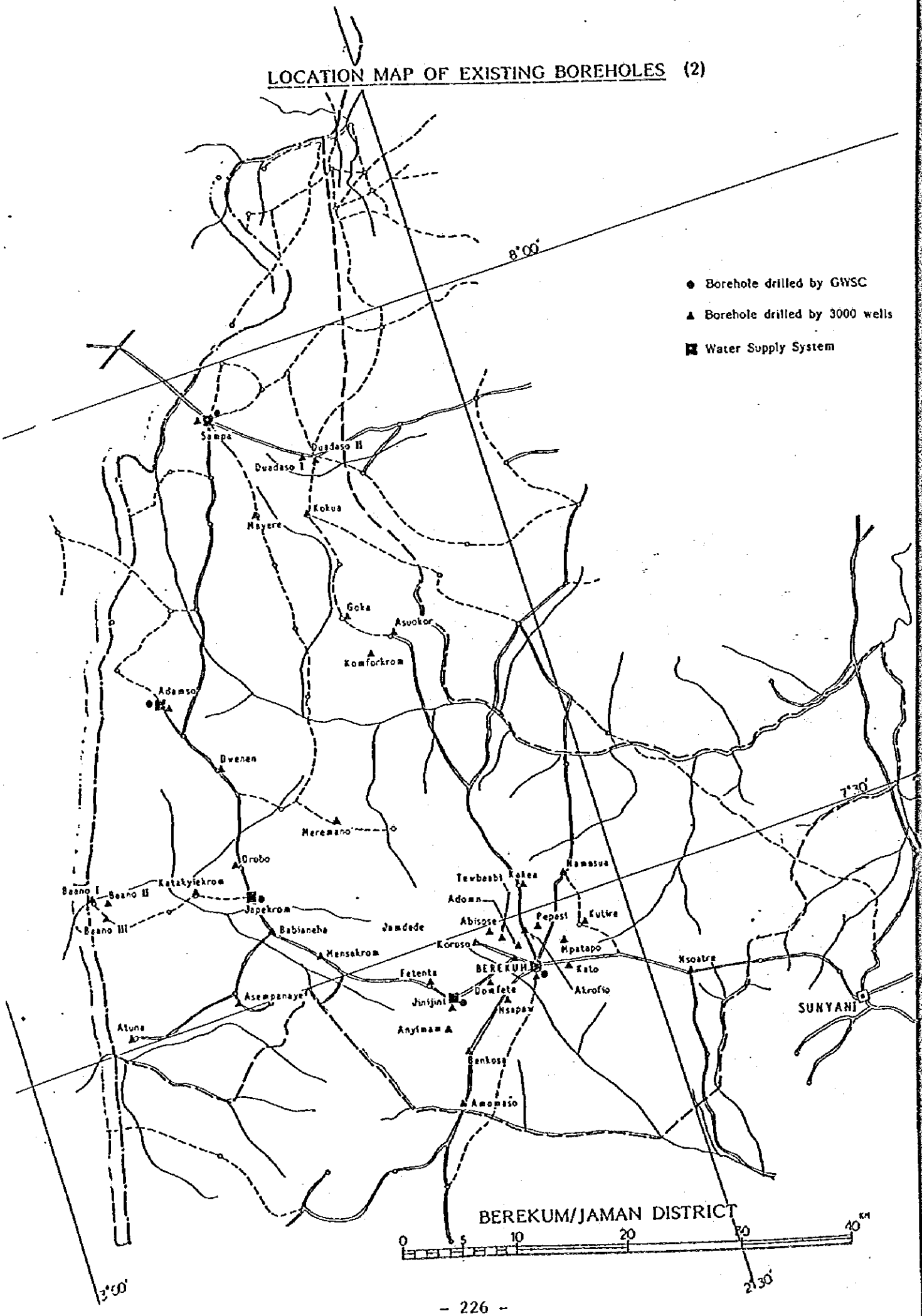


Appendix 12

LOCATION MAP OF EXISTING BOREHOLES (1)



LOCATION MAP OF EXISTING BOREHOLES (2)



LOCATION MAP OF EXISTING BOREHOLES (3)