4.2.3 SIMILAR PROJECTS IN THE PROJECT AREA

The latest rural water supply scheme in the Project area with foreign assistance is represented by two loan projects; one is for Central Province with a bilateral assistance through KFW from the Federal Republic of Germany; and the other by the World Bank. (Table 4 - 1). The latter already completed 700 boreholes and dug wells in three Provinces of Copperbelt, Luapula and Northern from the period between 1984 and 1987, and at the moment there is no additional assistance under planning. The former project with German assistance installed 109 dug wells in Central Province, along with rehabilitation works of 61 boreholes and 180 dug wells during the period of 1986 to 1989. Germany has an intention to provide an additional project, Phase II, but it remains yet to be realized. Germany's new plan, however, is again being focused on the installation of dug wells to a depth of about 10 meters and rehabilitation of existing wells, although its staff admits the necessity of new boreholes. The chief reason seems that they have not been able to afford the drilling equipment necessary for the work. During the field survey, this study team had an opportunity to exchange views with responsible officials for both projects, and the talks led to the conclusion that for Central Province, the Japanese project will undertake borehole construction, while Germany will be responsible for rehabilitation of existing boreholes. Both the Japanese and German teams agreed that the construction of boreholes to a depth of 50 to 70 m is urgently needed for that province, since the coverage of rural water supplies is still kept at a low level there.

4.2.4 MAJOR COMPONENTS OF THE PROJECT

This Project is mainly aimed at constructing 200 boreholes as stable water sources for rural supplies as well as encouraging groundwater resources development in seven districts of three provinces through the supply of equipment and materials required for such operations. At the same time its plan includes rehabilitation of 100

TABLE 4 - 1 SIMILAR PROJECT IN THE PROJECT AREA

PROJECT AREA	PHASE - I (1986 - 1989)					PHASE - II (1990 - 1992)					TOTAL
	NEWLY INSTALLED		REHABILITATED		SUB TOTAL	NEWLY INSTALLED		REHABILITATED		SUB TOTAL	
	BOREHOLES	DUG WELLS	BOREHOLES	DUG WELLS		BOREHOLES	DUG WELLS	BOREHOLES	DUG WELLS		
CENTRAL PROVINCE (WEST GERMANY LOAN)											
1. KABWE RURAL DISTRICT	1	6	1	2	10					130	140
2. MKUSHI DISTRICT	0	45	20	60	125					0	125
3. MUMBA DISTRICT	0	0	0	42	67					190	257
4. SERENJE DISTRICT	0	58	13	76	147					0	147
						(UNDER PLAN)					
TOTAL	1	109	61	180	349	32	72	0	216	320	669
COPPERBELT PROVEINCE (WORLD BANK LOAN) 1. NDALA RURAL DISTRICT	This project with the Bank's loan covered 3 Provincials, not any Copperbelt but Ruapula and Northern from 1984 to 1987, where 700 boreholes and dug wells in all were either installed or rehabilitated, as follows:					New boreholes 42 New dug wells 400 Rehabilatation 258 700					

existing boreholes to reactivate their function to serve clean and safe water to the rural population. Moreover, it is intended to provide technology transfer to DWA's staff engaging in groundwater development and to supply equipment and materials for operation and maintenance of completed boreholes. The major components of the Project thus to be performed by the Japanese side are summarized as follows:

1) Construction of boreholes and appurtenant facilities for rural water supplies at 200 sites in 7 districts of three provinces;

2) Rehabilitation of existing boreholes at 100 sites in 3 districts of 2 provinces;

3) Procurement of equipment and materials required for the construction and rehabilitation of boreholes;

4) Technology transfer to DWA's staff with regard to groundwater development, installation of rural water supply facilities and their operation and maintenance during the implementation period of the Project;

5) Construction of a depot for management of the execution of the Project as well as that of equipment and materials supplied under the Project;

6) Consulting service for the execution of the Project concerning all the above-described items of works.

4.2.5 ANALYSIS OF THE PLAN REQUESTED FOR THE PROJECT

This Project is mainly constituted of three components: construction of boreholes with water facilities; rehabilitation of existing boreholes with water facilities; and procurement of equipment and materials for operation and maintenance. The necessity and

feasibility of the framework of the plan requested for the Project are analyzed as follows:

1) Construction and Rehabilitation of Boreholes

The initial request by the Government of Zambia for the construction of boreholes with water facilities included 372 sites in total. A request combining the two proposals followed, adding a revision for urgent handling of 200 sites mentioning the district-wise priority but failing to indicate their specific names. Therefore, the basic design study team has selected 200 sites out of the initially requested 372 through the consultation with concerned officials of the DWA and the district councils as well as the analysis of the field study, based upon the following principles:

a. Sites currently having no water sources;

b. Sites currently having no sanitary, stable water sources;

c. Sites where existing water sources would routinely get dry during dry seasons;

d. Sites having public institutions such as schools, health and/or agriculture centers where water service has been definitely poor;

e. Sites appointed to agricultural development/resettlement areas where water service is urgently needed to meet the growth of population.

For the purpose of the rehabilitation of boreholes, the initial request asked only for the procurement of hand pumps. However, not only the procurement of materials but the work for their replacement should be undertaken under the Project, since such arrangements could sharply enhance the coverage of water supplies.

2) Procuremnt of Equipment and Materials for Groundwater Development

Equipment and materials required for groundwater development include drilling rigs, vehicles, survey and testing equipment, maintenance equipment, radiotelephone units, camping facilities, etc. The most suitable types of equipment will have to be provided to the operation teams and units in appropriate quantities.

Since the Project area covers a wide area including 7 districts of 3 provinces, roughly corresponding to 20 percent of the whole country, the formation of two independent units of drilling crews respectively equipped with one drilling rig each becomes an essential requirement to practically cope with the urgent requirements of the respective provinces for water service. For such independent operations, each drilling crew necessitates a complete assembly of a water tank truck, a fuel truck, supporting vehicles, camping facilities and wireless sets. Meanwhile, although the utilization of the existing Kabwe Provincial Water Engineer Office for the storage and maintenance of equipment and materials procured under this Project is highly desired, it has currently no room and appropriate facilities for the large-scale operation required for this Project. Accordingly, the construction of a new depot is needed to be designed in the vicinity of this existing office under this Project. Concerning the types of equipment for the hydrogeological survey, the application of geoelectric survey equipment is recommended to be combined with electromagnetic survey equipment, because of regional conditions of typical groundwater occurrence through fracture zones of prevailing rocks such as Precambrian granite and gneiss. The application of personal computer system will be effective for the planning, execution, and management of the rural water supplies in the Project area as well as for the control of equipment, materials and spare parts.

4.2.6 TECHNOLOGY TRANSFER

Upon completion of the Project, equipment and materials to be procured under the Project, including two units of drilling machines, are planned to be transferred to the executing agency, the office of DWA, and are to be operated and maintained by itself for its own program for development of water supply schemes. It is essential, therefore, to carry out effective technology transfer to the staff of DWA during the implementation of the Project. DWA itself is earnestly looking forward to such a program. The most suitable method for technological transfer is the style of on-the-job training of DWA's staff engaged directly in the Project, mainly concentrated on the hydrogeological survey, drilling technique and operation and maintenance of equipment and materials.

4.2.7 BASIC CONCEPT OF IMPLEMENTATION

As a result of the analyses described in the paragraphs of this Chapter, with the effect of the Project judged to meet the objectives of Japan's grant aid system, it is concluded that the Project is feasible for being implemented as one of the grant aid projects of the Government of Japan, with the basic design study developed in the following sections. It is noted that a part of the initial plan under the request is needed to be revised for the implementation, as has been described in the aforementioned analyses.

4.3 OUTLINE OF THE PROJECT

4.3.1 EXECUTING AGENCY AND ORGANIZATION FOR IMPLEMENTATION

The Department of Water Affairs (DWA) is responsible for the Project as the executing agency of the Project, and its major operations for the implementation of the Project are planned to be executed through the Japanese Project Base newly installed at Kabwe City in Central Province, taking into account the broad expanse of the Project area involving 7 districts across 3 provinces.

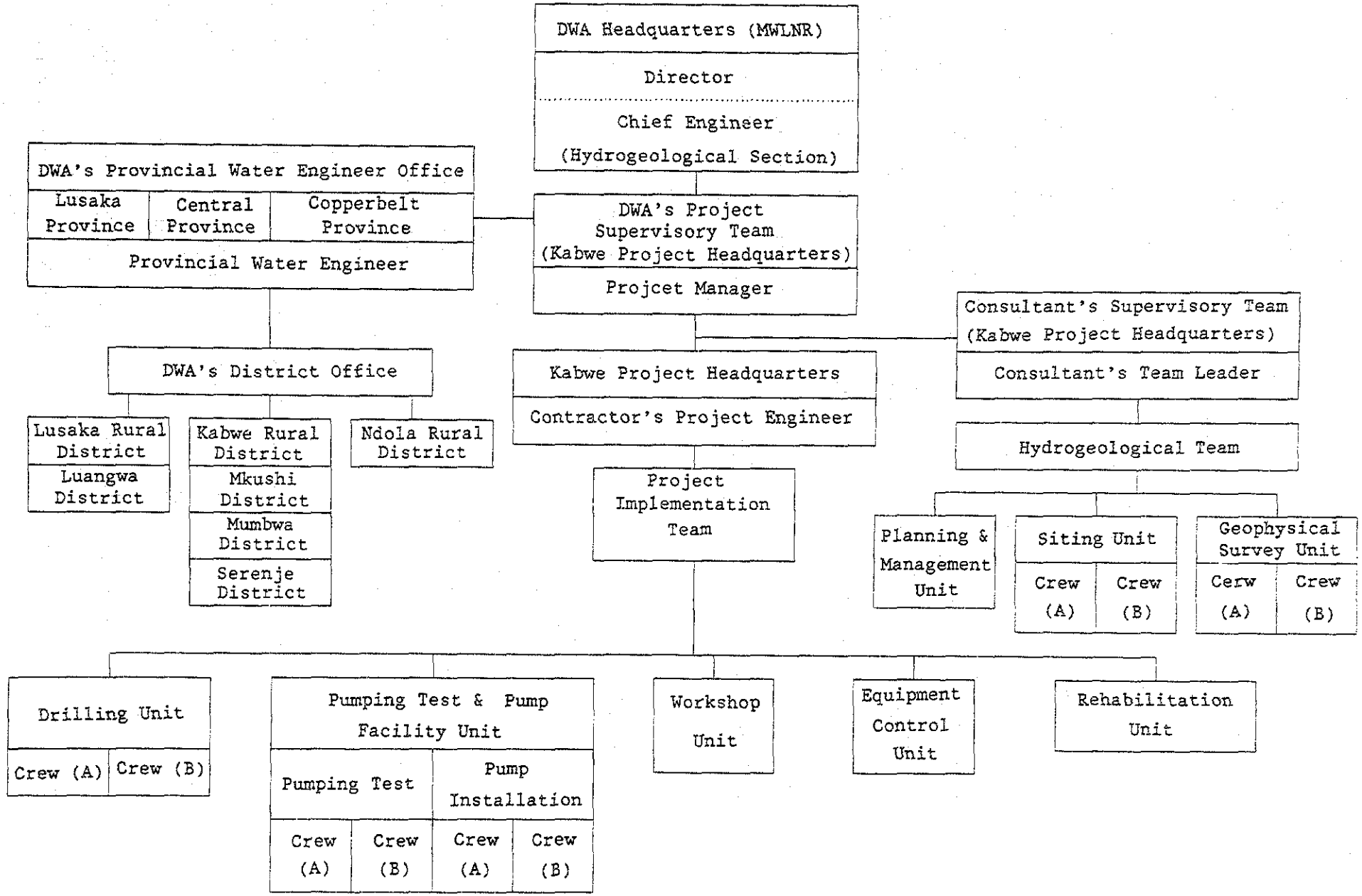
A new setup is proposed for practical implementation of the Project as follows, as a result of the review of the previous organizations for Japan's grant aid projects for Southern Province as well as of the framework of the present Project (Fig. 4 - 2).

1) The Project Manager will be assigned to a senior engineer in charge of this Project at DWA's Headquarters, supported by the Project Engineer from the contractor who will manage the actual work of construction and rehabilitation of boreholes. The Team Leader from the Consultant will be responsible for the supervision and control of the implementation of the Project.

2) The Planning Unit for controlling the entire aspects of the rural water supply scheme including operation and maintenance will be installed, and the Hydrogeological Survey Unit will be organized, consisting of two teams, each involving a consultant's hydrogeologist and DWA's counterparts for the purpose of the detailed hydrogeological survey, geophysical survey and decision on the drilling points in the respective sites prior to the commencement of actual works.

3) The Drilling Unit comprised of two crews will be set up to carry out borehole construction in the broad Project area.

FIG 4 - 2 ORGANIZATION CHART OF JAPANESE PROJECT TEAM



4) The Water Facilities Unit comprised of two groups of pumping test crew and two groups of water facilities installation crew as well will be organized for effective construction of facilities.

5) One crew member of the Rehabilitation Unit is responsible for rehabilitation works of existing boreholes.

6) One crew member of the Workshop Unit will be established in Kabwe Project headquarters to undertake maintenance and repair of drilling rigs, vehicles and other equipment.

7) One crew member of the Materials Control Unit will stationed at Kabwe Base as well in order to keep various materials and spare parts under control as well as arranging fabrication of wood form, etc., necessary for the execution of works.

4.3.2 DETAILS OF THE PROJECT PLANNING

As a result of the review of the request for the Project and the analyses of the field study data during the basic design study, the program of the Project is planned as follows:

1) Boreholes

Boreholes have been regarded to contribute to rural health as sanitary water sources not likely to be more contaminated from ground surface than dug wells currently in wide use in the rural area. Moreover, dug wells installed within a depth of 20 m would frequently get dry or sharply decrease the yield in dry seasons. For these reasons, boreholes are decidedly preferable to dug wells in rural water supply schemes.

(1) Depth of Boreholes:

Based upon the existing drilling record in the Project area, the relationships of various factors affecting groundwater occurrence in the Project area are shown in

Table 4 - 2, including drilling depths, aquifer types and depths, static water levels and estimated locations of fault/fracture zones.

TABLE 4 - 2 COMPARISON OF HYDROGEOLOGICAL CONDITIONS IN THE PROJECT AREA AND SOUTHERN PROVINCE

	Project Area	Southern Province
Borehole Depth (m)	40 - 85	30 - 80
Yield (lit/min)	12 - 312	5 - 300
Static Water Level (m)	6 - 70	1 - 40
Pumping Water Level (m)	8 - 75	8 - 43
Drawdown (m)	2 - 43	4 - 40
Specific Capacity ($m^3/d/m$)	1 - 180	1 - 160
Well Screen Position (m)	10 - 85	7 - 72
Thickness of Weathered Zone & Loose Rocks (m)	1 - 50	1 - 15
Types of Main Aquifers	Sand & gravel, Granite, Limestone, Schist Quartzite Gneiss	Sandstone, Basalt, Quartzite Limestone, Schist, Gneiss, Granite

According to the above table, the depths of penetrated aquifers in the Project area where the well screens were installed ranged from 10 to 80 m. Depending upon the results of geological and geophysical surveys conducted during the present study, the most promising zones of fractures are judged to exist within the range 40 to 85 m, averaging 60 meters. On the other hand, the average drilling depth of 200 boreholes in Southern Province was 50

odd meters through sandstone, granite, limestone, gneiss and/or schist, with the locations of aquifers ranging from 7 to 72 m below ground level. As a result of analyses of those existing data, it is concluded that the average depth of new boreholes in the Project area should be 60 meters, since the depths of aquifers in this area are generally deeper than those in Southern Province and their thicknesses widely vary with the locations of sites.

(2) Success Rate of Boreholes

In the actual construction of boreholes, diverse failures in water quantity and/or quality estimated in the plan are commonly experienced due to constraints of natural conditions at sites. Allowance in the time period and the quantity of materials should, therefore, be required to be included in the plan for the implementation program. Table 4 - 3 summarizes the actual situation of success ratios in the past Japanese projects, Phases I and II, in Southern Province, which were respectively 83.7 percent and 81.3 percent. The unsuccessful boreholes were most frequently encountered in tightly-cemented formations such as gneiss, granite and schist. Since these formations are more widespread in the Project area than they are in Southern Province, the hydrogeological environment in the former is anticipated to be harder than that in the latter. Accordingly this Project is recommended to be planned with the target for successful boreholes aimed at 80 percent, in view of the results of Southern Province Groundwater Development Projects Phases I and II under previous Japanese grant aid as well as apparently less promising hydrogeological conditions in the Project area of the three provinces.

Table 4 - 3 RESULTS OF BOREHOLE CONSTRUCTION IN PREVIOUS JAPANESE PROJECTS

Phase	Total No. of Boreholes	No. and Rate of Successful Boreholes	Type of Unproductive Aquifers and No. of Unsuccessful boreholes		
Phase I	43	36 (83.7 %)	1. Gneiss	4	7
			2. Granite	1	
			3. Mudstone	1	
			4. Mudstone Sandstone	1	
Phase II	32	26 (81.3 %)	1. Quartzite	1	6
			2. Schist	2	
			3. Granite	2	
			4. Siltstone	1	

(3) Selection of Drilling Points

In deciding the exact drilling points in the respective sites, not only the hydrogeological and engineering conditions around those points but the consent of inhabitants of the sites are indispensable. Therefore, the decision is made prior to construction works by the Survey Unit comprised of a consultant's hydrogeologist and DWA's counterparts from the Hydrogeological Survey Team.

2) Water Facilities

Hand pumps are recommended to be installed in the boreholes, since this type of pump is a standard unit in the rural water supply schemes, allowing easy handling and maintenance at the

respective sites. Table 4-4 shows the results of pump installation in the previous Japanese projects.

Table 4 - 4 INSTALLATION OF HAND PUMPS GROUNDWATER DEVELOPMENT PROJECT PHASES I & II IN SOUTHERN PROVINCE

Phase	Type of Hand Pump	Country of Origin	No. of Units	Total
Phase I	1. Bellows type	Japan	43	102
	2. Piston type (INDIA MARK IItype)	Germany	59	
Phase II	1. Bellows type	Japan	220	220

The DWA is trying to standardize the type of hand pumps to be employed for the rural water supplies among lots of kinds available in market, and the above model, India Mark II type, is one of DWA's favorite choices. As indicated in the above table, the bellows type of Japanese make is also in practical use in the country without any critical trouble in operation. Therefore, either type is considered to be acceptable for this Project.

Appurtenant facilities for pumps include a drain floor, a drain ditch and a soakaway of concrete in order to prevent direct contamination of aquifers by waste water from ground surface. These structures comply with the standard requirements of the DWA, as had been followed by the previous Japanese projects in Southern Province. Some of the existing drain ditches, however, were not long enough to safeguard against possible contamination, and it is necessary to employ an improved design to meet the conditions of the respective sites for this Project. Meanwhile, the installation of drainage facilities has been a responsibility of communities, but has often been a cause for health problems

due to their negligence. To improve the current situation for the promotion of a sanitary environment in the rural area, therefore, it would be pertinent to include the installation of this facility in the Project so that inhabitants could have an idea about the importance of such a type of health-protection structure.

3) Consumption and Served Population

The per-capita consumption of the rural water supplies in Zambia is 30 lit/day/capita in compliance with the standards of WHO. In addition, the DWA has its own standard of 5 lit/day/capita for the consumption of drinking water only. For practical purposes, this Project intends to provide one essential facility to the respective sites most urgently in need of water, to satisfy at least this minimum demand of 5 lit/day/capita as the first step, with a perspective to have the DWA itself tackle the next step to increase the rate of supply through installation of additional facilities by the hand of the DWA.

The calculation of served population by varied consumption rates is presented as follows:

a. Pumping rate of a hand pump: 750 lit/hr
b. Operating period of a hand pump: 10 hrs/day
c. Supply rate of a hand pump:
   750 lit/min x 10 hrs = 7,500 lit/day
d. Served population:
   * Case of unit consumption of 30 lit/day/capita:
     7,500 lit/day ÷ 30 lit/day/capita = 250 persons
   * Case of unit consumption of 5 lit/day/capita:
     (May happen during the extraordinary dry spells)
     7,500 lit/day ÷ 5 lit/day/capita = 1,500 persons

4) Rehabilitation of Existing Boreholes

The field survey for the basic design study has revealed

that a large number of sites already having existing facilities were included among initially requested 373 ones, asking for additional borehole construction, as their existing facilities had been left unused mainly because of the breakdown of pumps. It has been judged, therefore, that the replacement of damaged pumps with new ones should be carried out as the main item of rehabilitation works of facilities, in order to improve the current situation of rural water supplies and thereby to enhance their coverage.

Furthermore, the improvement of water environment will have to be undertaken by this Project in a portion of sites where such special care is needed, particularly where contamination with waste water due to lack of drainage facilities or defective ones has been rampant.

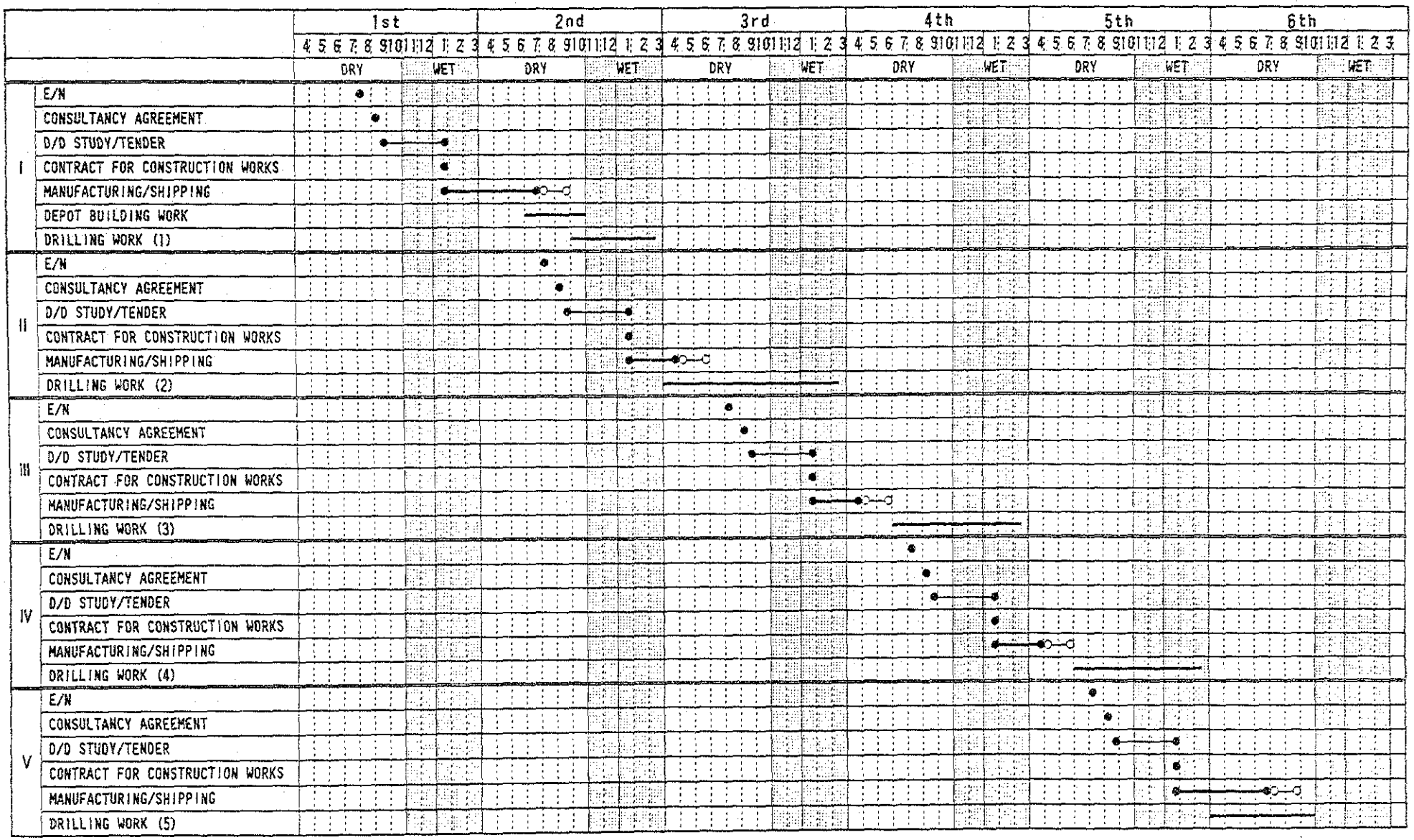
4.3.3 PROCEDURE OF THE IMPLEMENTATION PROGRAM

In view of constraints such as the slowdown of works during wet seasons and the required time limit under Japan's grant aid system, the implementation program of this Project for the completion of 200 borehole construction and 100 borehole rehabilitation is considered to be divided into several phases, since all works involved in the plan could not be completed within a single fiscal year. Fig. 4 - 3 presents a proposed program for such a phased implementation of the plan. The basic concept of this proposed program is explained in the following sections, featuring the main work of borehole construction.

1) Phased Program of Borehole Construction

The main target of this Project is to construct 200 boreholes in the Project area. Since some portion of boreholes are likely to result in facilities with unsuitable quality and/or scarce or no production, the entire program of implementation must be composed with an allowance included for the estimated rate of success of 80 percent, as analyzed in the preceding section. The

FIG. 4-3 PROPOSED IMPLEMENTATION SCHEDULE OF THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT PHASE III



total number of boreholes to be constructed amounts, therefore, to 250 (200 ÷ 0.8 = 250), to assure successful boreholes of 200 in number.

The works to be performed in the respective stages thus divided are summarized in Table 4 - 5. The period of the wet season during which drilling operations will slow down has been determined on the months from November to March of the subsequent year, based upon the meteorological data during the past twenty years. During this period, the operation of the drilling rigs is estimated to drop by 50 percent on the average, compared to that in the dry season. Accordingly the numbers of boreholes completed during the respective seasons are calculated to be four (4) per month in the dry period and two (2) per month in the wet one. To monitor the actual progress of works, it is considered necessary to carry out the intermediate evaluation of the program, preferably at the end of the third stage, including such elements as price fluctuation, review of the estimate on the Project cost, feasibility for the continuation of the Project and the style of assistance, etc.

TABLE 4 - 5 IMPLEMENTATION SCHEDULE OF BOREHOLE CONSTRUCTION DIVIDED INTO STAGES

1 st STAGE **NO. OF BOREHOLES = 20**	* Conclusion of Agreement for Consulting Service : 1.0 month * Detailed Design Study (D/D) & Tender: 4.0 months * Contract, Procurement of Equipment/ Materials and Shipment: 6.0 months (Drilling rigs and related equipment take 6 months for procurement, while other equipment/materials are expected to take 3 months. Accordingly drilling works commence in October and are completed by the middle of March of the following year. During this period, it is planned that the number of wells completed with one unit of rig in the dry season is 4/month, while that in the wet season is 2/month. The total number of boreholes during this stage is calculated as follows: (4 Nos. x 1 Mon.) + (2 Nos. x 4.5 Mon.) = 26 Nos. 26 Nos. x 80 % = 20.8 Nos. → 20 Nos. * Construction of Operation Base/Depot: 4.0 months
2 nd STAGE **NO. OF BOREHOLES = 59**	Borehole construction follows the 1st stage without suspension, with all necessary equipment/materials included in the 1st stage. This stage has a construction period as follows: Dry season 7.0 months Wet season 4.5 months The same rate of construction of boreholes during each season can be applied to produce the total number of the boreholes as follows: (8 Nos./Mon/2 Units x 7 Mon) + (4 Nos./Mon/2 Units x 4.5 Mon) = 74 Nos. 74 Nos. x 80 % = 59.2 Nos. → 59 Nos.

3 rd STAGE **NO. OF BOREHOLES** **= 40**	Equipment/materials necessary for works are procured as the first step under this stage in 5 months. Accordingly, the number of boreholes is calculated as follows: (8 Nos./Mon/2 Units x 4 Mon.) + (4 Nos./Mon/2 Units x 4.5 Mon.) = 50 Nos. 50 Nos. x 80 % = 40.0 Nos. → = 40 Nos.
INTERMEDIATE REVIEW OF PROJECT	At the end of the 3rd stage, the comprehensive review of the Project for the subsequent implementation is made, including the actual progress of the Project, prevailing prices, examination of equipment/materials, study on the feasibility of subsequent stages, etc.
4 th STAGE **NO. OF BOREHOLES** **= 40**	This stage is implemented, based upon the conclusion of the review of the Project at the end of the previous stage. Basically, the same pattern of borehole construction is planned for this stage, with a target of successful number of boreholes of 40.
5 th STAGE **NO. OF BOREHOLES** **= 41**	The final stage involves construction of the remaining number of boreholes (41) during the same period as that for the previous stages. Therefore, materials necessary for construction works for this stage have to be procured during the previous 4th stage to minimize the idle period in the works. Further, spare parts for drilling rigs are delivered in this stage to cover 2 years of operation after completion of the final stage. Their procurement takes 8 months (6 for manufacturing and 2 for shipping). The construction of borehole is planned as follows: 41 Nos. ÷ 80% = 51.25 Nos. → 52 Nos. 52 Nos. ÷ 8 Nos./Month = 6.5 Months 52 boreholes are constructed during the period of 6.5 months, following the completion of the previous 4th stage. The successful wells of 41 in number is planned to be completed in this final stage.

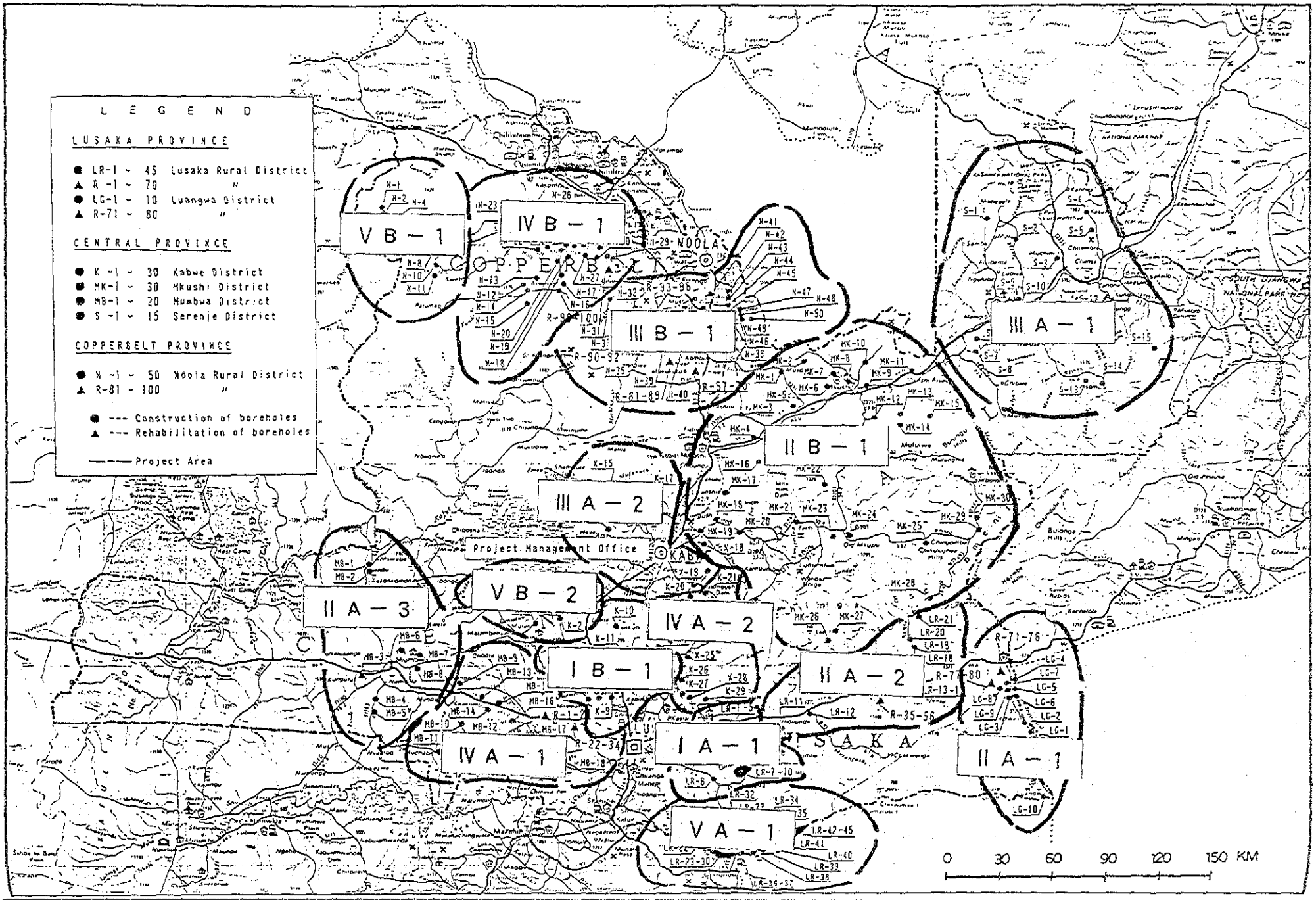
2) BOREHOLE CONSTRUCTION SCHEDULE

Since the whole program is divided into 5 stages, with each stage having a limit in the number of borehole constructions, priority has been given in the decision on the order of implementation of 200 boreholes on the bases of district-wise overriding urgency, conditions of access during dry seasons, the degree of difficulty with actual construction works, arrangements for technological transfer to DWA's employees in districts, etc. Table 4-6 and Fig. 4-4 illustrates the procedure of borehole construction thus decided on the priority-basis. This order is expected to ensure efficient and effective operations of the Drilling Unit consisting of 2 crews, Crew-A and Crew-B, in the wide area of the Project covering 7 districts of 3 provinces.

TABLE 4 - 6 BOREHOLE CONSTRUCTION SCHEDULE

Governorate	District	No. of Boreholes	Stage I	Stage II	Stage III	Stage IV	Stage V
Lusaka	Lusaka Rural	45	10 (A-1)	11 (A-2)	0	0	24 (A-1)
	Luangwa	10	0	10 (A-1)	0	0	0
Central	Kabwe Rural	30	10 (B-1)	0	5 (A-2)	9 (A-2)	6 (B-2)
	Mukushi	30	0	30 (B-1)	0	0	0
	Mumbwa	20	0	8 (A-3)	0	12 (A-1)	0
	Serenje	15	0	0	15 (A-1)	0	0
Copperbelt	Ndola	50	0	0	20 (B-1)	19 (B-1)	11 (B-1)
Total:	7	200	20	59	40	40	41

FIG. 4 - 4 DIAGRAM SHOWING LOCATIONS OF STAGE-DEVIDED DRILLING WORKS



3) Schedule of Water Facilities Construction

The completion of a successful boreholeis followed by the construction of water facilities. This type of work is to be executed in the same order as of the borehole construction, and the same division of the schedule into the stages is applied.

4) Schedule of Rehabilitation Work

The rehabilitation work of existing boreholes are scheduled to be executed concurrently with the construction of new boreholes. The division of this type of work into the stages and the order of the work progress are shown in Table 4 - 7 as follows:

TABLE 4 - 7 SCHEDULE OF REHABILITATION WORK

Governorate	District	No. of Boreholes for Rehabilitation	Stage I	Stage II	Stage III	Stage IV
Lusaka	Lusaka Rural	70	1	45	17	7
	Luangwa	10	-	10	-	-
Copperbelt	Ndola	20	-	-	20	-
Total:	3	100	1	55	37	7

4.3.4 TYPES OF EQUIPMENT/MATERIALS AND THEIR MANAGEMENT

The request for the Project had the requirement for the procurement of equipment/materials for the construction of boreholes including drilling rigs, with which planned boreholes were intended to be constructed, with a program to provide technology transfer to the staff engaging in the implementation.

Particulars of equipment and materials to be procured have been studied with regard to the purpose and environment of their use, interchangeability with existing equipment, degree of proficiency of counterpart staff in this type of equipment, etc. The results of this review are described as follows:

1) Drilling Rigs

The average type of boreholes for rural area water supplies in the Project area have been 4 in. to 6 in. in diameter (100 to 150 mm) and about 60 m in avarage depth. The drilling method and the equipment to be employed for such boreholes decidedly depend upon the hydrogeological conditions of the area under the plan. The geological features of the area of this Project vary from Precambrian granite, gneiss and schist to Paleozoic or Mesozoic sandstone, mudstone, conglomerate, quartzite, shale, limestone and dolomite, all of which are tightly cemented hard rocks showing complex distribution. The following table 4 - 8 summarizes hydrogeological data of the Project area prepared by the DWA. According to the data in this table, hard rocks such as granite, gneiss, schist, quartzite and limestone are being drilled to depths of 60 - 120 m. Such current practice is considered to require new machines having a capacity of drilling to a depth of 150 m.

Table 4 - 8 HYDROGEOLOGICAL DATA OF PROJECT AREA

Types of Rocks	Borehole Depth (m)			Q	K
	Min.	Max.	Ave.	(lit/s/m)	(m/d)
Granite, Gneiss, Schist	20	60	36	0.11	0.39
Mudstone, Siltstone, Sandstone, Marl, Grits	30	65	55	0.20	0.55
Quartzite, Conglomerate	20	70	50	0.22	0.63
Shale, Schist	40	120	60	0.28	0.64
Sand, Gravel, Clay	10	45	30	0.33	0.66
Limestone, Dolomite, Carbonate, Argellite	14	70	45	2.58	6.71

Q = Specific Capacity (lit/s/m)
K = Permeability Coefficient (m/d)

Concerning the type of rigs, the DWA owns both rotary and percussion rigs. However, for efficient and effective drilling through hard rocks prevalent in the Project area, the rotary type rigs are preferred to the percussion ones, since the former can employ the down-the-hole drilling method which have an advantage of the fastest drilling speed through such hard types of rocks. Furthermore, the rigs should be of truck-mounted type enabling high mobility. The similar types of rotary rigs mounted on the truck were already procured by the DWA, four units in all, with two units under Southern Province Groundwater Development Project and another two, under Non-Project Assistance.

For drilling operations, the respective units of those machines require sufficient drilling tools, supporting equipment such as a high-pressure compressor and spare parts. Such a lineup of rigs with tools and supporting equipment can guarantee

satisfactory operations undertaken by the DWA itself in the future.

2) Vehicles, Survey Equipment & Workshop Equipment

Technology transfer in style of on-the-job training is planned to be carried out during the progress of works for groundwater development, utilizing procured equipment and materials. Upon completion of the Project, the equipment and materials are transferred to the DWA which will resume its own program for borehole construction for rural area water supplies. Through the study of the Project planning under the request as well as the analysis of the current situation of factors affecting drilling operations, the lineup of equipment and materials required for work on borehole construction and pre-construction hydrogeological survey are proposed as enumerated hereafter. Further, it is indispensable to add to the list such equipment and materials as required for the repair and maintenance of the completed facilities and procured construction equipment.

Types, uses and numbers of equipment and materials are studied as follows, taking into account the setup of the entire organization and work forces for the Project implementation.

(1) Two units of drilling rigs, drilling tools and high compressors are required for the entire Project to allocate one unit each to the respective drilling crew of two forming the Drilling Unit.

(2) The quantity of materials necessary for borehole construction such as casing pipes, well screens and others are calculated, based upon the planned number of 200 for successful boreholes with an average drilling depth of 60 m and the average aquifer length of 12 m. The unit length of pipe employed for calculation is a standard length of 4 m. Since the rate of successful wells is 80 percent, the quantities of materials to be procured is required to be

increased accordingly.

(3) The Hydrogeological Survey Team consists of two units, and needs two sets of survey equipment consisting of geoelectric prospecting equipment and borehole logging equipment. Pumping test equipment is to be provided respectively to two crew members of the Pumping Test Unit. Concerning water analysis equipment consisting of a water analysis kit, a water level meter, a pH meter and an electric conductivity meter, five (5) sets are required to support activities of two units of the Hydrogeological Survey Team, two crew members of the Pumping Test Unit and one crew member of the Rehabilitation Work Unit.

In view of the hydrogeological conditions of the Project area where groundwater occurs mainly through fracture zones of hard rocks such as granite, gneiss and schist, two units of electromagnetic survey equipment are added to the list of the above survey equipment. This type of survey equipment is especially effective for groundwater research in hard rock areas.

(4) Hand pumps are installed at 300 units, with 200 for new boreholes and 100 for rehabilitation use.

(5) The numbers of supporting vehicles are calculated, based upon the setup of the entire Japanese project team, the numbers of the respective task forces and the range of their activities. The results of the calculation are listed in Table 4 -9.

(6) The number of necessary wireless sets is 6 units, to link DWA Lusaka Headquarters, Kabwe Japanese Project Operation Base/Depot, two crews of the Drilling Unit and three teams outgoing for Project inspection and management, each from the DWA, the Consultant and the Contractor.

(7) Two units of camping facilities are necessary for the

TABLE 4 - 9 EQUIPMENT SCHEDULE

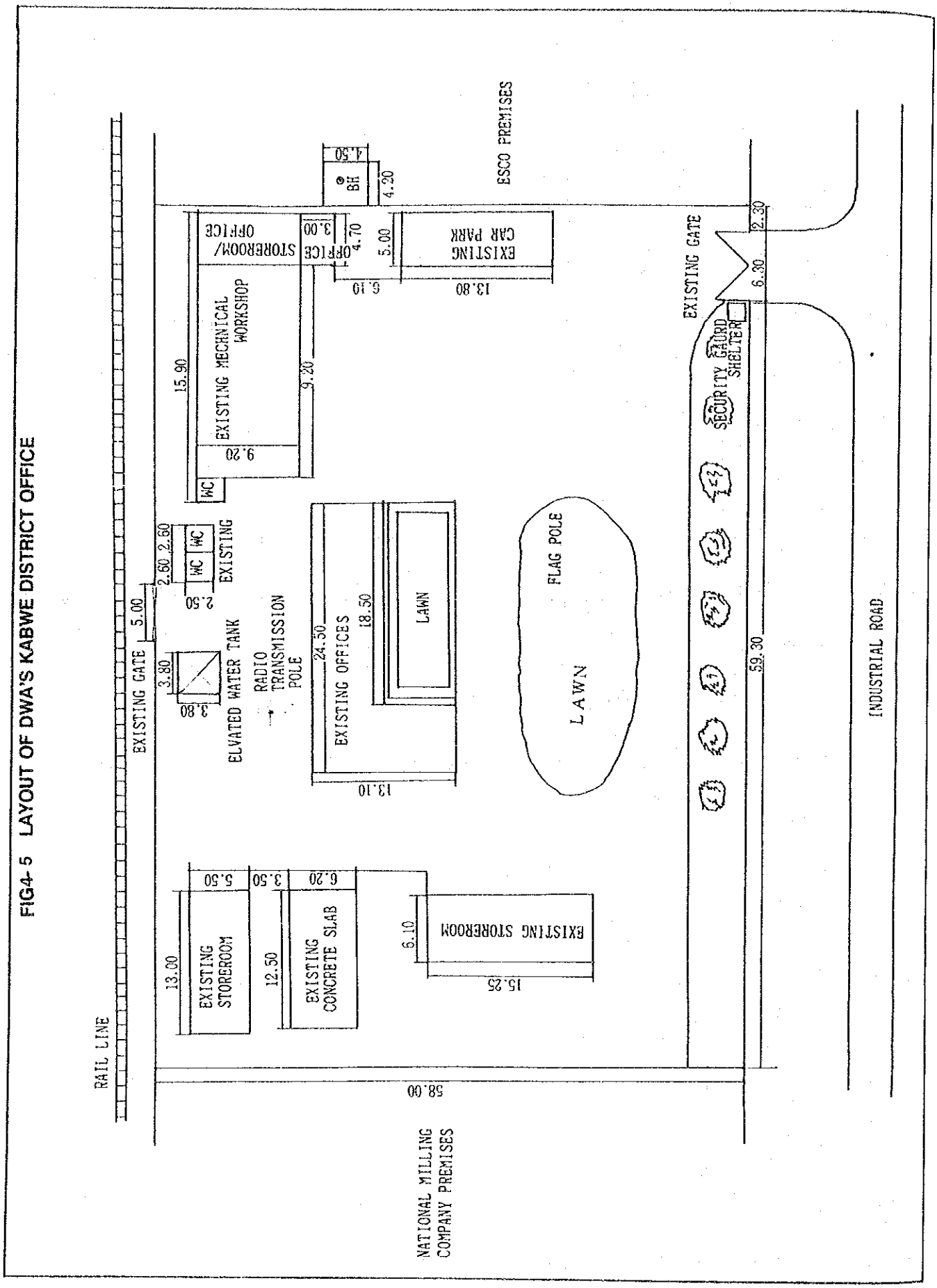
ITEMS	REQUESTED QUANTITY	PROPOSED QUANTITY
1. DRILLING RIG WITH STANDARD ACCESSORIES	2 Units	2 Units
2. DRILLING TOOLS & OTHER TOOLS	2 Sets	2 Sets
3. HIGH PRESSUER AIR COMPRESSOR /DIESEL WELDER	2 Units /each	2 Units /each
4. BOREHOLE CONSTRUCTION MATERIALS		
1) Casing Pipes	2,060 Pcs.	12,000 m (3,000 Pcs.)
2) Well Screen	690 Pcs.	3,000 m (750 Pcs.)
3) Other Misc. Materials	1 Lot	1 Lot
5. SURVEY EQUIPMENT		
1) Geoelectric Survey Equipment	1 Unit	2 Units
2) Borehole Logging Equipment	2 Units	2 Units
3) Pumping Test Equipment	2 Units	2 Units
4) Potable Water Analysis Kit	2 Units	5 Units
5) Water Level Meter	1 Unit	5 Units
6) pH Meter	2 Units	5 Units
7) Electric Conductivity Meter	2 Units	5 Units
8) Electmagnetic Survey Equipment	-	2 Units
6. HAND PUMPS		
1) For New Boreholes	200 Sets	200 Sets
2) For Rehabilitation	120 Sets	100 Sets
7. VEHICLES		
1) Large Size Gargo Truck	2 Units	2 Units
2) Medium Size Cargo Truck With 3 ton Crane	2 Units	2 Units
3) Compressor Carrier Truck With 5 ton Crane	2 Units	2 Units
4) Pick - up Truck	2 Units	3 Units
5) Station Wagon	4 Units	15 Units
6) Hand Pump Maintenance Car	2 Units	3 Units
7) Potable Compressor Trailer	2 Units	-
8) Water Tanker	-	2 Units
9) Fuel Tanker	-	2 Units
8. RADIO TELEPHONE EQUIPMENT	4 Sets	6 Sets
9. WORKSHOP EQUIPMENT	1 Unit	1 Unit
10. MISCELLANEOUS MATERIALS ALLIED TO THE PROJECT IMPLEMENTATION	1 Unit	1 Unit
11. SPARE PARTS FOR TWO YEARS	1 Unit	1 Unit
12. CAMPING EQUIPMENT	-	2 Units

operations of the respective drilling crews of two in number, since the Project sites are scattered over a wide area.

3) Depot for Storage and Maintenance of Equipment

A depot of suitable size with relevant facilities is required to be installed at the headquarters of the Project for the operation base of the Project as well as the storage and management of two drilling rigs, vehicles and other equipment and materials. Although a part of the Kabwe Provincial Water Engineer Office could be utilized by the Japanese project team, the size and existing facilities are far from sufficient for the management of large-scale equipment and materials to be procured under the Project. (For the layout of the existing office, see Fig. 4 - 5). The new depot is desired to be located near the existing office and to be comprised of a management office building, a warehouse, a workshop and a garage. During the explanation of the draft final report of this Project to the Government of Zambia conducted in March 1991, the discussions were held with the DWA on this point, and eventually the required site was designated in the minutes. (For the details of this Base, refer to the layout drawing included in the Appendix to this report).

FIG4-5 LAYOUT OF DWA'S KABWE DISTRICT OFFICE



4.3.5 OPERATION AND MAINTENANCE PROGRAM

The planning and implementation of rural area water supplies in Zambia is undertaken by the DWA, while their operation and maintenance is basically responsibilities of district councils in the respective districts. Due to lack of manpower or other reasons, however, the greater part of that responsibility has been taken over by the DWA. Inhabitants of rural communities also offered activities of self reliance such as the construction of dug wells. During the previous Japanese projects for Southern Province, the installation of drainage facilities surrounding boreholes was a responsibility of rural communities. Those facilities, however, have not been installed in places. The current rural scenes of water supplies are seen to urge concerned officials to further promote training of inhabitants on public health. This Project needs proper operation and maintenance for completed facilities of boreholes and procured equipment and materials, A proper system for that purpose is proposed as follows:

1) O/M of Borehole Facilities

Borehole facilities must be properly operated and maintained with periodical inspection and repair, whenever necessary, to constantly serve the population hygienic drinking water. A great many facilities, however, are seen to have been left useless, simply because of breakdown of hand pumps. To cope with such a situation, it is advisable to establish a communal unit responsible for regular inspection and maintenance of facilities through participation of as many inhabitants as possible. This Project plans to provide a maintenance tools kit to the respective sites, including training of operators to enable them to manage minor troubles with pumps. Shutdown of boreholes due to decreased yield or sharp decline of the water level can be revived by rehabilitation works such as air cleaning work with or without aid of chemicals. The application of such high-level technique must be assisted by the DWA. Existing wells frequently have been a cause of waterborne epidemics through artificial contamination. The rural environment could largely be improved if efforts would be made for promoting health education

among its inhabitants. This Project is intended to assist the DWA in enlightening inhabitants on sanitary environment.

Under those circumstances, the installation of an O/M unit in the respective sites will be most helpful for maintaining borehole facilities. Tools necessary for routine inspection and repairs should be provided to such units to inspire their practical activities. The details of such an O/M system for borehole facilities are summarized as follows:

(1) The operation and maintenance of boreholes shall basically be performed by the respective communities themselves with technical support of the DWA.

(2) A number of operators of borehole facilities shall be selected from the inhabitants of the respective communities. They shall train at the DWA regarding essential techniques of O/M.

(3) Health education programs shall be carried out to enlighten sanitary concerns of the rural population.

(4) Public relations programs shall be organized to let the rural people know about the significance of this Project so that they may have acute interest in the Project and spend their own efforts to protect their facilities.

(5) Sustained maintenance of facilities shall be practiced by the above-described system through periodical checks of water quantity and quality and surrounding sanitary conditions.

2) Management of Equipment and Materials

The DWA has its own workshops and warehouses for the equipment and materials it procured in the past. Those facilities have been utilized to their full capacities under control of the DWA's personnel having an adequate capability for

repairing equipment and vehicles as well as managing stocks of materials and spare parts. Drilling rigs ordinarily assure sustained operation of 10 or more years, if properly operated and maintained with appropriate supply of spare parts. Their continued operation after the completion of the Project is quite possible, through the establishment of pertinent O/M system by the DWA.

For the purpose of maintenance, this Project plans to offer workshop machinery and tools and spare parts for supplied equipment and materials to cover the two-year period.

The following points are particularly drawn to attention, therefore, concerning the operation and maintenance of equipment and materials.

(1) According to the survey results of DWA's current O/M system, no special question is raised about its effectiveness for repair and maintenance of rigs and vehicles as well as their management. Its technical staff already has knowledge of equipment and materials of Japanese make through its experience in previous Japanese grant aid projects. Technology transfer is also planned to be provided under this Project to further upgrade its knowledge so that the operation and maintenance of equipment/materials can effectively and efficiently be carried out.

(2) Periodic inspection and maintenance of equipment and vehicles is indispensable to get maximum effect in their operation. A workshop should be included as a facility of a new depot.

(3) The depot shall have a warehouse for the organized storage of materials and spare parts to prevent theft or possible damage during wet seasons of goods in open storage. The accurate record of supply, consumption, points of problems, etc., shall be kept with those materials for reference of

the future planning for additional procurement.

3) Operation and Maintenance Cost

The recurring cost for operation and maintenance of the completed facilities is estimated for expenses of the DWA's periodic inspection and those for repairing damages which could not be coped with by inhabitants themselvs. The calculation assumes that the DWA's staff would be dispatched twice a year. The calculated cost, therefore, does not include expenditure for routine operation and maintenance by inhabitants.

(1) Personnel

The team for operation and maintenance is headed by a team leader, composed of three crews, each staffed with technicians, workers and a drivers. The total number of personnel of the team is 10. The respective crews handle one site in one day. With 300 sites completed under this Project, they will have to be engaged in service for their inspection and maintenance throughout the year.

a.	Team leader	1
b.	Technicians	3
c.	Workers	3
d.	Driver	3
	Total:	10

(2) Fuel

The calculation of fuel cost is based upon the mileage of the inspection by the DWA's O/M team from Kabue Depot, covering 300 sites comleted under this Project.

(3) Maintenance of Vehicles

The cost for maintenance of vehicles to be used for the DWA's maintenance team is estimated at 20 percent of the fuel cost calculated for the regular inspection, covering routine checks and supply of oils.

(4) Spare Parts

The expenses for repair and parts replacement are estimated at 5 percent of equipment and vehicles to be procured under this Project.

Based upon the thus-assumed factors, a yearly cost for operation and maintenance of the completed facilities by the DWA is estimated to total 3.69 million Kwacha (about 92,000 U.S. dollars).

a.	Personnel	966,000 (Kwacha)
b.	Fuel	1,342,000
c.	Vehicles	268,000
d.	Repair/Spare Parts	1,114,000
	Total:	3,690,000 (Kwacha)
		(About 92,000 dollars)

CHAPTER V

BASIC DESIGN STUDY

CHAPTER V

BASIC DESIGN STUDY

5.1 DESIGN CONCEPT

The design concept of this Project is established for the practical realization of borehole construction at 200 sites as the responsibility of the Japanese side, taking into account the background of the request from the Government of Zambia and its guidelines for rural area water supplies. Special attention is drawn to the conditions of the long wet season as a critical factor affecting the design of the whole program, since it creates difficulty both in works and access. This Project also intends to promote the education of inhabitants on public health through the implementation of the Project, advising them on the formation of a relevant operation and maintenance unit for the community and offering them hand tools for encouraging their direct participation in the regular inspection and repair of their own facilities. Technical particulars adopted for the planning reflect and are adapted to the current situation of the country's rural water supplies. The implementation program has carefully been arranged to conform to the rules of Japan's grant aid system so that each stage divided under the program can satisfactorily be concluded within a designated time period under that system.

This Project not only intends to supply equipment and materials and to execute the construction of boreholes with them at 200 sites, but also aims to offer the staff of the DWA opportunities for technology transfer on hydrogeological survey for groundwater development, drilling techniques, rehabilitation method and management of project implementation, and operation and maintenance, so that the DWA can take over the project for its own program for promotion of water supplies, employing procured equipment and materials.

5.2 DESIGN CONDITIONS

The plan of this Project largely resembles those of the previous Japanese grant aid projects for this sector, Groundwater Development Project Phases I and II for Southern Province. The results of those preceding projects were closely studied and have been reflected in the design of this Project. Those design conditions, based upon such results of the study and the field survey in the Project area, are summarized as follows:

1) The specifications and design conditions of boreholes, pumps and appurtenant facilities shall be based upon DWA's design standards and standard working drawings.

2) Since the objective of the Project is to construct urgently needed facilities for the sites extremely suffering from scarcity of drinking water, only a single facility can be offered to each site. For this reason, the standards of the WHO and DWA regarding the unit supply rate and the planned served population is confined to reference only.

5.3 DESIGN OF FACILITIES

5.3.1 FACILITIES OF NEW BOREHOLES

1) Project Sites

The Project sites are 200 in number located in 7 districts of 3 provinces. The priority for the selection of these sites have been decided through consultation with the officials concerned of the DWA as well as local authorities of the respective districts, taking into account the analysis of results of the field survey. High priority was given to the influential sites in the regions in respect to the public interests such as education, health, agricultural development, etc., where no sanitary water sources currently exist or the existing ones would routinely get empty

during dry seasons.

2) Boreholes

Water sources for the Project are boreholes, stable and hygienic in quantity and quality, which can hardly dry up during the dry seasons. Pumping units to be installed in boreholes are hand pumps, complying with the DWA's criterion for rural area water supplies.

3) Unit Supply Rate

A target rate of the unit supply is basically 30 lit/day/capita, complying with WHO's standards . The rate during emergent seasons of dry spells, however, is reduced to 5 lit/day/capita meeting the criterion for drinking water only.

4) Planned Served Population

A pumping rate with a hand pump is approximately 750 lit/hr. The conventional pumping period is confined to 10 hours a day from dawn to sunset. Accordingly, the planned population at one site served with a single borehole facility is calculated as follows:

a. Ordinary situation
750 lit/hr x 10 hrs ÷ 30 lit/day/capita = 250 persons

b. Dry season
750 lit/hr x 10 hrs ÷ 5 lit/day/capita = 1,500 persons

5) Appurtenant Facilities to Boreholes

A drainage facility consisting of concrete drain floor, drain ditch and a soakaway is constructed in the surrounding area of the borehole to prevent seepage of waste water underground. A drain floor is made of reinforced concrete to safeguard against cracks.

5.3.2 REHABILITATION OF EXISTING BOREHOLES

1) Project Sites

The Project sites for rehabilitation works are 100 in number in 3 districts of 2 provinces. These sites have been confirmed through consultation with responsible officials of DWA and the districts. The selection has been made, based upon the public elements in the education, health or agriculture sectors featuring the sites whose existing boreholes are anticipated to revive the function of producing clean drinking water through rehabilitation works.

2) Rehabilitation Works

Troubles with the existing boreholes, which have been left unused, stem mostly from broken-down hand pumps. The rehabilitation of the existing boreholes, therefore, will focuse on the replacement of damaged pumps with new ones.

5.3.3 STRUCTURE OF NEW BOREHOLES

1) Drilling Depth of Boreholes

The average drilling depth of boreholes under the Project is 60 meters, based upon the prevalent hydrogeological conditions of the Project area, involving the distribution of hard rocks such as gneiss, schist and granite, as well as the results of the analysis of geoelectric prospecting conducted over the area.

2) Diameter of Boreholes

The diameter of boreholes is 4 in. or 6 in.(100 mm or 150 mm), according to the planned populations to be served at the sites. The latter size of 6 in. will be selected for the sites with favorable hydrogeological conditions, where water demand is

expected to increase in the near future so that hand pumps are likely to be replaced by power-driven pumps.

3) Casing Pipes and Well Screens

Casing pipes and well screens are of FRP make. These types of casings and screens have long been employed by the DWA, since they are strong despite their light weights to allow easy handling during transportation and field works as well as fitness to groundwater quality having a pH value of 6.9 to 7.3. Their unit length is 4 meters as employed in standard products. The average length of well screens per borehole is 12 meters, corresponding to 20 percent of the average depth of the well of 60 meters. Accordingly, the average length of casing pipes per borehole is 48 meters.

4) Cementing and Gravel Packing

The uppermost section of boreholes to a depth of 5 to 6 m shall be tightly sealed with cement grout to prevent direct intrusion of waste water through this zone. Gravel packing of selected particles is basically applied between aquifers and well screens.

5) Centralizer

Centralizers can help keep straight the alignment of casing pipes and well screens into drilled boreholes.

The proposed design of typical borehole structure, as described herein, is illustrated in the Appendix to this report.

5.4 EQUIPMENT SCHEDULE

Specifications of equipment and materials required for borehole construction, hydrogeological survey and operation and maintenance are listed below.

1) Drilling Rigs and Related Equipment

a. Drilling rigs & standard accessories:

Q'ty: 2 units

Type: Rotary, all-wheel drive (6x6) truck-mounted

Capacity: 6 in. (150 mm) x 150 m

b. Drilling tools and other equipment

Q'ty: 2 sets

Type: For use of the above rigs

c. High pressure air compressor

Q'ty: 2 units

Type: Diesel engine driven, portable type

Air volume: 21 m^3/min

Pressure: 21.0 kg/cm^2

d. Welding equipment

Q'ty: 2 units

Type: Gas welding equipment and an electric welder

2) Materials for Borehole Construction

a. Casing pipes

Material: FRP

Diameter & Length:	6 in. (150 mm) x	1,200 m L
	4 in. (100 mm) x	10,800 m L

b. Well screens

Material: FRP

Diameter & Length:	6 in. (150 mm) x	300 m L
	4 in. (100 mm) x	2,700 m L

c. Well bottom

Diameter & Q'ty:	6 in. (150 mm) x	25 pcs
	4 in. (100 mm) x	225 pcs

d. Well cap

Diameter & Q'ty:	6 in. (150 mm) x	25 pcs
	4 in. (100 mm) x	225 pcs

e. Centralizer

Diameter & Q'ty:	6 in. (150 mm) x	150 pcs
	4 in. (100 mm) x	1,350 pcs

f. Materials for drilling fluid control: 1 lot

3) Survey & Testing Equipment

a. Geoelectric prospecting equipment

Q'ty: 2 units
Type: Digital type
Depth of measurement: not less than 200 m

b. Borehole logging equipment

Q'ty: 2 units
Type: Digital type
Depth of measurement: not less than 300 m
Items of measurement: Normal resistivity
Natural Gamma

c. Electromagnetic survey equipment

Q'ty: 2 units
Depth of measurement: not less than 100 m

d. Data processing unit

Q'ty: 1 lot
Type: For analysis of above data, (a) to (c)

e. Pumping test equipment

Q'ty: 2 units
Type: Submersible motor pump
Discharge: 200 lit/min
Total head: 100 m
Power source: Diesel engine 400V, not less than 20 KVA

f. Portable water analysis kit

Q'ty: 5 units

Type: Portable, drinking water standards

g. Water level meter

Q'ty: 5 units

Type: Portable

Depth of measurement: not less than 100 m

h. pH meter

Q'ty: 5 units

Type: Portable, digital type

i. Electric conductivity meter

Q'ty: 5 units

Type: Portable

4) Hand Pump

a. For new boreholes

Q'ty: 200 units

Type: Borehole type

b. For rehabilitation

Q'ty: 100 units

Type: Borehole type

c. Tools set for hand pump

Q'ty: 300 sets

Type: For inspection and repair of hand pumps

5) Vehicles

a. Cargo truck with crane

Q'ty: 2 units

Max. payload: Not less than 12,500 kg

Engine: Water cooled diesel engine not less than 250ps

Crane capacity: Not less than 5,000 kg/2.5 m

b. Service truck

Q'ty: 2 units

Max. payload: 7,500 kg

Engine: Water cooled diesel engine not less than 190ps

c. Medium-size cargo truck with crane

Q'ty: 2 units

Drive: All wheel drive (4 x 4)

Max. payload: Not less than 3,500 kg

Engine: Water cooled diesel engine not less than 160ps

Crane capacity: Not less than 2,000 kg/2.5 m

d. Water tank truck

Q'ty: 2 units

Drive: All wheel drive

Tank capacity: Not less than 4,000 lit.

Engine: Water cooled diesel engine not less than 190ps

e. Fuel tank truck

Q'ty: 2 units

Drive: All wheel drive (4 x 4)

Tank capacity: Not less than 4,000 lit.

Engine: Water cooled diesel engine not less than 190ps

f. Station wagon

Q'ty: 15 units

Drive: All wheel drive (4 x 4), long wheel base type

Engine: Water cooled diesel engine not less than 90ps

Passenger: Not less than 6

g. Pickup truck

Q'ty: 3 units

Drive: All wheel drive (4 x 4), double cabin type

Engine: Water cooled diesel engine not less than 90ps

h. Service vehicle for rehabilitation & O/M

Q'ty: 3 units

Drive: All wheel drive (4 x 4), long wheel base

Engine: Water cooled diesel engine not less than 90ps
Crane capacity: not less than 450 kg

6) Radio Telephone Equipment

a. Fixed station type
Q'ty: 2 units
Output: Not less than 100 W
Type: MHF/HF, SSB

b. Mobile type
Q'ty: 4 units
Output: Not less than 100 W
Type: MHF/HF, SSB

7) Workshop Equipment

a. Gas welding equipment
Q'ty: 1 set
Type: Gas/acetylene welding

b. Electric welding equipment
Q'ty: 1 set
Type: Diesel engine driven, portable type
for a combined use of power generating & welding
Range of current: Not less than 50 - 270 A

c. Maintenance equipment and tools
Q'ty: 1 set
Type: Include both for general use and for vehicles

8) Other Misc. Equipment

a.	Portable fuel storage tank :	2 units
b.	Portable concrete mixer:	3 units
c.	Hand tools:	3 sets

9) Spare Parts (for O/M for 2 years) 1 lot

10) Camping Facilities 2 lots

11) Project Operation Base 1 lot

The Japanese Project Operation Base is constructed at Kabwe City of Central Province for the mobilization of equipment and materials to ensure effective and efficient operation of the Project. The proposed layout of the structure is illustrated in the Appendix.

5.5 PROJECT IMPLEMENTATION

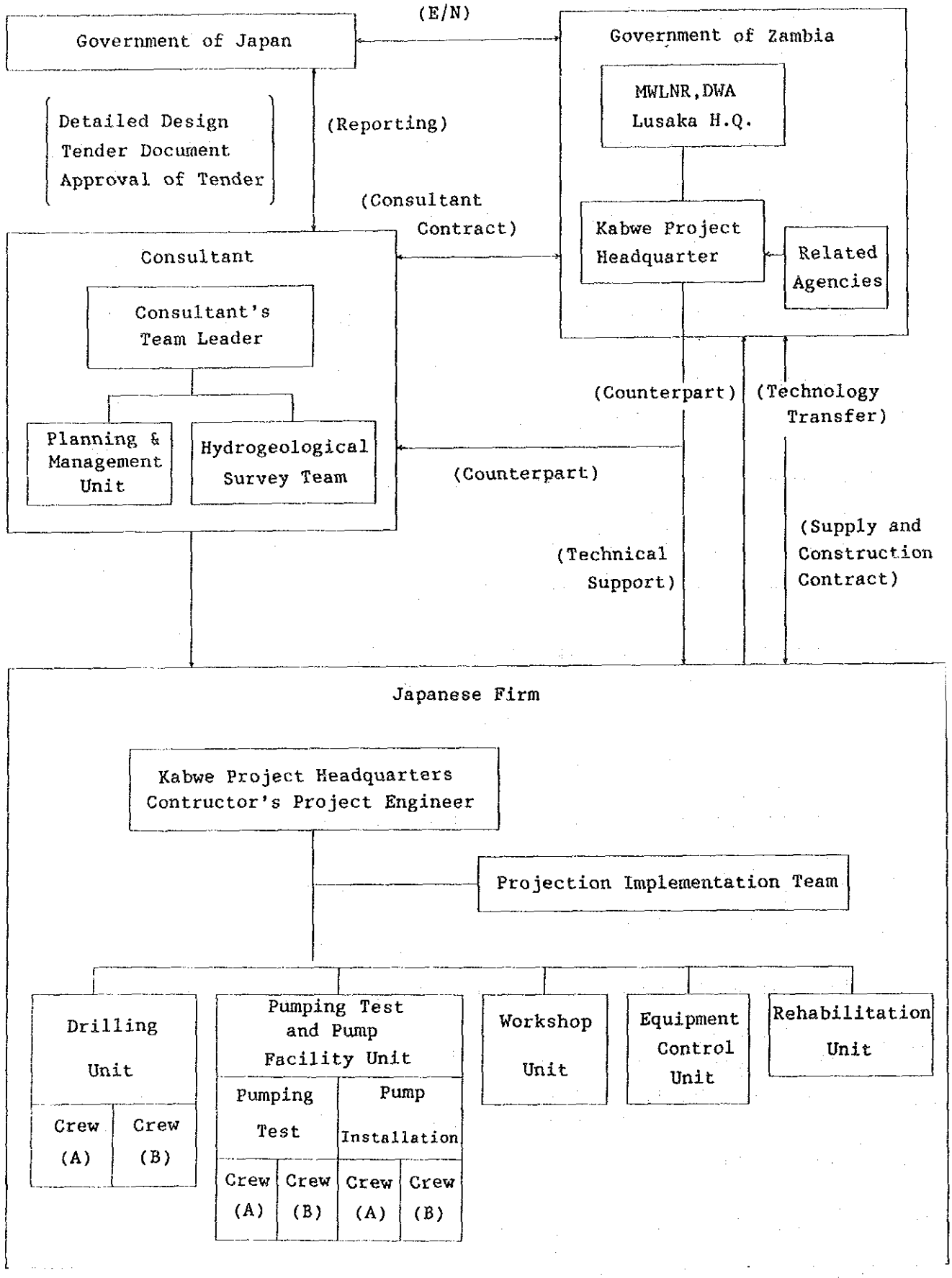
5.5.1 Organization for Project Implementation

After the Exchange of Notes, the executing agency DWA will make a contract with a Japanese consultant for the detailed designing and construction supervision and the agency will perform a package tendering for the construction of water supply facilities and supply of related equipment and materials with the assistance of the consultant. As a result of evaluation on tenders, the agency will enter into the contract with a firm. As this is a Japanese grant aid Project, the principal contractor shall be a Japanese firm. Framework of the Project implementation is shown in Fig. 5-1

Under the supervision of the consultant, the contractor will construct the required water supply facilities and supply the related equipment and materials. Meanwhile, the DWA will dispatch counterparts who engage in the execution of works and receive technology transfer during the implementation period.

After the inspection by the DWA, the completed water supply facilities will be handed to the respective rural communities for general operation and maintenance while the DWA will be responsible for works requiring special skill and technique. The supplied equipment and materials shall be handled by each section which receives technical transfer through the implementation of the Project after the inspection by the DWA.

FIG. 5 - 1 IMPLEMENTATION SYSTEM



5.5.2 RESPONSIBILITUES OF ZAMBIAN SIDE

1) Acquisition of land for sites and a depot required for the water supply facilities and preparation of access roads to the land for the implementation of the Project.

2) Smooth enforcement of administrative measures necessary for the implementation of the Project such as arrangements on duty clearance and tax exemption, the furnishing of data and information.

3) Bearing any changes including the bank commission charge other than those covered by the Japanese grant aid necessary for the execution of the Project.

4) Preparation of an appropriate managing and maintenance organization with personnel and budget required for properly functioning the supplied equipment and materials for the Project and the completed facilities.

5) The Zambian Government shall provide necessary personnel for the job site training of the Project.

5.5.3 CONSULTING SERVICES

This Project is executed as Japan's grant aid project by Japanese firms from the detailed design to the commissioning of completed water supply facilities. Since the Project includes the sector of groundwater resources development as well as that of water supply facilities construction in arid or semi-arid environment, firms having sound technical and engineering knowledge and expertise in both fields are sought. Concerning the construction work of the Project operation base at Kabwe City, the employment of local subcontractor (s) specialized in this sector is economically more feasible. With proper management and control of such local firm (s) in engineering, the contractor will be able to complete the work within a planned schedule

at a reasonable cost. The consulting service is carried out by a Japanese consulting firm under Japan's grant aid system. The consultant undertakes services such as the detailed design study, tendering and contracting procedures, the supervision of construction works and commissioning of completed work, which proceed in the following order (Refer to Table 5 - 1):

Pre-construction stage:

1. Detailed design study;
2. Preparation of tender documents;
3. Assisting the Client in tender;
4. Evaluation of the tender;
5. Assisting the Client in concluding the contract

Construction stage:

6. Supervision of construction work;
7. Formulation of technology transfer program and advice;
8. Inspection and commissioning;
9. Preparation of final completion report.

After the conclusion of Exchange of Notes between both the Governments, the detailed design study (including the field survey, necessary for the execution of the Project) is performed by the consultant. He prepares tender documents including specifications for both the equipment and materials to be procured and construction of facilities. In the next step, the Consultant prepares the tendering program, presides the tender opening and assists the Client and the contractor in entering into the contract for the construction works.

During the construction stage, the consultant engages in coordination among the offices concerned with the Project, quality control of the works and the management of work progress. He is also responsible for planning the training program for technological transfer and carrying out technical training on the hydrogeological survey and the construction of boreholes and water supply facilities.

Upon completion of water facilities, the inspection of the works, as well as the delivered equipment and materials, will be performed by

the Client with the assistance of the consultant. As the final step, the consultant will prepare the final completion report.

5.5.4 PROCUREMANT PLAN

Among construction materials used for the Project, cement, cement products, brick, sand, gravel and borehole packing gravel can be procured in the domestic market of Zambia, but most of the major materials must be imported from abroad.

Foreign currency is under strict control of the Government and imports of materials, even for grant aid projects, requiress permission of the Government. Care must be taken of this process of official permission, particularly when there is a need to import a third country's products. The past case indicates that the acquisition of permission takes one to three months, after the application is submitted to the Ministry of Commerce and confirmed by the Bank of Zambia. The second step after the acquisition of this import license is the request for customs exemption, which must be applied to the Ministry of Finance, and takes about one week. Therefore, the period necessary for the clearance of this procedure should be added to the implementation schedule of shipment and delivery of materials to construction sites.

Furthermore, transport routes to landlocked Zambia are decidedly limited. A major part of the transport of materials used to be through South Africa and Zimbabwe, but the latest trend is to employ Tanzan Railway or Tanzan Highway from the port of Dar Es Salaam of Tanzania, as was the case with previous Japanese grant aid projects. For the smooth implementation of the Project, a transportation program must be formulated with care in advance of commencement of works.

5.5.5 IMPLEMENTATION SCHEDULUE

The implementation schedule of the entire Project is divided into five stages, taking into account various factors such as the rules of

Japan's grant aid system, the organization setup of the Zambian side, the period required for procurement and delivery of equipment and materials, natural conditions, particularly the influence of wet seasons, etc. Table 5 - 1 shows this divided program, based upon the analysis described in the foregoing Chapter IV.

TABLE 5 - 1 IMPLEMENTATION PROGRAM (1)

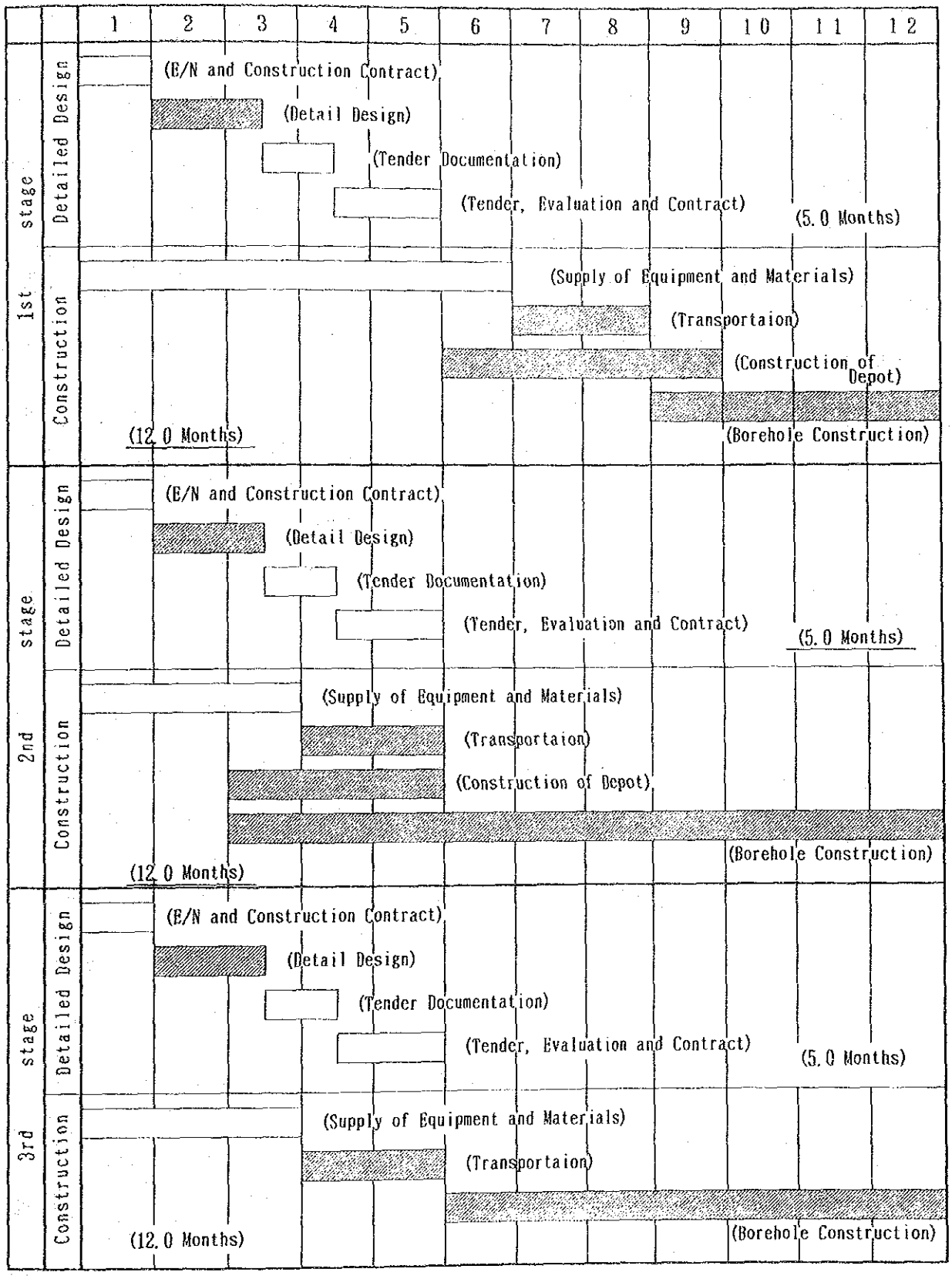
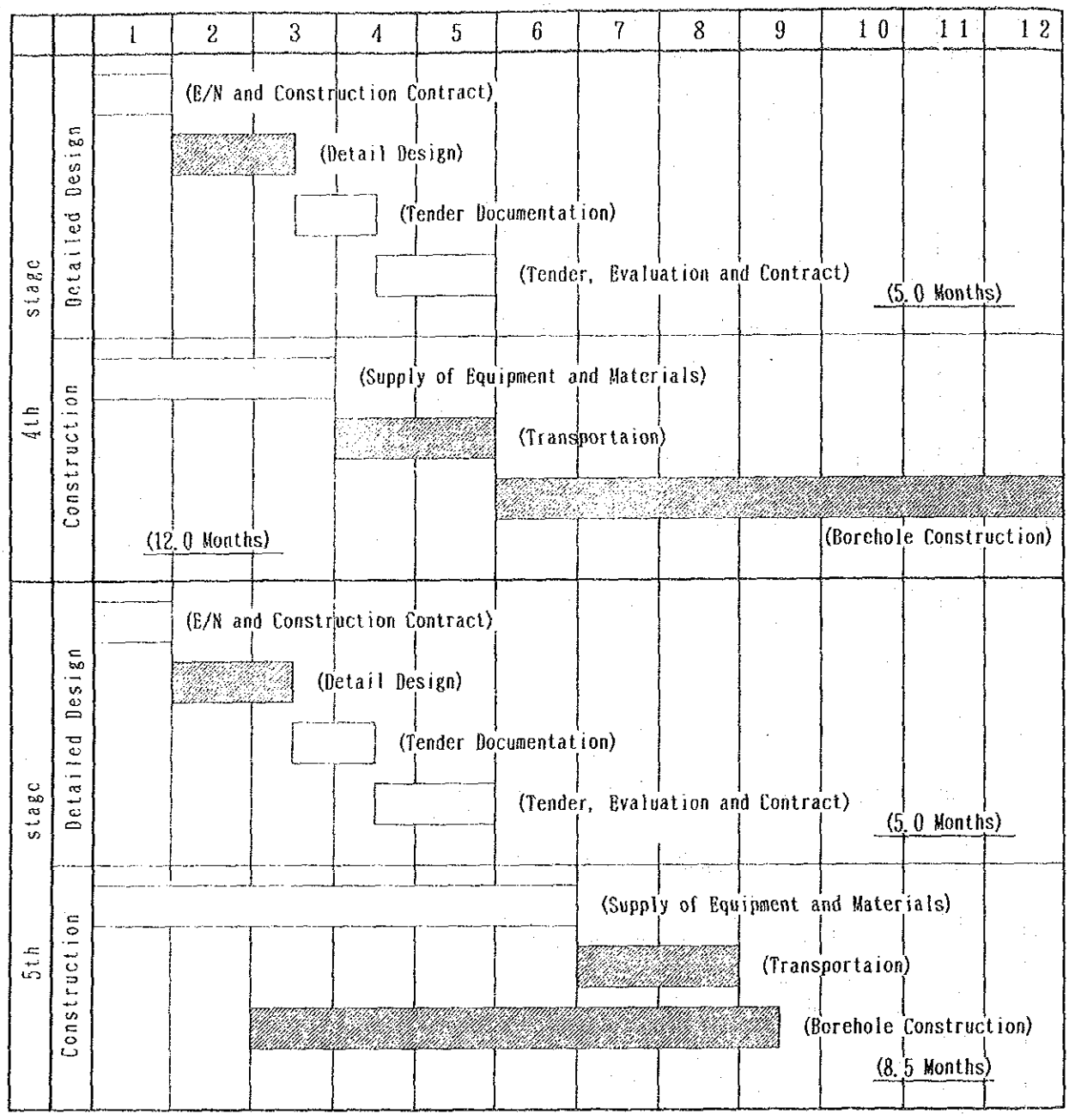


TABLE 5 - 1 IMPLEMENTATION PROGRAM (2)



CHAPTER VI

PROJECT EVALUATION, CONCLUSION AND RECOMMENDATION

CHAPTER VI

PROJECT EVALUATION AND CONCLUSION

6.1 PROJECT EVALUATION

It is evident that this Project ranks critically. It is important and urgent in view of the high priority given to the rural water supply schemes in the Fourth National Development Plan (1989 - 1993), as well as its high rating among diverse projects now under the request from Zambia to Japan. The Project is beneficial to the rural inhabitants sharing the rural development now being promoted by the Government. The EC, Germany and Norway as well as the World Bank join forces with such a view, positively offering assistance to this sector. The effects of this Project are summarized in the following table:

Table 6 - 1 Effects of the Project/Extent of Improvement

Current Situation/ Difficulties	Measures Taken by the Project	Anticipated Effects/ Improvement Range
1. *In the Project area, the year is divided into the wet and dry seasons. During the latter, hand-dug wells dry up, causing acute shortage of water over the area, where the coverage of rural water supplies is a remarkably low 24% compared to 41% of national average. Inhabitants have frequently been hit	*In 7 districts of 3 provinces of Lusaka, Central and Copperbelt, new boreholes will be constructed at 200 sites, and existing ones will be rehabilitated at 100 sites, for providing a stable supply of sanitary drinking water and augumenting the coverage.	*The total population of the Project area is 851,000, 24% of which are now being served with water. Upon completion of the Project, 200 new boreholes and 100 rehabilitated ones can serve 119,000 and 44,000 respectively (163,000 in total), corresponding 19% of the total population.

Current Situation/ Difficulties	Measures Taken by the Project	Anticipated Effects/ Improvement Range
1. (Continued) by outbreak of water borne diseases and intestinal infection due to deteriorated water qualities.		*The current coverage of 24% will be raised to 38%, and through rehabilitation of existing boreholes, a 5% portion already served can receive upgraded service. *Although a standard supply rate of 30 lit. per day per capita could not always be served due to a large population to be covered, the Project can alleviate acute shortage of water during dry seasons, assuring a minimum 5 lit per capita per day of safe drinking water.

Current Situation/ Difficulties	Measures Taken by the Project	Anticipated Effects/ Improvement Range
2. *The DWA, the executing agency of this Project is promoting the rural water supply scheme in line with the Fourth National Development Plan. The construction of boreholes as stable and sanitary water sources is being executed by two units of drill rigs deployed in the respective provinces by the DWA. However, 3 provinces under this Project have no rigs at all and the pace of development has been quite slow.	*Equipment and materials for ground water development including two units of drill rigs are procured under this Project. Technology transfer is carried out on hydrogeological survey, drilling work and operation and maintenance of water facilities to counterpart staffs of the DWA.	*Technology transfer is anticipated to bolster engineering staff of hydrogeology and drilling work in the DWA and to reinforce its organization for the promotion of rural water supply schemes. *Upon completion of the Project, the DWA can launch its own program for borehole construction, employing procured equipment and materials.
3. *In rural areas, water bill collection has not yet been introduced. Without any fund, therefore, damaged pumps have been left unrepaired.	*In this Project, 100 existing boreholes in 3 districts of 2 provinces are rehabilitated. A tools set for O/M is supplied to each site and training for O/M is carried out.	*Inhabitants' perception of sanitary environment will be improved. Their direct involvement in O/M of completed facilities and the establishment of autonomous bodies for such purpose in the respective communities including sharing expenses are anticipated.

Current Situation/ Difficulties	Measures Taken by the Project	Anticipated Effects/ Improvement Range
4. Bringing water home is the daily work of woman and children, and it requires them to work from dawn to sunset.	*The newly installed boreholes in the village will provide safe and stable water and shorten the distance between home and water resources.	*The painstaking labor of woman and children for bringing water home will be alleviated. Thereby they can use their time and energy for other activities such as agricultural production, study in school, recreation.

6.2 CONCLUSION

The Government of Zambia has been in immediate need of construction of numerous rural water supply facilities to provide a stable supply of safe and sanitary water to the rural inhabitants and has been endeavouring to accelerate its support of bilateral and international cooperation.

The construction of water supply facilities using groundwater from boreholes will be carried out in this Project in rural villages where inhabitants suffer from the scarcity of drinking water. At the same time, equipment and materials from the drilling of boreholes with water facilities shall be supplied in order to reinforce DWA for its undertakings of borehole construction works on its own. Moreover, the operation and maintenance of water supply facilities is to be improved to realize sanitary water environment of the area through the Project implementation and training program of inhabitants.

The Project is expected to contribute to raising the level of living standards and the rural economy of the Project area, complementing the rural recovery and development program now underway

in the same area. The DWA, the executing agency of the Project, has been promoting its reorganization for upgraded service since 1989 when it was transferred from the Ministry of Agriculture and Water Development to the Ministry of Water, Land and Natural Resources, and could offer a firm technical and organizational base for the implementation of the Project.

Therefore, the Project is concluded to be meaningful and feasible to be implemented under the Japanese grant aid.

6.3 RECOMMENDATIONS

The Project is expected to contribute to the betterment of a sanitary environment and life in the Project area and eventual rural area promotion as mentioned above. However, the following points must be considered for further effective performance of the supplied equipment and the completed water facilities, and for stable rural life in the future:

1) Increased efforts for maintenance will be required for the proper and smooth operation of water facilities to the Zambian Government, rural administrations and inhabitants themselves.

2) The systematic approach to application of a personal computer has already been introduced to Zambia for compilation, integration and storing of records and files of construction, observation and operation. Thus, a more effective system is recommended for managing the completed facilities and for future utilization of compiled data for the planning, construction, operation and maintenance of the water facilities.

3) The continuous efforts of the Zambian Government are encouraged for promoting the education of rural inhabitants on the meaning of a stable supply of safe and sanitary water and for inspiring them towards understanding the significance of conserving sanitary environment through effective use of served water.

4) The DWA is recommended to technically reinforce its maintenance

system and substantiate the periodic training program for the rural people including such action as the supply of tools and spare parts.

5) Zambia has a high potential for surface water and groundwater resources in comparison with neighboring countries. Since the DWA is in a position to control nationwide surface water and groundwater resources at a national level, it is recommended to manage to promote their effective development and conservation at the same time, to establish a regional monitoring system, including water quality control, and to formulate a comprehensive water resources control plan.

APPENDICES

APPENDIX 1 MINUTES OF MEETING

MINUTES OF DISCUSSIONS
ON
THE PROJECT
FOR
THE RURAL WATER SUPPLY DEVELOPMENT PHASE-III
IN
THE REPUBLIC OF ZAMBIA

In response to the request made by the Government of Zambia for the Rural Water Supply Development (Phase- III) in Lusaka and Central Provinces, and Ndola Rural District, Copperbelt Province, the Government of Japan has sent, through the Japan International Cooperation Agency (hereinafter referred to as "JICA") which is an official agency implementing the technical cooperation of the Government of Japan, a team headed by Mr. Osamu IKEDA, Deputy Director for International Cooperation, International Affairs Division, Minister's Secretariat, Ministry of Health and Welfare, to conduct the survey for 40 days from November 11th to December 20th 1990.

The team carried out a field survey, held a series of discussions and exchanged views with the authorities concerned of the Government of the Republic of Zambia.

Both parties have agreed to recommend to their respective Governments and the autorities concerned to examine the result of the survey attached herewith towards the realization of the Project.

Lusaka, 23rd of November, 1990

池田修

Osamu Ikeda
Team Leader
JICA Study Team
Japan

Namukolo Mukutu
Permanent Secretary
Ministry of Water, Lands and Nartural Resources
The Republic of Zambia

REPUBLIC OF ZAMBIA
MINISTRY OF WATER, LANDS AND
23 NOV 1990
NATURAL RESOURCES
P.O. BOX 50571, LUSAKA

M C SOKO
ACT/ Permanent Secretary
National Commission for
Development Planning
The Republic of Zambia

ATTACHMENT

1. The objective of the Project is to improve and stabilize the social conditions of the rural areas by supplying safe and clean drinking water to the rural people in Lusaka and Central Provinces and Ndola Rural District, Copperbelt Province.

2. The Project areas are located in the 7 Districts of 3 Provinces as follows.
   1) Lusaka Province
      Lusaka Rural and Luangwa Districts
   2) Central Province
      Kabwe Rural, Mkushi, Mumbwa, and Serenje Districts
   3) Copperbelt Province
      Ndola Rural District

3. The Project for the Rural Water Supply Development Phase- III in the Republic of Zambia consists of three (3) main items as follows.

   1) Construction of 200 new boreholes and water facilities in the above Project area

   2) Procurement of materials and equipment including two (2) drilling rigs and other necessary accessories.

   3) Transfer of technological know-how during the Project execution

4. The Ministry of Water, Land and Natural Resources through The Department of Water Affairs is responsible for the administration and execution of the Project.

5. The Government of the Republic of Zambia will take necessary measures listed in Annex- I under the condition that the grant aid assistance by the Government of Japan is extended to the Project.

6. Both parties confirmed that the Survey Team explained Japan's grant aid programme and the Zambian side had understood it.

N.M.

ANNEX-I

The following arrangement are requested to be taken by the Government of the Republic of Zambia;

1. To provide data and information necessary for the Project works

2. To ensure prompt unloading, tax exemption, customs clearance of the products in Lusaka and prompt internal clearance therein of the products and related equipment under the grant.

3. All goods, equipment and personal effects of the Japanese consultants and contractors brought under the Project shall be exempted from all duties and taxes.

4. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the B/A.

   (1) Advising commission of A/P
   (2) Payment commission

5. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.

6. The Zambian Government shall provide all the local personnel and bear all their expenses under the Project.

7. To provide convenience to allow Japanese consultants and constractors to use freely the workshops or other facilities/equipment of DWA not covered by the grant when necessary, and to provide consumed materials for the equipment.

8. To organize well in advance suitable and sufficient personnel for management, planning and implementation (siting, drilling, installation of well materials, etc.) before commencement of the Project.

9. To maintain and use properly and effectively the equipment and materials purchased under the grant and to arrange the budget and personnel for the maintenance/operation of the equipment and for the construction of boreholes, after the termination of Japanese construction aid.

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

LIST OF ATTENDANCE

1. National Commission for Development Planning (NCDP)

   Mr. M.M. Liswaniso, Permanent Secretary, NCDP.
   Mr. M.S. Soko, Director, NCDP.
   Mr. M.S. Mwale, Deputy Director, NCDP.
   Mr. L.S. Chiinda, Economist, NCDP.

2. Ministry of Water, Lands and Natural Resources (MWLNR)

   Mr. N. Mukutu, Permanent Secretary, MWLNR.
   Mr. L.L. Mbumwae, Director, Department of Water Affairs (DWA)
   Mr. J.J. Makwaya, Acting Deputy Director, DWA.
   Mr. O.L. Sangulube, Senior Hydrogeologist, DWA.

3. Embassy of Japan (EOJ)

   Mr. S. Ueda, Second Secretary, EOJ.

4. Japan International Cooperation Agency (JICA), Zambia Office

   Mr. K. Tomita, Resident Representative, JICA.
   Mr. S. Miyoshi, Asst. Resident Representative, JICA.

5. JICA Study Team

   Mr. O. Ikeda, Team Leader.
   Mr. E. Inui, Project Coordinator.
   Mr. S. Kagawa, Groundwater Development Planner.
   Mr. A. Satoh, Hydrogeologist.
   Mr. Y. Hamanaka, Material and Equipment Planner.

MINUTES OF DISCUSSIONS

ON

THE PROJECT

FOR

THE RURAL WATER SUPPLY DEVELOPMENT PHASE-Ⅲ

IN

THE REPUBLIC OF ZAMBIA

In November 1990, the Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched the Basic Design Study Team on the Project for The Rural Water Supply Development Phase－Ⅲ (hereinafter referred to as the Project), and through a series of discussions, field survey in Zambia, and technical examination of the results in Japan, has designed the appropriate plan for the Project and prepared the Draft Report of the Basic Design Study.

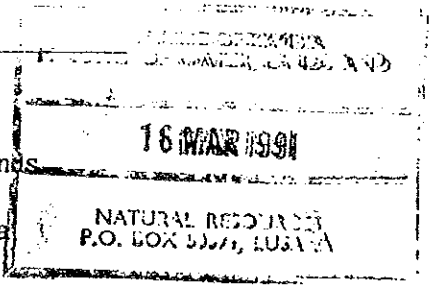
In order to explain and to consult on the components of the Draft Report, JICA sent a team, headed by Mr. Toru Maeda, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from March 11th to 21st, 1991.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Lusaka, March 18th, 1991

Toru Maeda
Team Leader
JICA Study Team
Japan

Namukolo Mukutu
Permanent Secretary
Ministry of Water, Lands
and Natural Resources
The Republic of Zambia



M. C. Soko
Acting Permanent Secretary
National Commission for
Development Planning
The Republic of Zambia

A T T A C H M E N T

1. Components of Draft Report

The Government of Zambia has agreed and accepted in principle the components of the Draft Report proposed by the Team.

2. Japan's Grant Aid System

1) The Government of Zambia has understood the system of Japanese Grant Aid explained by the Team.

2) The Government of Zambia will take the necessary measures, described in the previous minutes dated November 23rd, 1990, for smooth implementation of the Project on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

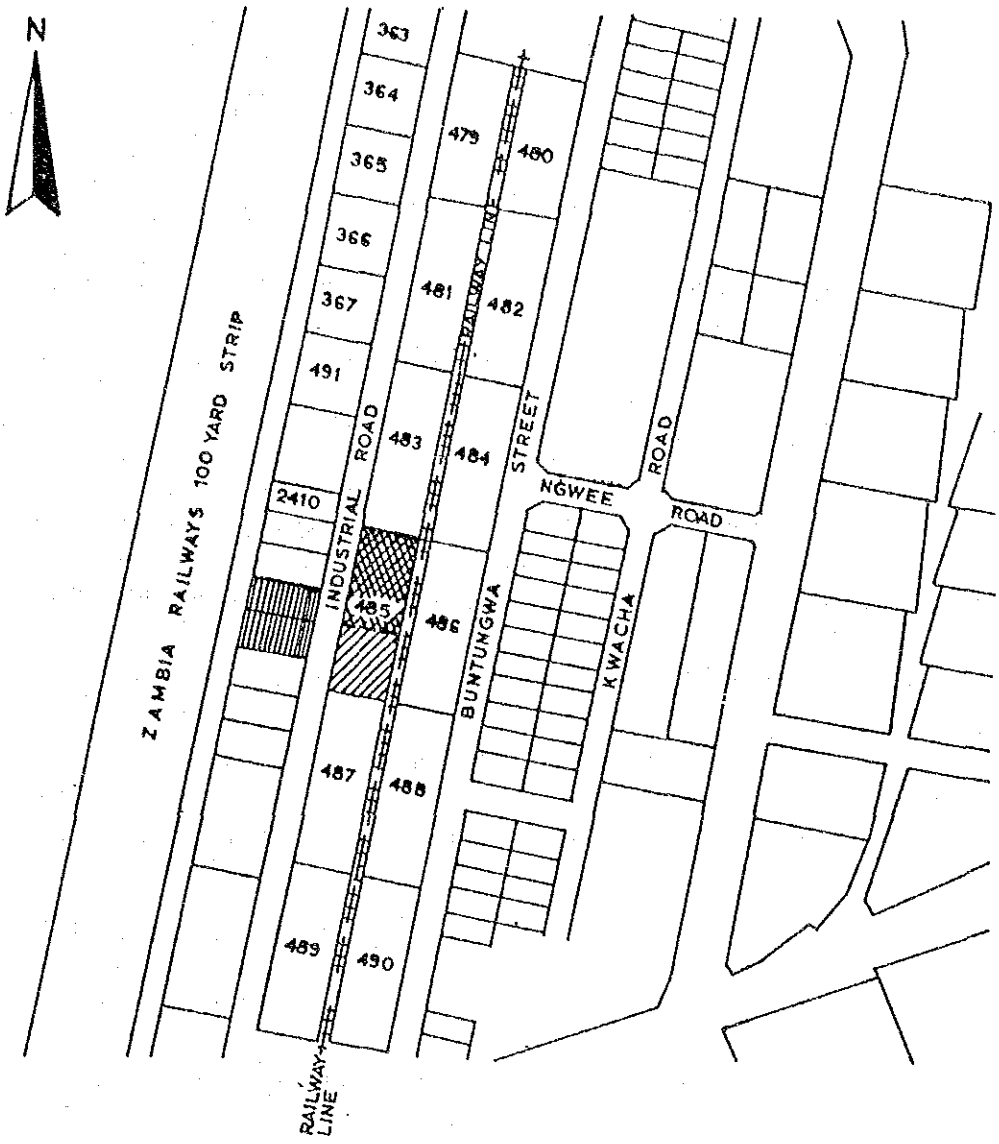
3. The Government of Zambia confirmed that the site for constructing depot has been secured in the area shown in Annex- I .

4. The Government of Zambia futher confirmed the planned implementation schedule into several stages and priority of borehole construction discussed in the report.

5. The Government of Zambia shall provide all necessary local counterparts for the implementation of the Project.

6. Further Schedule

The team will make the Final Report in accordance with the confirmed items, and send it to the Government of Zambia by the end of April, 1991.



PLOT 485– PROPOSED SITE KABWE (SIZE 60x90m)

EXISTING OFFICE AND YARD

ZAMBIA RAILWAY LINE

0 50 100 150 200m

REPUBLIC OF ZAMBIA
DIRECTOR OF WATER
16 MAR 1991
AFFAIRS
P.O. BOX 50288, LUSAKA

MINISTRY OF WATER LANDS & NATURAL RESOURCES
DEPARTMENT OF WATER AFFAIRS KABWE -- CENTRAL PROVINCE

Proposed Operation Base for The Japanese Government Rural Water Supply Development Project

SITE LOCATION MAP

DRAWN BY: J. J. NJOBVU
APPROVED BY: L.L MBUMWAE DIRECTOR
O.L.SANGULUBE SENIOR HYDROGEOLOGIST
DATE: MARCH 1991

APPENDIX 2 ITINERAY OF FIELD SURVEY

No	Date	Day	Schedule	Survey Activity
1	Nov. 11	Sun	Leave Tokyo	Leave Tokyo for London
2	12	Mon	Arrive London	Leave London for Lusaka
3	13	Tue	Arrive Lusaka	Courtesy call to Embassy of Japan and JICA Zambia Office
4	14	Wed	Lusaka City	Courtesy call to NCDP, MWNLR
5	15	Thu	Lusaka City	Meeting with DWA
6	16	Fri	Lusaka City	Meeting with UNDP and KFW, Preparation of Minutes
7	17	Sta	Southern Province	Site Survey, Monze District
8	18	Sun	Southern Province	Site Survey, Mazabuka District
9	19	Mon	Lusaka Province	Meeting with DWA & Site Survey
10	20	Tue	Central Province	Site Survey, Kabwe Rural D.
11	21	Wed	Copperbelt Province	Meeting with DWA & Site Survey
12	22	Thu	Lusaka City	Meeting with NCDP and DWA
13	23	Fri	Lusaka City	Signing of Minutes
14	24	Sta	Lusaka City	Meeting with DWA
15	25	Sun	Lusaka City	Data Collection & Analysis
16	26	Mon	Lusaka City	Meeting with DWA
17	27	Tue	Lusaka City	Meeting with JICA, DWA
18	28	Wed	Lusaka Province	Site Survey, Luangwa District
19	29	Thu	Lusaka Province	Site Survey, Lusaka Rural D.
20	30	Fri	Lusaka Ruralst.	Meeting DWA & Site Survey, Lusaka Rural District
21	Dec. 1	Sta	Lusaka City	Data Collection & Analysis
22	2	Sun	Lusaka City	Water Quality Analysis
23	3	Mon	Central Prvc.	Site Survey, Mumbwa District
24	4	Tue	Central Prvc.	Site Survey, Kabwe Rural D. & Data Collection
25	5	Wed	Central Prvc.	Site Survey, Mukushi District & Data Collection
26	6	Thu	Central Prvc.	Site Survey, Serenje District
27	7	Fri	Copperbelt Prvc.	Site survey, Ndola Rural D.
28	8	Sta	Lusaka City	Meeting with DWA
29	9	Sun	Lusaka City	Data Collection & Analysis
30	10	Mon	Lusaka City	Meeting with DWA & Site Survey, Lusaka Rural District
31	11	Tue	Lusaka Province	Site Survey, Lusaka Rural D.
32	12	Wed	Southern Province	Site Survey, Mazabuka & monze
33	13	Thu	Central Province	Site Survey, Kabwe Rural D.
34	14	Fri	Lusaka City	Meeting with JICA
35	15	Sta	Lusaka City	Water Quality Analysis
36	16	Sun	Lusaka City	Data Collection & Analysis
37	17	Mon	Lusaka City	Meeting with NCDP and DWA
38	18	Tue	Lusaka City	Courtesy call to Embassy of Japan and JICA
39	19	Wed	Leave London	Leave Lusaka for London
40	20	Thu	Arrive Tokyo	Leave London for Tokyo

APPENDIX 3 STUDY TEAM MEMBER LIST

THE RURAL WATER SUPPLY DEVELOPMENT PHASE III		
Basic Design Study Team		
Assignment	Name	Affiliation
Team Leader	Osamu Ikeda	Deputy Director for International Cooperation, International Affairs Division, Minister's Secretariat Ministry of Health and Wealth
Project Coordinator	Eiji Inui	First Basic Design Study Division Grant Aid Study and Design Department, Japan International Cooperation Agency
Groundwater Development Planner	Shigeyoshi Kagawa	Japan Techno Co., Ltd.
Hydrogeologist	Akira Satoh	Japan Techno Co., Ltd.
Material and Equipment Planner	Yoshitaka Hamanaka	Japan Techno Co., Ltd.
Cost Estimation	Ichiro Takamatsu	Japan Techno Co., Ltd.

Draft Final Report Explanation Team		
Assignment	Name	Affiliation
Team Leader	Toru Maeda	Grant Aid Division, Economic Assistance Department, Ministry of Foreign Affairs
Groundwater Development Planner	Shigeyoshi Kagawa	Japan Techno Co., Ltd.
Material and Equipment Planner	Yoshitaka Hamanaka	Japan Techno Co., Ltd.

APPENDIX 4 LIST OF PERSONS VISITED

1. NATIONAL COMMISSION FOR DEVELOPMENT PLANNING (NCDP)

Mr. M.M. Liswaniso, Permanent Secretary
Mr. M.S. Soko, Director, NCDP.
Mr. M.S Mwale, Deputy Director, NCDP.
Mr. L.S. Chiinda, Economist, NCDP

2. MINISTRY OF WATER, LANDS AND NATURAL RESOURCES (MWLNR)

Hon. M.L. Muyuda MCC, MP, Cabinet Minister, MWLNR.
Hon. K. Shepaude MCC, MP, Minister of State Water, MWLNR.
Mr. N. Mukutu, Permanet Secretary, MWLNR.
Mr. C. Mulenga Deputy Permanent Secretary, MWLNR.

Mr. L.L. Mbumwae, Director, Department of Water Affairs(DWA)
Mr. J.J. Makwaya, Acting Deputy Director, DWA.
Mr. O.L. Sangulube, Senior hydrogelogist, DWA.

Mr. C.D. Maseka, Hydrogelogist, Officer-in Charge,
Hydrogelogical Branch (H.Q.) DWA. Lusaka

Mr. L.C. Mapulanga, Hydrogelogist, DWA. Monze
Mr. A.K. Phiri, Engineer Assist, Drilling, DWA. Monze
Mr. H.C.K. Chinzila, Water Development Officer III, DWA. Monze
Mr. A. Njobvu, Water Development Officer III, DWA. Monze

Mr. P.C. Chola, Provincial Water Engineer, DWA. Lusaka
Mr. G. Mahanae, Water Engineering Assistant, DWA. Lusaka

Mr. D.S. Mudenda, Officer-in-Charge, DWA. Mkushi
Mr. E.M. Tembo, DWA. Mumbwa
Mr. R.N. Saini, DWA. Serenje
Mr. R. Kabalakata, DWA. Serenje
Mr. E. M. Tembo, Water Affairs Department Mumbwa
Mr. S.M. Chilufya, Engineering Assistant, DWA. Ndola
Mr. P.B. Kamlewe, Engineering Assistant, DWA. Ndola

3. EMBASSY OF JAPAN (EOJ)

Mr. H. Nomoto, Councellor, EOJ.
Mr. S. Ueda, Second Secretary, EOJ.
Mr. K. Turita, Second Secretary, EOJ.

4. JAPAN INTERNATIONAL COOPERATION AGENCY (JICA), Zambia Office

Mr. K. Tomita, Resident Representative, JICA.
Mr. S. Miyoshi, Asst. Resident Representative, JICA.
Mr. S. Nabeya, Asst. resident Representative, JICA.

Mr. T. Dokiya, JICA Expert, Ministry of Agriculture
Mr. H. Uera, JICA Expert, Northern Technical College, Ndola

Mr. H. Inami, Coordinator, JOCV
Mazabuka Tradiyional Farm Development Project

5. CENTRAL PROVINCE (CP)

Mr. D. Kenete, Deputy Permanent Secretary, C.P.
Mr. P. Mbamgweta, Journalist (ZANA), C.P.
Mr. K. Chisebe, Journalist (ZIS), C.P.

5-1. Mumbwa District

Mr. J. Chivema MP, Mumbwa District Governor
Mr. L.B. Shadunka, District Excutive Secretary, Mumbwa District Council
Mr. S.S. Phiri, Development Secretary, Mumbwa District Councel

5-2. Kabwe District

Mr. W.M. Ntalaska, District Governor
Mr. J.D. Muyabala, District Executive Secretary
Mr. R.S. Chella, District Political Secretary
Mr. H.B. Muchila, Development Secretary

5-3. Mkushi District

Mr. H.C. Mawanamulando, District Governor
Mr. H.M. Kayula, District Executive Secretary
Mr. C. Sichizya, Development Secretary
Mr. M.M. Amukena, Director of Works
Mr. G.M. Mwangala, Chief Administrative Officer

5-4. Serenje District

Mr. M.M. Kabanda, Administrative Secretary
Mr. J.L. Kaoma, Development Secretary

6. LUSAKA PROVINCE (LP)

6-1. Luangwa District

Mr. Henry C Kimba, District Executive Secretary
Mr. Ignatius K Mukuua, Development Secretary

6-2. Lusaka Rural District

Mr. Andrew D. Mukutu, Development Secretary

6-3. Lusaka Rural District, Kanakantapa

Mr. J.E. Msoni, Center Administrator
Mr. J.F. Mulamfu, Coordinator Youth Resettlement

7. COPPERBELT PROVINCE (CP)

Mr. Hon Alexander Kamalondo MCC, Copperbelt Province

7-1. Ndola Rural District Council, Masaiti

Mr. B.M. Akende, District Executive Secretary

8. **UNDP Lusaka, Zambia**

Mr. Marco Borsotti, Deputy Redsident Representative
Ms. E.T. Phiri, National Programme Officer

9. **BANK OF ZAMBIA**

Mr. David Chitundu, Deputy Senior Director, Research
Ms. Ngwenya, Manager, Foreign Cooperation

10. **KFW CONSULTANTS, Lusaka, Zambia**

Mr. Ernst Farber,gauff Ingenieure, Dipl. Eng. (FH),
Branch Manager, Zambia
Mr. G.N.R. Reddy, Gauff Ingenieure, Asst. Manager

APPENDEX 5 LIST OF PROJECT SITES

1. BOREHOLE CONSTRUCTION SITES (a)

PROVINCE	1. LUSAKA			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
1-1. LUSAKA RURAL	LR- 1	2	KANAKANTAPA SETTLEMENT (1)	5,000
	LR- 2	3	KANAKANTAPA SETTLEMENT (2)	-
	LR- 3	4	KANAKANTAPA SETTLEMENT (3)	-
	LR- 4	5	KANAKANTAPA SETTLEMENT (4)	-
	LR- 5	6	KANAKANTAPA SETTLEMENT (5)	-
	LR- 6	23	MAYANGA	600
	LR- 7	41	LUIMBA AREA (1)	4,000
	LR- 8	42	LUIMBA AREA (2)	-
	LR- 9	43	LUIMBA AREA (3)	-
	LR-10	44	LUIMBA AREA (4)	-
	LR-11	45	CHINYANJA SCHOOL	500
	LR-12	7	TSETSE PICKET CAMP, SHIKABETA	150
	LR-13	34	REFUNSA AREA (1)	5,000
	LR-14	35	REFUNSA AREA (2)	-
	LR-15	36	REFUNSA AREA (3)	-
	LR-16	37	REFUNSA AREA (4)	-
	LR-17	38	REFUNSA AREA (5)	-
	LR-18	8	SHIKABETA, FARM BLOCK	600
	LR-19	10	CHIEF PALACE, SHIKABETA CLINIC	1,500
	LR-20	9	SHIKABETA, SCHOOL	350
	LR-21	39	SHIKABETA CLINIC	1,900
	LR-22	40	MULUWE VILLAGE	250
	LR-23	24	MAFUNGAUSI	1,500
	LR-24	25	MAFULUSA	750
	LR-25	26	CHALEZERA	1,200
	LR-26	27	MATOPA	800
	LR-27	28	MUPINGA	650
	LR-28	29	MALABANIKA	2,500
	LR-29	30	SHAMPEO	1,800
	LR-30	31	CHISAKILA	350
	LR-31	22	KABWATO VILLAGE	350
	LR-32	11	MUSHONGETENDE VILLAGE	950
	LR-33	12	CHIMUSAMBO VILLAGE	800
	LR-34	13	CHIINYE VILLAGE	700
	LR-35	14	KANDOKO VILLAGE	600
	LR-36	32	MBOZA	850
	LR-37	33	CHIMULAMBE	400
	LR-38	16	NYAMALAPA	150
	LR-39	15	MUNNDA VILLAGE	400
	LR-40	1	CHIAWA RURAL HEALTH CENTER	1,000
	LR-41	17	KANYANGALA	2,000
	LR-42	18	KALOMBO	200
	LR-43	19	MAFUKU	500
	LR-44	20	CHILIMANGA	800
	LR-45	21	GUNDUZA	600
TOTAL	45	-	-	39,700

1. BOREHOLE CONSTRUCTION SITES (b)

PROVINCE	1. LUSAKA			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
1-2. LUANGWA	LG- 1	1	CHILIWE SCHOOL	400
	LG- 2	2	UNDI VILLAGE	200
	LG- 3	3	KAPETE VILLAGE	300
	LG- 4	4	MANUELE VILLAGE	400
	LG- 5	5	CHIKUMA VILLAGE	250
	LG- 6	6	KASINSA	600
	LG- 7	7	CHIWELA VILLAGE	800
	LG- 8	8	MULAMBA VILLAGE	500
	LG- 9	9	MPONA	180
	LG-10	10	SOWETO	100
TOTAL	10	-	-	3,730

PROVINCE	2.CENTRAL			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
2-1. KABWE RURAL	K- 1	1	CHINYONGOLA PRIMARY SCHOOL	3,000
	K- 2	6	SHIMUKUNI RURAL HEALTH CENTER	3,000
	K- 3	8	CHIPESO RURAL HEALTH CENTER	3,000
	K- 4	26	MUCHOKO	450
	K- 5	9	CHIPITO VILLAGE, CHIEF LITETA	200
	K- 6	7	NALUYANDA RURAL HEALTH CENTER	3,000
	K- 7	25	KABONGOLA	400
	K- 8	24	MAYABA	500
	K- 9	4	MULEBELA	400
	K-10	10	CHANGALA VILLAGE, CHIEF LITETA	200
	K-11	2	MULUNGUSHI AGRO SCHOOL	700
	K-12	5	KAMANO SCHOOL	300
	K-13	3	SHALUBALA SCHOOL	300
	K-14	14	SIPONDO	500
	K-15	28	MWANACHILENGA	400
	K-16	27	MAKUKWA	300
	K-17	29	WILSON TABUKILE	300
	K-18	16	SHAMAKULILA	250
	K-19	22	MINGACHE	600
	K-20	4	CHOWA SCHOOL	300
	K-21	21	CHANKOSA	450
	K-22	20	MALAKATA	450
	K-23	18	KALEMBA KAPASO	300
	K-24	15	CHIKONKOTO	350
	K-25	19	MUNGOLHI	250
	K-26	17	SAILI	400
	K-27	11	KANAKANTAPA SCHOOL & CLINIC	450
	K-28	13	MUDENDA VILLAGE	300
	K-29	12	CHIKWASHA VILLAGE	200
	K-30	30	KATUKWE SCHOOL	450
TOTAL	30	-	-	21,700

1. BOREHOLE CONSTRUCTION SITES (c)

PROVINCE	2. CENTRAL			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
2-2. MKUSHI	MK- 1	2	MUSOFU COOP. SOCIETY	300
	MK- 2	29	SEPE SECTION	300
	MK- 3	12	NKOLE PALACE	400
	MK- 4	13	LUKOMBA COOP. SOCIETY	400
	MK- 5	4	NKUMBI COLLEGE	800
	MK- 6	30	PILLO CHISENGA VILLAGE	300
	MK- 7	3	KACHASU	250
	MK- 8	6	CHKWATE COMPOUND	2,000
	MK- 9	26	ITALA COMPOUND	3,000
	MK-10	1	SHAIBILA PALACE	400
	MK-11	5	CHALATA	2,000
	MK-12	11	MASANSA DEPOT	2,000
	MK-13	9	FIWILA MISSION RURAL CENTER	700
	MK-14	10	SHAIBILA PALACE	400
	MK-15	21	MULUNGWE PALACE	200
	MK-16	14	LUNCHU COOP. SOCIETY	300
	MK-17	16	MAKAFU SCHOOL	400
	MK-18	17	MONDAKE SCHOOL	500
	MK-19	18	ST. PAULS SCHOOL	800
	MK-20	19	KAKWELESA SCHOOL	800
	MK-21	15	PANTOON CAMP	300
	MK-22	20	CHKUPILI PALACE	600
	MK-23	27	NIKISHI VILLAGE & DEPOT	200
	MK-24	28	TOUMU VILLAGE & WILD LIFE CAMP	400
	MK-25	22	KANYESNHAY PALACE	300
	MK-26	8	CHEMBE PALACE	300
	MK-27	7	CHEMBE SCHOOL	200
	MK-28	25	MBOSHYA PALACE	700
	MK-29	24	NDAUNI	250
	MK-30	23	KATETAULA SCHOOL	200
TOTAL	30	-	-	19,700

1. BOREHOLE CONSTRUCTION SITES (d)

PROVINCE	2. CENTRAL			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
2-3. MUMBWA	MB- 1	10	KAINDU RURAL HEALTH CENTER	872
	MB- 2	9	KAINDU SCHOOL	500
	MB- 3	5	CHIEF KABULWEBULWE'S PALACE	120
	MB- 4	16	NALUBANDA SCHOOL	545
	MB- 5	12	CHOOMBWA SETTLEMENT SCHEME	570
	MB- 6	2	MUMBA SETTLEMENT SCHEME	750
	MB- 7	1	MAIMWENE SETTLEMENT SCHEME	250
	MB- 8	3	CHIWENA RURAL HEALTH CENTER	345
	MB- 9	4	NAKABU SCHOOL	300
	MB-10	7	SHIBUYUNJI SUB-CENTER	180
	MB-11	17	MUKUPI SCHOOL	565
	MB-12	14	MUCHABI SCHOOL	550
	MB-13	13	KEEZWA SCHOOL & HEALTH CENTER	525
	MB-14	11	KAPYANGA SETTLEMENT SCHEME	475
	MB-15	6	SHACHELE SCHOOL	346
	MB-16	18	MAMVULE SCHOOL	585
	MB-17	15	MARTIN LUTHER BASIC SCHOOL	800
	MB-18	8	MUNYATI SCHOOL	400
	MB-19	20	SHIKATENDE SCHOOL	560
	MB-20	19	SICHOBO	150
TOTAL	20	-	-	9,388

PROVINCE	2.CENTRAL			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
2-4. SERENJE	S- 1	8	MUSANGA SCHOOL	200
	S- 2	10	KASHISHI	300
	S- 3	11	MUCHINKA RURAL HEALTH CENTER	600
	S- 4	3	KASUKO PRIMARY SCHOOL	660
	S- 5	14	KATIKULULA	1,000
	S- 6	5	NCHIMISHI NEW RURAL HEALTH C.	600
	S- 7	7	KABWE KUPELA	300
	S- 8	6	MAILO RURAL HEALTH CENTER	400
	S- 9	4	SERENJE SECONDARY SCHOOL	660
	S-10	15	SERENGE TOWNSHIP	800
	S-11	9	SERENJE TURN OFF	500
	S-12	13	CHAWAMA	800
	S-13	12	CHIMBAYA PRIMARY SCHOOL	450
	S-14	2	CHISOMO RURAL HEALTH CENTER	1,000
	S-15	1	KABANSA PRIMARY SCHOOL	200
TOTAL	15	-	-	8,470

1. BOREHOLE CONSTRUCTION SITES (e)

PROVINCE	3. COPPERBELT			
DISTRICT	NO.	PRIORITY	SITE NAME	POPULATION
3-1. NDOLA RURAL	N- 1	38	KAMBILOMBILO RESETTLEMENT (1)	2,000
	N- 2	33	KAMBILOMBILO RESETTLEMENT (2)	2,000
	N- 3	35	KAMBILOMBILO RESETTLEMENT (3)	-
	N- 4	37	KAMBILOMBILO RESETTLEMENT (4)	-
	N- 5	34	KAMBILOMBILO RESETTLEMENT (5)	-
	N- 6	33	KAMBILOMBILO RESETTLEMENT (6)	-
	N- 7	43	NTYAKA PRIMARY SCHOOL	350
	N- 8	2	KALONGEWA VILLAGE	250
	N- 9	3	LUSWISHI PRIMARY SCHOOL	300
	N-10	6	CHIBUNDI	300
	N-11	5	FUNDA PRIMARY SCHOOL	300
	N-12	9	CHISANINA	300
	N-13	11	NSALENI	300
	N-14	10	MIYENGO	250
	N-15	15	MACHILEMA	250
	N-16	16	YUDA-CHITULA	300
	N-17	20	LONDELA	250
	N-18	24	SHIBEMBA	250
	N-19	23	NACHEMBO	250
	N-20	22	CHIYANDA	250
	N-21	21	CHIKABUKILA	250
	N-22	25	MAKOPO	250
	N-23	14	CHIPISONI	250
	N-24	13	SHAMAPANGO	250
	N-25	12	MUKWASHI	250
	N-26	8	MALUKUTILA	250
	N-27	26	NKANA COURT	250
	N-28	51	NKANA AREA (1)	300
	N-29	52	NKANA AREA (2)	300
	N-30	27	KALYAMBA	250
	N-31	32	KALINSANGE	250
	N-32	7	ESHILONI VILLAGE	300
	N-33	46	CHIBOTE SECTION	250
	N-34	39	CHISOKONE VILLAGE	400
	N-35	4	KAFULAFUTA BASIC SCHOOL	300
	N-36	41	SHIMBI VILLAGE	400
	N-37	28	CHIPANDA	250
	N-38	50	KITWE-KABWE RD. MARKET	350
	N-39	19	KANESALA VILLAGE	250
	N-40	49	MBUNDA	400
	N-41	42	LUMANO PRIMARY SCHOOL	400
	N-42	18	MAKOLONI VILLAGE	250
	N-43	30	KAFYELA	250
	N-44	29	KALASABWE	250
	N-45	31	MAKANGILA	250
	N-46	48	KANAMA	350
	N-47	44	KAUNGA PRIMARY SCHOOL	450
	N-48	17	DAYIMANI VILLAGE	250
	N-49	45	MUTETESHI PRIMARY SCHOOL	250
	N-50	1	MUTABA RURAL HEALTH CENTER	350
TOTAL	50	-	-	16,700

2. EXISTING BOREHOLES REHABILITATION SITES (a)

PROVINCE	1. LUSAKA (1)			
DISTRICT	NO.	CHIEF	SITE NAME	POPULATION
1-1. LUSAKA RURAL	R- 1	SETTLEMENT	KANAKANTAPA	150
	R- 2	NKOMESHYA	MAWANTALASHA	300
	R- 3	NKOMESHYA	MWALUMUNA	200
	R- 4	NKOMESHYA	MATI	500
	R- 5	NKOMESHYA	MUTUBISHA	700
	R- 6	NKOMESHYA	CHIKULI SCHOOL	500
	R- 7	NKOMESHYA	CHIPAPA LOCAL COURT	100
	R- 8	NKOMESHYA	KACHETA SCHOOL	100
	R- 9	NKOMESHYA	KAMPOLILWE	300
	R-10	NKOMESHYA	CHAMPENGA	400
	R-11	NKOMESHYA	NKHUMBULA	500
	R-12	NKOMESHYA	SHANTUMBU	200
	R-13	NKOMESHYA	FUNGANISHA	300
	R-14	NKOMESHYA	MPOFU	250
	R-15	NKOMESHYA	KAPEKETE	200
	R-16	NKOMESHYA	LOBELA	350
	R-17	NKOMESHYA	CHILIABALE SCHOOL	200
	R-18	NKOMESHYA	MASHELELA	250
	R-19	NKOMESHYA	LUIMBA SCHOOL	200
	R-20	NKOMESHYA	MWAKAWALO	200
	R-21	NKOMESHYA	MULAIKA SCHOOL	200
	R-22	NKOMESHYA	KAPUTI	200
	R-23	NKOMESHYA	KAFUE MISSION SCHOOL	250
	R-24	NKOMESHYA	SHEKESWE	200
	R-25	NKOMESHYA	MWABULA SCHOOL	150
	R-26	NKOMESHYA	MPHNDE SCHOOL	200
	R-27	NKOMESHYA	MUKHOMBWE SCHOOL	200
	R-28	NKOMESHYA	MBOSHA	200
	R-29	BUNDA-BUNDA	BUNDA-BUNDA ADMINISTRATION C.	100
	R-30	BUNDA-BUNDA	CHINYUNYU SCHOOL	150
	R-31	BUNDA-BUNDA	CHINYUNYU TSETSE CONTROL	100
	R-32	BUNDA-BUNDA	CHIMPUNGU ILLS	200
	R-33	BUNDA-BUNDA	MWALIKANGA	200
	R-34	BUNDA-BUNDA	CHIMPINDIKA	300
	R-35	MPHASHYA	CHIWALA	200
	R-36	MPHASHYA	KOKOWE	300
	R-37	MPHASHYA	NGULUKA	300
	R-38	MPHASHYA	TETHANI SCHOOL	350
	R-39	MPHASHYA	NKHOLOMA	250
	R-40	MPHASHYA	SABANI	200
	R-41	MPHASHYA	TALUBUKA	300
	R-42	MPHASHYA	MAKUNKU	350
	R-43	MPHASHYA	SALA SCHOOL	400
	R-44	MPHASHYA	SANJE	300
	R-45	MPHASHYA	MWEMBESHI	1,000
	R-46	MPHASHYA	KASOKO	300
	R-47	MPHASHYA	CHIKUPI	300
	R-48	MPHASHYA	MUNGU RESETTLEMENT	360
	R-49	MPHASHYA	KABANANA PRIMARY SCHOOL	1,500
	R-50	MPHASHYA	KABANANA CO-OPERATIVE	300

2. EXISTING BOREHOLES REHABILITATION SITES (b)

PROVINCE	1.LUSAKA(2)			
DISTRICT	NO.	CHIEF	SITE NAME	POPULATION
1-1. LUSAKA RURAL	R-51	MPHASHYA	CHIPINGU RURAL HEALTH CENTER	380
	R-52	MPHASHYA	MUWEZWA VILLAGE A	250
	R-53	MPHASHYA	MUWEZWA VILLAGE B	300
	R-54	MPHASHYA	MUNGU RESETTLEMENT A	300
	R-55	MPHASHYA	MUNGU RESETTLEMENT B	300
	R-56	MPHASHYA	MUNGU RESETTLEMENT C	300
	R-57	MPHASHYA	KAPETE SCHOOL	1,600
	R-58	MPHASHYA	CHIOTA COORPERATIVE	300
	R-59	MPHASHYA	CHIPAPA RURAL HEALTH CENTER	700
	R-60	MPHASHYA	MUTU WA NGOMBE SCHOOL	1,600
	R-61	MPHASHYA	MAKENI POLICE CAMP	300
	R-62	MPHASHYA	TUBALANGE COOPERATIVE	300
	R-63	MPHASHYA	SHIKATENDE SCHOOL	1,500
	R-64	MPHASHYA	SHABWALA	600
	R-65	MPHASHYA	CHAINDE	1,600
	R-66	MPHASHYA	KACHETA SCHOOL	1,500
	R-67	MPHASHYA	KEEMBE	900
	R-68	MPHASHYA	KAPIRI	700
	R-69	MPHASHYA	KATUBA SCHOOL	1,600
	R-70	MPHASHYA	MWANACHILENGA SCHOOL	1,600
TOTAL	70	-	-	31,890

PROVINCE	1. LUSAKA			
DIATRICT	NO.	CHIEF	SITE NAME	POPULATION
1-2. LUANGWA	R- 1	MPHUKA	MPHUKA RURAL HEALTH CENTER	750
	R- 2	MPHUKA	CHIENDIENDE	700
	R- 3	MPHUKA	KAVALAMANJA	300
	R- 4	MPHUKA	KAKARO VILLAGE AND PRIMARY SCHOOL	1,300
	R- 5	MPHUKA	JANEIRO	400
	R- 6	MPHUKA	KAPOCHE SCHOOL	500
	R- 7	MPHUKA	KATONDWE PRIMARY SCHOOL	1,500
	R- 8	MPHUKA	LUINGA	300
	R- 9	MPHUKA	LINGA	250
	R-10	MPHUKA	CHIKUNI	500
TOTAL	10	-	-	6,500

2. EXISTING BOREHOLES REHABILITATION SITES (c)

PROVINCE	2. COPPERBELT			
DISTRICT	NO.	CHIEF	SITE NAME	POPULATION
2-1. NDOLA RURAL	R- 1		CHOMOTO PRIMARY SCHOOL	200
	R- 2		CHINEMU RURAL HEALTH CENTER	250
	R- 3		FUMBWE PRIMARY SCHOOL	300
	R- 4		MPOPO PRIMARY SCHOOL	250
	R- 5		LUMPUMA LOCAL COURT	300
	R- 6		MUNKUMPU PRIMARY SCHOOL	250
	R- 7		CHILESHE RURAL HEALTH CENTER	450
	R- 8		CHIEF NKANA'S PALACE	300
	R- 9		MIENGWE CENTER	400
	R-10		LUMPUMA RURAL HEALTH CENTER	300
	R-11		MUSHINGASHI RURAL HEALTH CENTER	250
	R-12		CHINEMU PRIMARY SCHOOL	250
	R-13		KAPILAMIKWA PRIMARY SCHOOL	250
	R-14		MUKUTUMA PRIMARY SCHOOL	300
	R-15		MISHIKISHI PRIMARY SCHOOL	300
	R-16		ZEMBA VILLAGE	300
	R-17		MUSHILI PRIMARY SCHOOL	350
	R-18		CHISANGA PRIMARY SCHOOL	300
	R-19		FUNGULWE RURAL HEALTH CENTER	250
	R-20		CHIKABUKE CLINIC	300
TOTAL	20	-	-	5,850

APPENDIX 6 BASIC DESIGN DRAWINGS

1. Hand Pump Installation

2. Borehole Structure (ø 4")

3. Borehole Structure (ø 6")

4. Hand Pump Facility

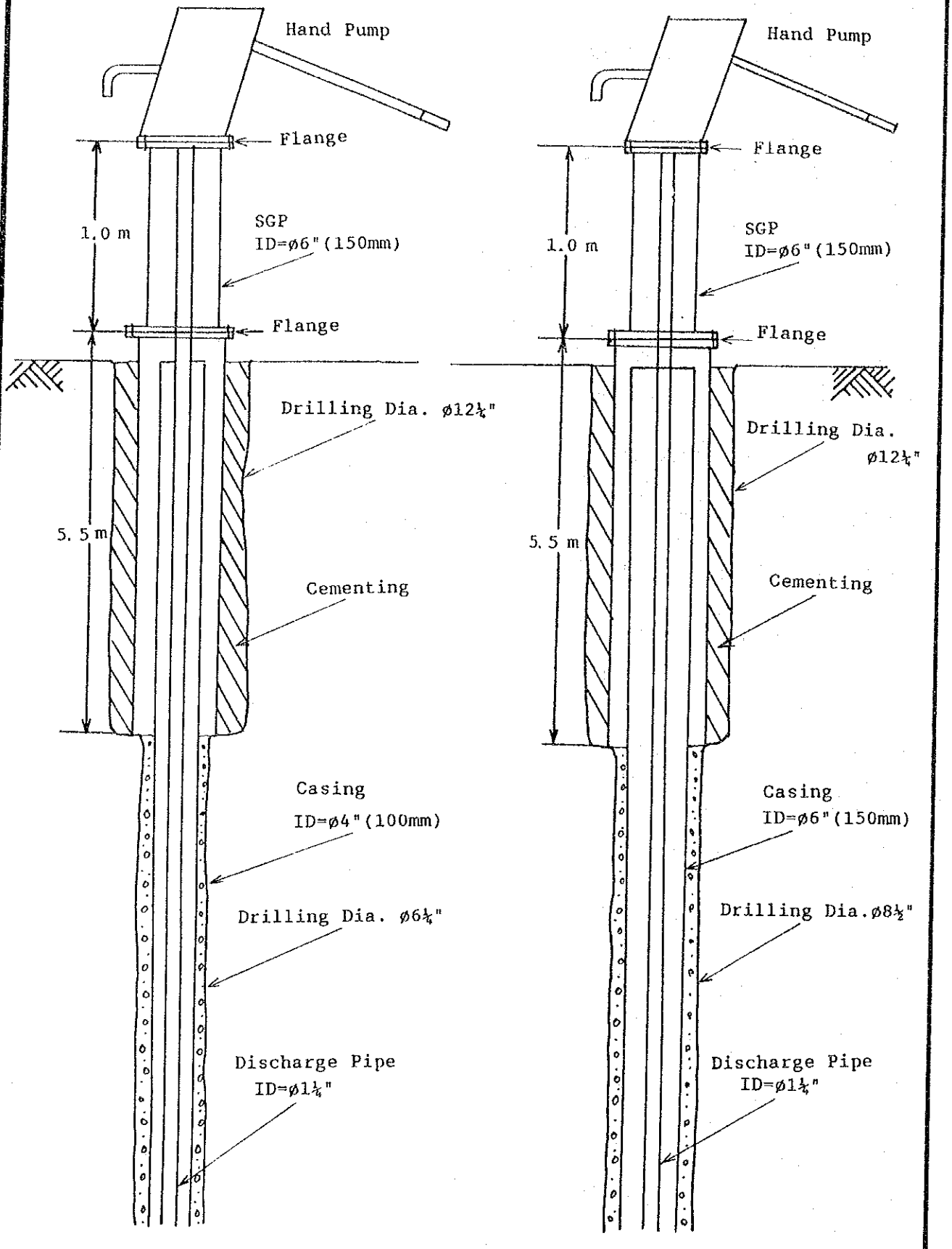
5. Project Operation Base

6. Operation Office

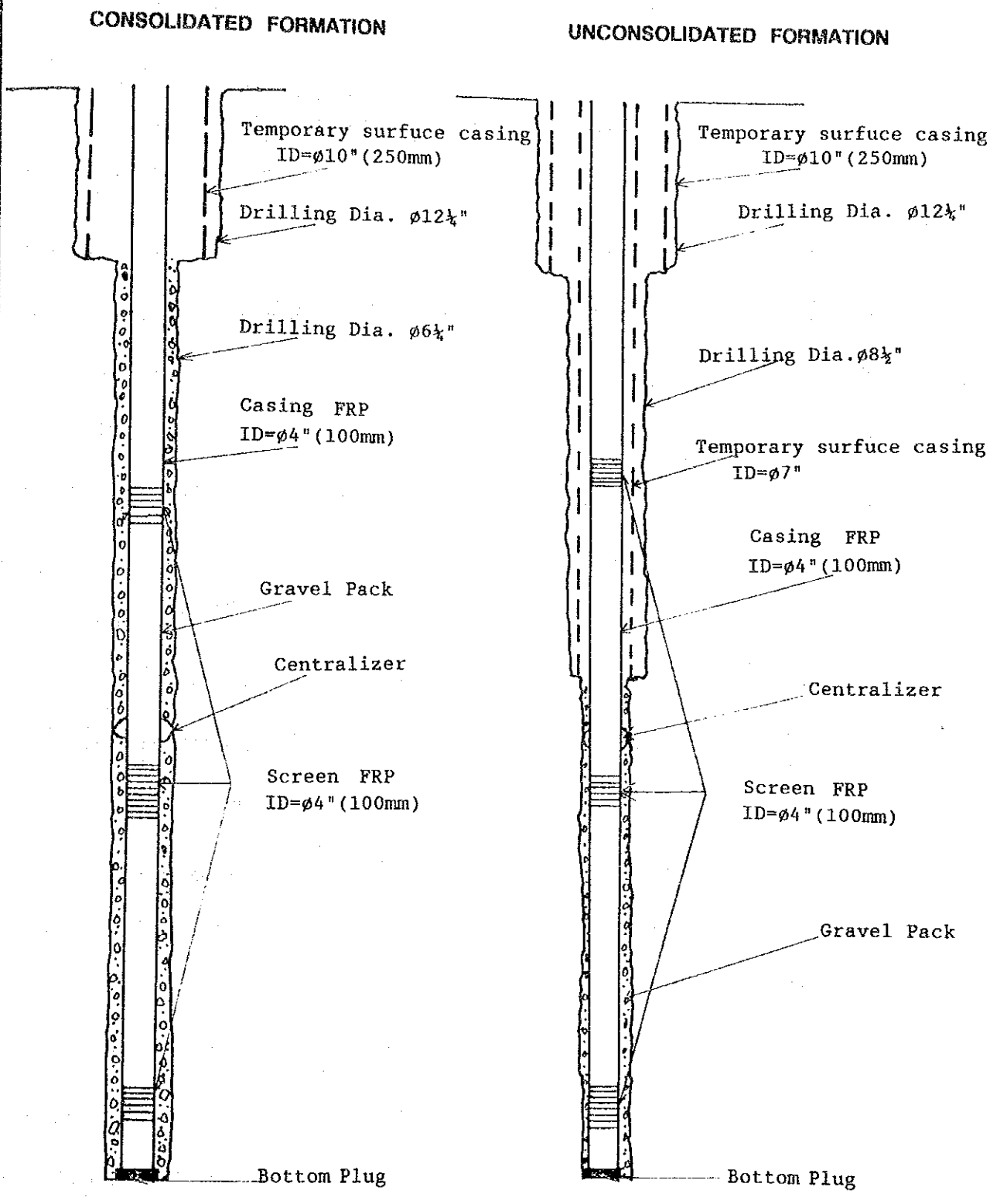
7. Workshop

8. Garage

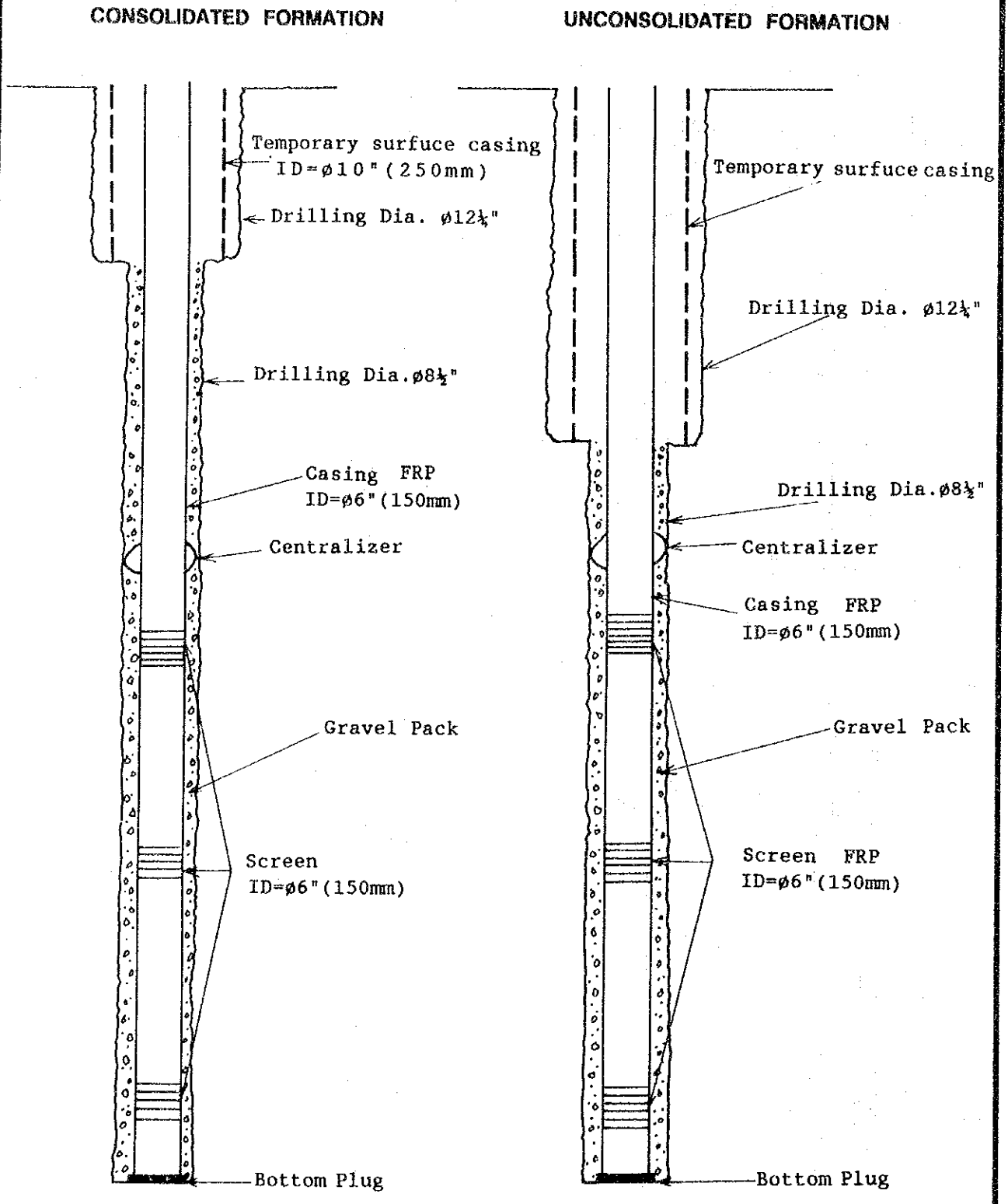
1. PROPOSED DESIGN OF HAND PUMP INSTALLATION

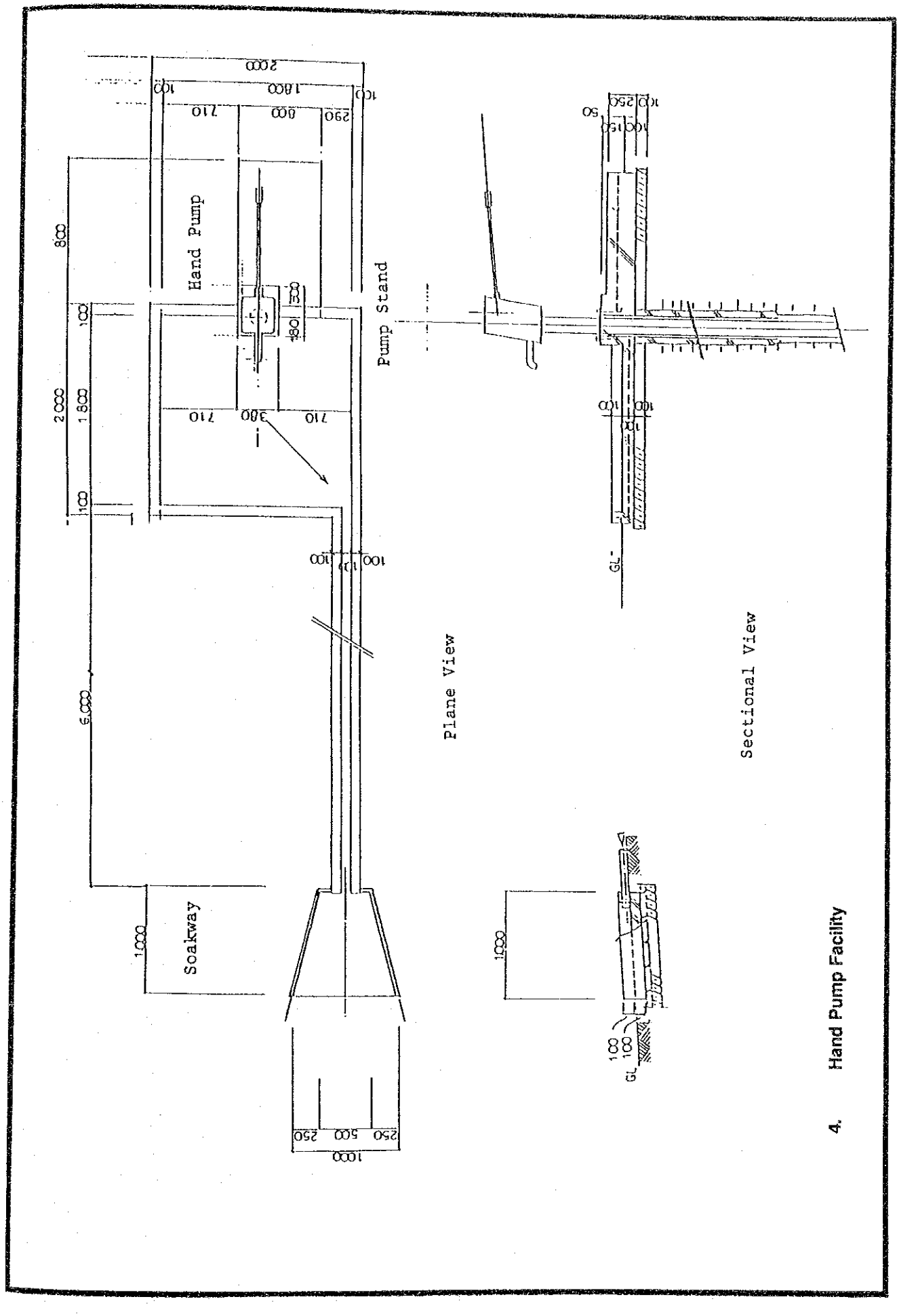


2. PROPOSED DESIGN OF BOREHOLE STRUCTURE (φ4")

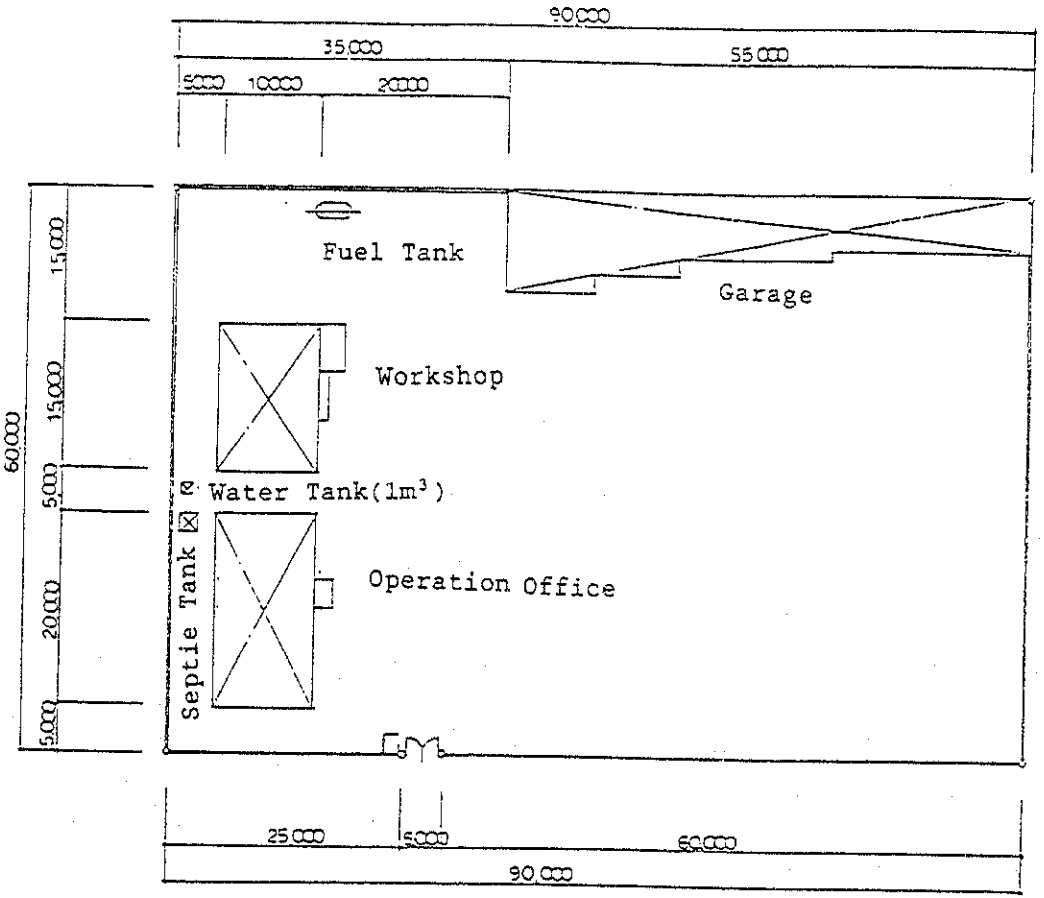


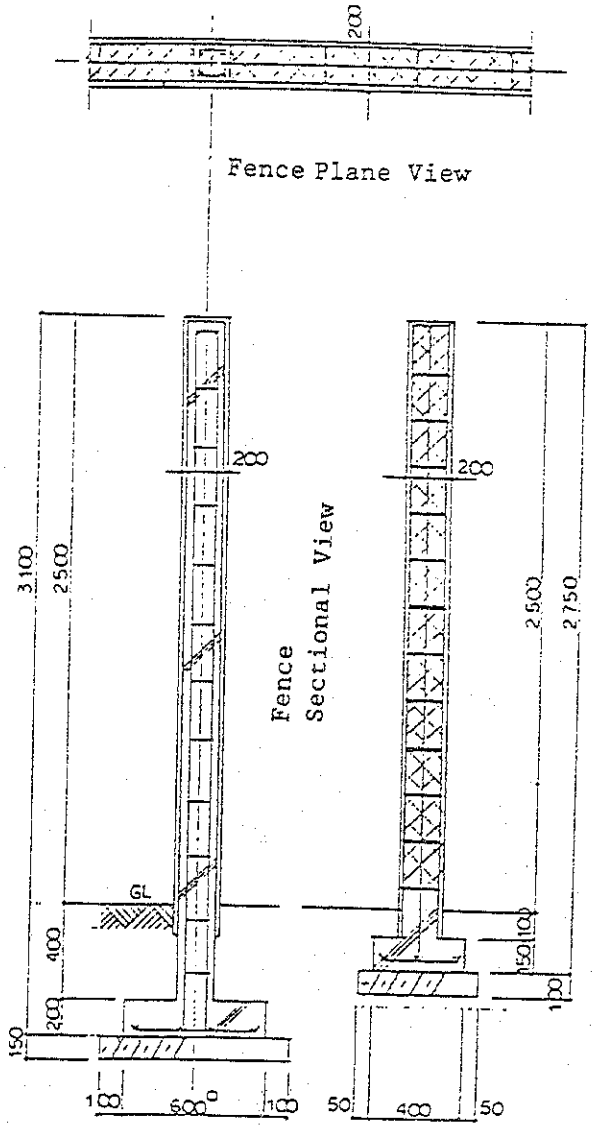
3. PROPOSED DESIGN OF BOREHOLE STRUCTURE (ϕ6")





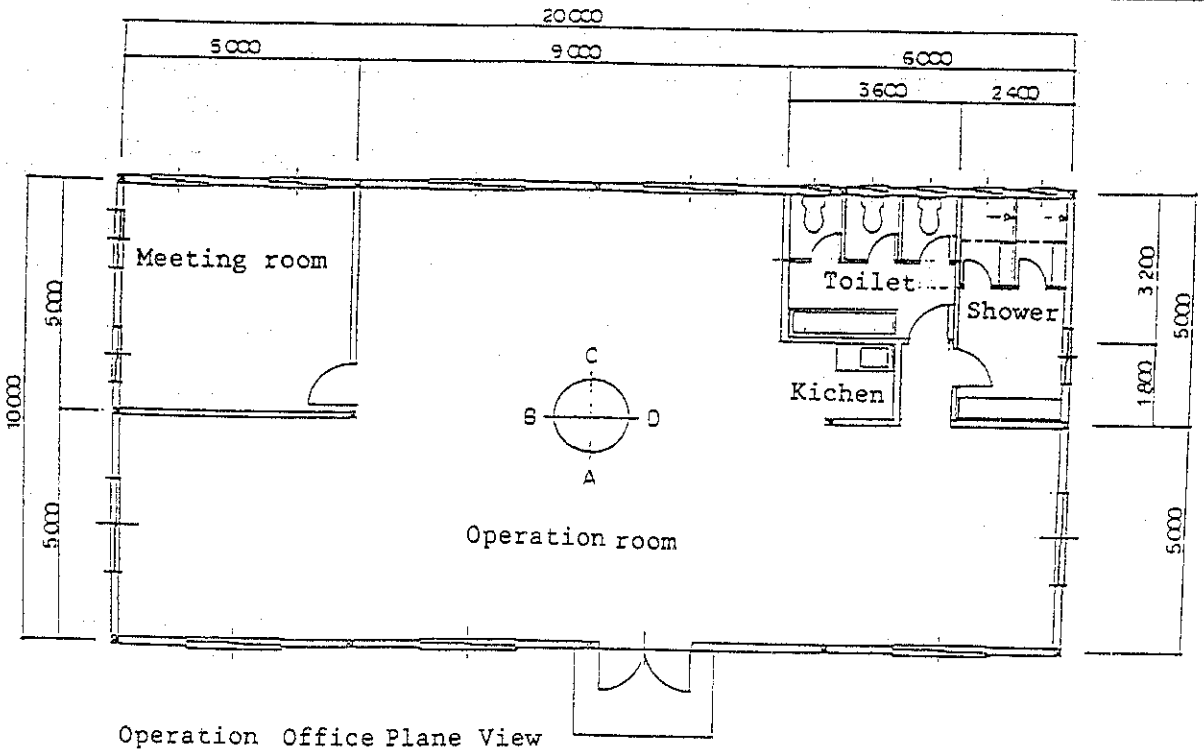
4. Hand Pump Facility





The proposed layout of the Project Operation Base

5. Project Operation Base

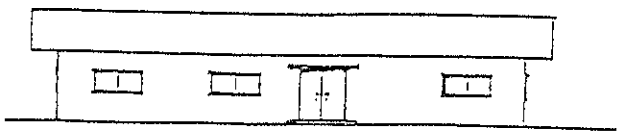


Operation Office Plane View

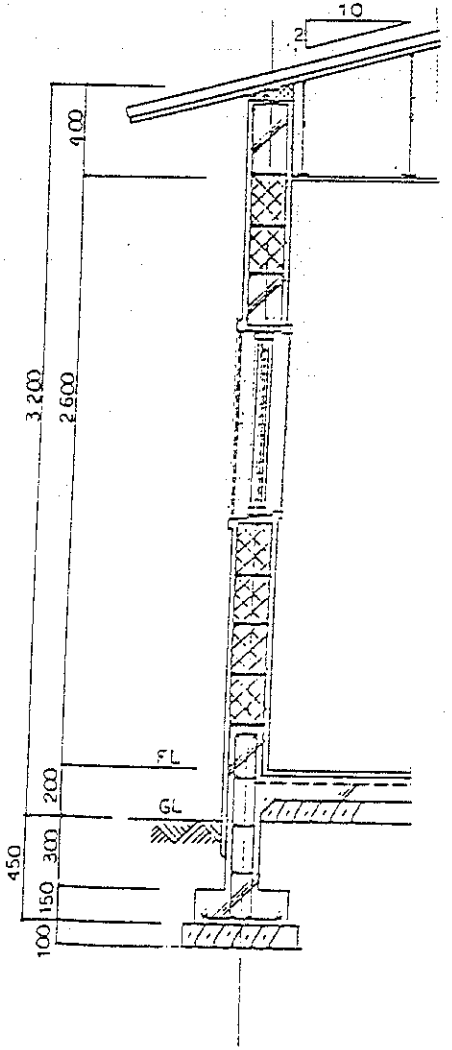
Back C View

Side D View

Side B View

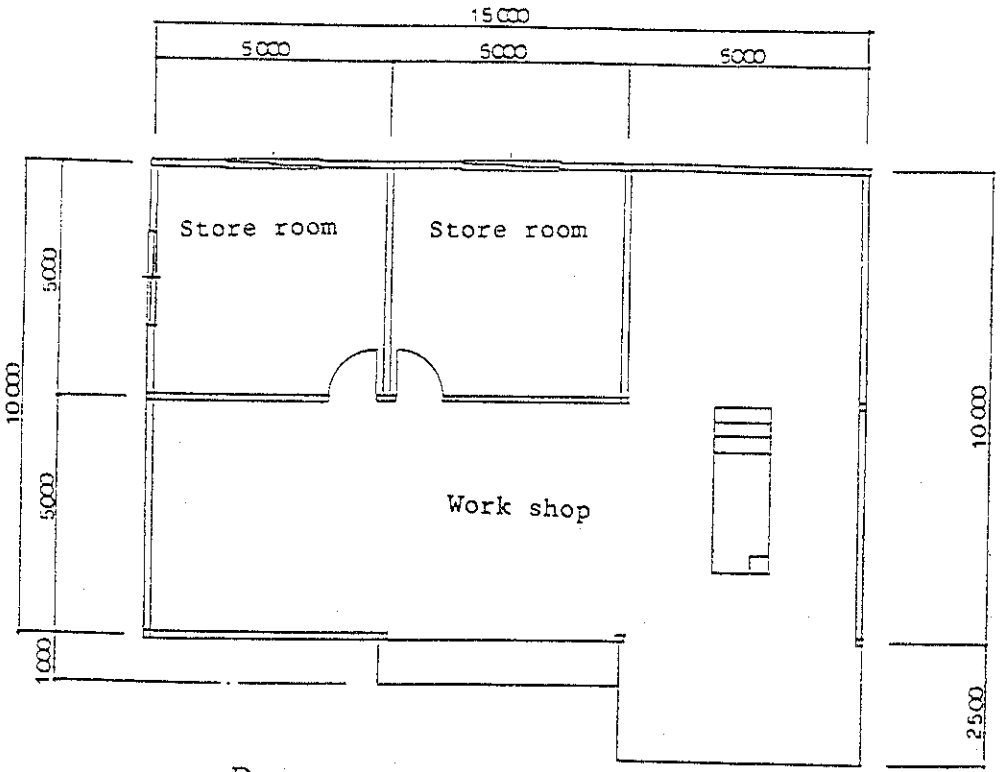


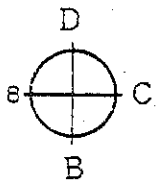
Front A View



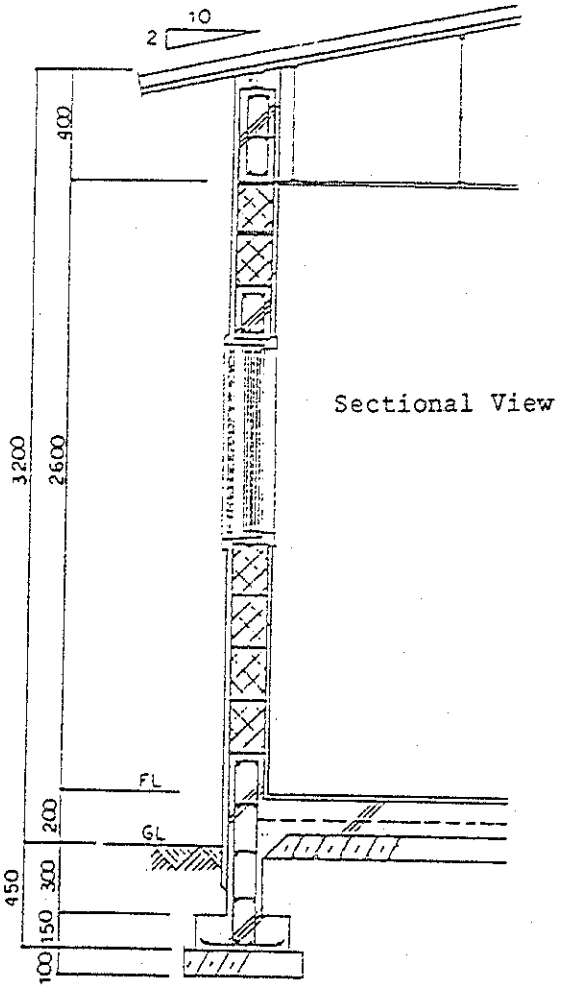
Sectional View

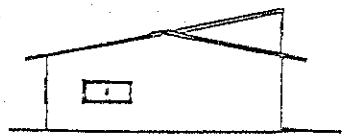
6. Operation Office



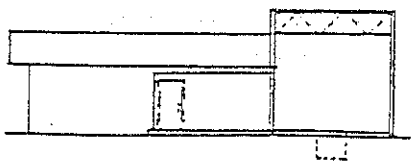


7. Workshop

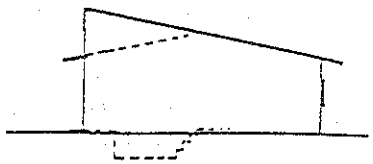




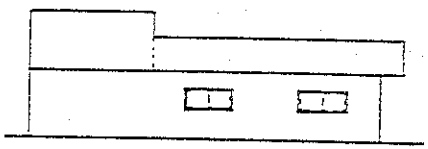
Side A View



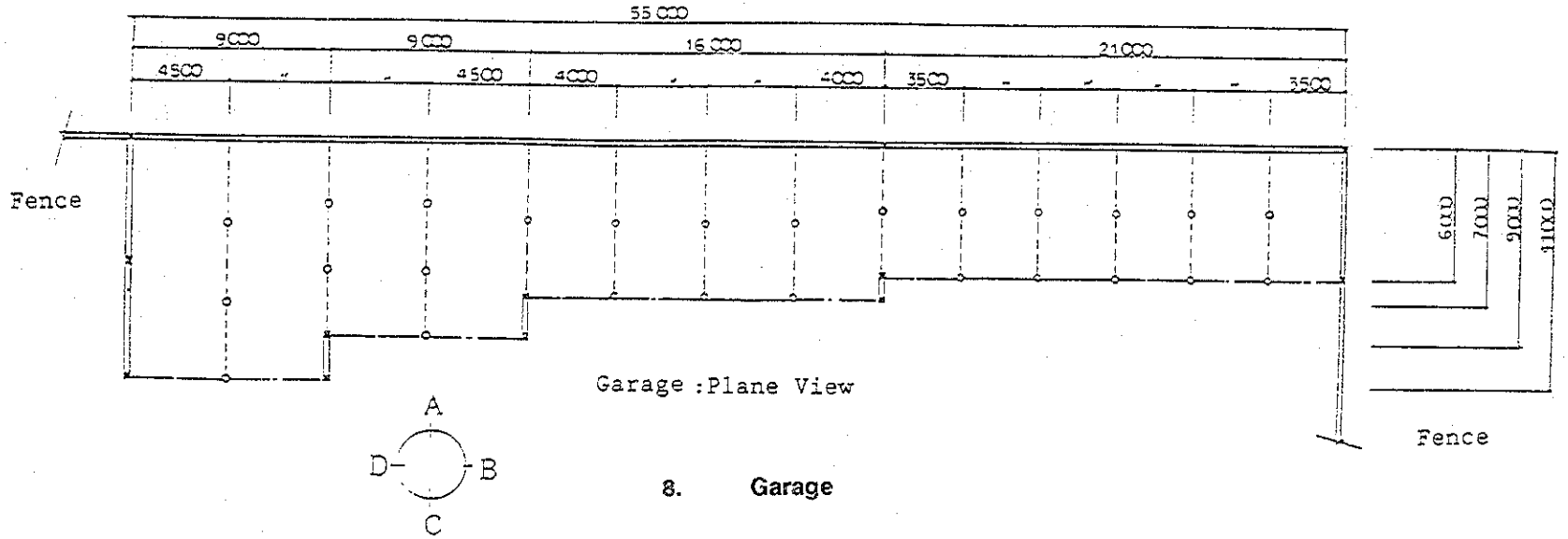
Front B View



Side C View

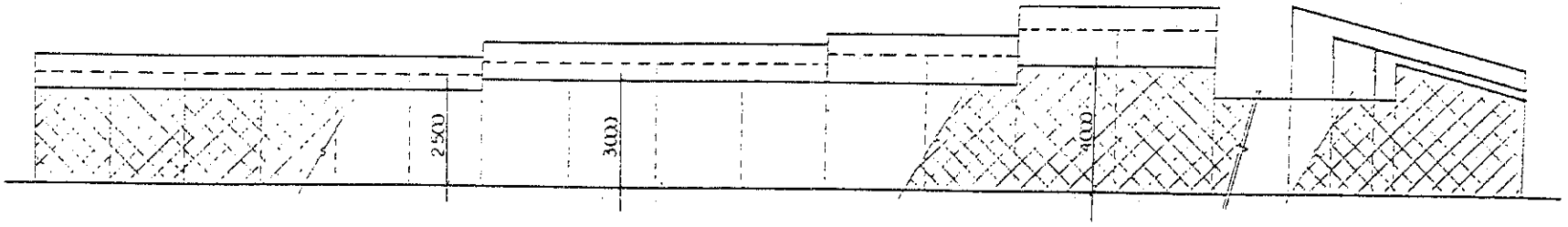


Back D View



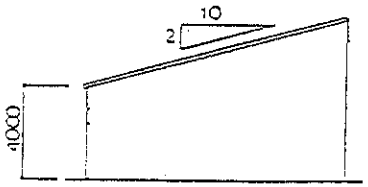
Garage :Plane View

8. Garage

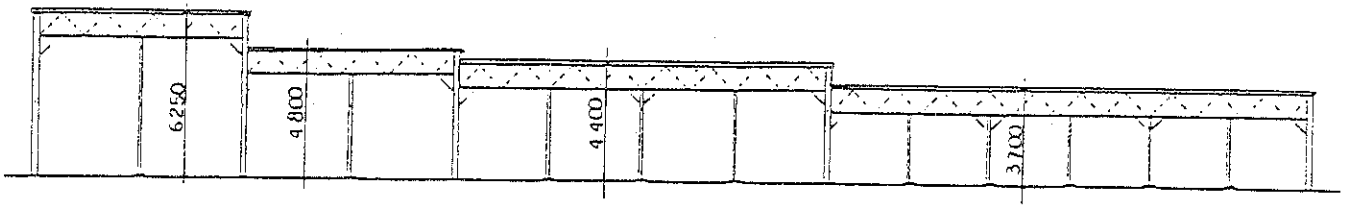


Front A View

Side B View



Side D View



Back C View

APPENDIX 7 LIST OF COLLECTED DATA

1. NATIONAL DEVELOPMENT PLANS

   1) New Economic Recovery Programme, Fourth National Development Plan 1989-1993 volume I, office of President, National Commission for Development Planning, January, 1989

   2) New Economic Recovery Programme, Fourth National Development Plan 1989-1993 volume II, office of president, National Commission for Development Planning, January, 1989

   3) Report on Development Co-operation with Zambia 1986, United Nations Development Programme

2. UNITED NATIONS INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE

   1) International Drinking Water Supply and Sanitation Decade 1981-1990, Plan of Action for Water Supply and Sanitation, National Action Committee, June, 1985

   2) International Drinking Water Supply and Sanitation Decade 1981-1990, Conference on Strategies and Implementation of IDWSSD Programme in Zambia, Volume I Proceedings, December, 1987

   3) International Drinking Water Supply and Sanitation Decade 1981-1990, Conference on Strategies and Implementation of IDWSSD Programme in Zambia, Volume II Project Data Sheets, December, 1987

3. AGRICULTURE, ECONOMICS AND EDUCATION

   1) Balance of Payments Statistics 1984-1985, Central Statistical Office, December, 1989

   2) Agricultural and Pastral Production (Non-Commercial Sectors) 1985-1986, Central Statistical Office, November, 1989

   3) Agricultural and pastral Production (Commercial Farms) 1987-1988, Central Statistical Office, September,1990

   4) Educational Statistics 1980, Planning Unit, Ministry of Education and Culture, August, 1982

4. POPULATION CENSUS

   1) 1980 Census of Population and Housing, Preliminary Report, Central Statistical Office, Junuary, 1981

   2) 1980 Census of Population and Housing, Volume I (General Population and Migration table), Central Statistical Office, September, 1985

   3) 1980 Census of Population and Housing, Volume II Part I (Socio-Economic tables), Central Statistical Office, September, 1985

5. TOPOGRAPHY, GEOLOGY AND HYDROGEOLOGAL MAPS

1) Geological Survey of Zambia, the Geology of the Nansenga River Area

2) Northern Rhodesia Geological Survey, the Geology and Groundwater Resources of the Lasaka Area

3) Hydrogeologal Map of Zambia, 1990, 1: 1,150,000

4) Geological Map 1:1,000,000, Survey Department, Surveyor General, Ministry of Lands and Natural Resources, 1981, (4 sheets)

5) Topographical Map 1;1,500,000, Survey Department, Surveyor General, Ministry of Lands and Natural Resources, 1981

6) Topographical Map 1:250,000, Survey Department, Surveyor General, Ministry of Lands Natural Resources, 1973

7) Topographical Map 1:50,000, Survey Department, Surveyor General, Ministry of Lands and Natural Resources, 1986

8) Civil Aviation Chart 1:1,500,000, Survey Department, Surveyor General, Ministry of Lands and Natural Resources, 1987

9) Map Catalogue, Survey Department, Surveyor General, Ministry of Lands and Natural Resources, January, 1984

10) Atlas Sheet No.8

6. OTHERS

1) Zambia in Figures 1987, Central Statistical Office

2) Zambia in Figures 1988, Central Statistical Office

3) The Natural of Zambia, a Guide to Conservation and Development