as the executing agency in Zambia.

Therefore, the Project is concluded to be very meaningful and feasible to be implemented under the Japanese grant aid because this Project can be expected to contribute in many areas as explained above and raise the living environment in wide area, and the benefits of the inhabitants of the area will be increased and if the revised Project is implemented for the increase in the project sites and the acceleration of the implementation through the reinforcing the equipment and materials and the man-power.

4.3 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 through the supply of safe and stable drinking water. However, the following points must be considered for the further effective utilization of the supplied equipment and the completed water facilities, and for stable rural life in the future:

1) More self-efforts for management and maintenance will be required for the proper and smooth operation of water facilities to all of the Zambian Government, rural administrations and inhabitants themselves. This is particularly true to the DWA of the Ministry of Energy and Water Development who is nationally in charge of the planning and the facility construction regarding the rural water supply. Although the completed facilities are supposed to be managed by the district councils of the respective District after handing over the rural water facilities to the community, the DWA is currently carrying out this management in reality due to the facts of lack of the budget, man-power and technological background of the district councils.

   Therefore, it is vital to organize the Water Committee in the community in this Project to enable the daily management, operation and maintenance of the water facilities completed through the thoroughly training by the DWA. It can be judged to be more important for Zambia that the DWA, who has the national organization and technological capabilities for the rural water supply, would support the villagers technically under the integrated system, well financed by budget, with full

responsibilities of planning, construction, management and maintenance for the facilities, in stead of the district councils.

2) Although a systematic approach to application of a personal computer has already been introduced to Zambia and the DWA has started to compile, integrate and store the records and files of construction, observation and operation, 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 Zambian Government should be encouraged to make the continuous efforts 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. The DWA is also advised to provide a special training to the villagers for the close relations of the facility maintenance and the sanitary environments.

5) Zambia has a higher potential for surface water and groundwater resources than 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 REVISED REQUEST FROM

THE GOVERNMENT OF THE REPUBLIC OF ZAMBIA

(December 3, 1992)

REPUBLIC OF ZAMBIA

OFFICE OF THE DEPUTY MINISTER
NATIONAL COMMISSION FOR DEVELOPMENT PLANNING
NATIONALIST/MBITA ROAD
P.O. BOX 50268
LUSAKA

3rd December, 1992

His Excellency The Ambassador,
Embassy of Japan,
LUSAKA.

FLU0131-03

Your Excellency,

RE: PROJECT AID: RURAL WATER SUPPLY AND DEVELOPMENT

I have the honour to invite your attention to the above subject.

As you may no doubt be aware, the above project is already being implemented and the following are the major components:

(a) procurement of two drilling machines, support vehicles, drilling accessories and materials;

(b) drilling and equipment of 200 new boreholes with hand pumps and rehabilitation of 100 existing boreholes;

(c) on-job training of Zambian counterpart staff in hyrogeological related fields.

The project was designed to be implemented in five stages and estimated to be completed in 1996.

The main objective of the project is to provide potable and adequate water to the rural population of the project areas, notably Lusaka Central and Copperbelt Provinces, which were two areas declared affected by the drought in April 1992.

As you know, the lack of rain of 1991 - 1992 has caused the severest drought ever experienced in the history of Zambia.

The consequences of this drought have affected most of the water users, forcing some villagers to abandon their villages due to the water wells, streams and other traditional water sources drying up. Some parts of the country hitherto not declared as drought affected areas, are now also under strain, notably North Western and Copperbelt Provinces. Therefore, we are now speeding up the review of all drought affected areas and the preparation of the Action Plans.

2/.....

It is with this view that the Government of the Republic of Zambia requests the Government of Japan, as a first stage, to shorten the implementation period of the project from five to three stages, ie ending December 1994. In order to shorten the implementation period, it will be necessary to increase the requirement for drilling machines from two to three. The Government of the Republic of Zambia undertakes to prepare the necessary measures this will incorporate.

Furthermore, after the review of the drought affected areas and the action plan, the Government of the Republic of Zambia would like to request the Government of Japan to increase the number of new boreholes and existing boreholes to be rehabilitated. This request will be made once the Action Plan for the overall project, based on the drought evaluation, has been completed but we would be grateful if this future request could be borne in mind.

The Government of the Republic of Zambia would like to take this opportunity if expressing their gratitude for the assistance the Japanese Government has already granted in the construction of boreholes elsewhere in Zambia. this assistance is greatly appreciated.

Please accept, Your Excellency, the assurances of my highest consideration.

Yours sincerely,

DEAN N. MUNG'OMBA, MP
DEPUTY MINISTER
PLANNING AND DEVELOPMENT COOPERATION
OFFICE OF THE PRESIDENT

c.c. Hon. Hambayi, MP, Minister of Energy and Water Development

c.c. L. M. Munalula, Acting Permanent Secretary,
Energy and Water Development

c.c. Director of Water Affairs

/mkk

APPENDIX - 2 QUESTIONNAIRE ABOUT THE REVISED REQUEST

TO: Department of Water Affairs
The Ministry of Energy and Water Development
Republic of Zambia

RE: The Project for the Rural Water Supply Development

SUB: Implementation Review on the Project

In response to the request made by the Government of the Republic of Zambia dated 3rd December, 1992 for the Project for the Rural Water Supply Development in Zambia, the Government of Japan has decided to review the implementation of the Project through the Japan International Cooperation Agency (JICA). The study is to be conducted from the middle of February to the end of March, 1993 by the work in Japan.

The following matters are considered to be the main points by the study team to implement the project as effective as possible. If DWA agree and/or have any comment on the following contents, please inform us before the middle of March, 1993 when the study shall be concluded.

1. The Project was originally designed for the construction of new boreholes at 200 sites and the rehabilitation of existing ones at 100 sites to be implemented in five stages and estimated to be completed in 1996. However, because of the severest drought of 1991-1992 and shortage of drinking water, the Project was requested to be speeding up and to shorten the implementation period from five to three stages, ending in December 1994.

   The possibility of speeding up the implementation of Project was reviewed by the study team. As a result, the speeded up implementation schedule shall be designed for the implementation in four stages and the estimated completion shall be in March 1996. For this schedule, one drilling team together with one drilling rig with necessary equipment and tools shall be added; consequently, the additional 20 new boreholes construction and 60 existing boreholes rehabilitation works can be implemented within the Project.

   Therefore, the revised Project is aimed at totally enhancing the coverage of rural water supplies and improving the degenerated water environment through the construction of new boreholes at 220 sites and the rehabilitation of existing ones at 200 sites.

2. The actual implementation of borehole construction sites have been reviewed and the priority of the sites have been given as follows by considering the affection by the drought in 1991-1992 in the project area, availability of organizing an additional drilling team, and other geopolitical situation.

* Stage-1 (1991) Total Project Sites : 20
Completion in March 1993

* Stage-2 (1992) Total Project Sites : 59
Completion in March 1994

Stage-3 (1993) Total Project Sites : 53
Existing Drilling Teams : 40
New Drilling Team : 13
Completion in March 1995
Project Sites;
Lusaka Rural District : 24
Mumbwa District : 12
Kabwe Rural District : 7
(Additional Lusaka Rural): 10

Stage-4 (1994) Total Project Sites : 88
Existing Drilling Teams : 60
New Drilling Team : 28
Completion in March 1996
Project Sites;
Kabwe Rural District : 13
Serenje District : 15
Ndola Rural District : 50
(Additional Lusaka Rural): 10

3. The implementation of rehabilitation of existing borehole sites have been reviewed and the priority of the sites have been given as follows considering the affection of the drought in 1991-1992, availability of reorganizing existing rehabilitation teams, and other geopolitical situation.

* Stage-1 (1991) Total Project Sites : 1
Completion in March 1993

* Stage-2 (1992) Total Project Sites : 55
Completion in March 1994

Stage-3 (1993) Total Project Sites : 64
Lusaka Rural District : 24
(Additional Lusaka Rural): 20
(Additional Kabwe Rural) : 20
Completion in March 1995

Stage-4 (1994) Total Project Sites	:	40
Ndola Rural District	:	20
(Additional Ddola Rural)	:	20
Completion in March 1996		

4. About 30 number of DWA counterparts consisting of Project Manager, Administrative Officer, Hydrogeologist, Geophysical Technician, Drilling Engineer, Driller and Driver are now working under Stage-1 to carry out borehole construction. In addition, under Stage-2, about 5 to 10 number of DWA counterparts consisting of Civil Engineering Technician and Driver are to be assigned for rehabilitation works. Futhermore, when we increase one drilling team, it will require newly about 10 number of DWA counterparts consisting of Drilling Engineer, Driller and Driver. The Zambian Government shall provide the necessary counterparts for the Project.

5. For smooth implementation of the next stage, the following improvement on the technical matters are necessary.

(1) The surface casing shall be installed instead of temporary casing up to about 15 m below the ground due to the problem of soft formation, especially in Lusaka Rural.

(2) From technical view points, DTH (Down the Hole Hammer) method shall be considered to apply for the heavy collapse formation at the deeper part by adding the tool of S-type bits for cased DTH.

(3) The camping facilities such as portable water tanks and camping beds for drilling and geophysical survey teams shall be added.

(4) Through the implementation of the Project, it is necessary to reinforce store room, workshop, hydrogeological training room and water quality laboratory at Kabwe Project Operation Base.

(5) To reduce fuel cost, the engine type of supporting vehicle for the new team shall be changed from gasoline to diesel one.

(6) To cope with the problems of rural access road, trailer mounted air compressor shall be changed to truck mounted and/or separate trailer type.

* * * * *

APPENDIX - 3 REPLY OF THE DWA TO THE QUESTIONNAIRE

Communications should be addressed to the Director

Telephone LUSAKA 213281

Telegrams ZAMWATER, LUSAKA

In reply please quote: WA/13/20A

No.....

REPUBLIC OF ZAMBIA

DEPARTMENT OF WATER AFFAIRS—HEADQUARTERS

OFFICE OF THE DIRECTOR
P.O. BOX 50288
LUSAKA

Japan International Co-operation Agency
17 MAR 1993
ZAMBIA

17th March, 1993

Resident Representative,
JICA Zambia,
LUSAKA.

Dear Sir,

RE: IMPLEMENTATION REVIEW ON THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

I refer to your letter of 15th March, 1993 on the above subject and confirm that the review of the need to accelerate the programme implementation of the rural water supply development Zambia is cordially accepted.

I could highly appreciate if this can be conveyed to the JICA Headquarters as soon as possible.

J.J. MAKWAYA
ACTING DEPUTY DIRECTOR OF WATER AFFAIRS.

APPENDIX - 4 STUDY PERIOD AND MEMBER LIST

(1) STUDY PERIOD

February 19 - March 26, 1993

(2) MEMBER LIST

Assignment	Name	Affiliation
Team Leader/ Ground Water Development Planner	Shigeyoshi Kagawa	Japan Techno Co., Ltd.
Cost Estimation	Ichiro Takamatsu	Japan Techno Co., Ltd.

APPENDIX - 5 PROJECT SITE LIST

1. ADDITIONAL 20 SITES FOR BOREHOLE CONSTRUCTION

PROVINCE	LUSAKA		
DISTRICT	NO.	SITE NAME	POPULATION
1.LUSAKA RURAL		(A)SHANTUMBU AREA	
	1	- MWANACHILENGA VILLAGE	200
	2	- MAHOPO VILLAGE	150
	3	- KAKOTE VILLAGE	180
	4	- CHIPWELU VILLAGE	200
	5	- CHISOMPELO VILLAGE	250
	6	- SHANTUMBU VILLAGE	300
	7	- SHIYALA VILLAGE - KAWMALA VILLAGE	300
	8	- SHIBELEKA VILLAGE	200
		(B)KASAKA CAMP AREA	
	9	- KASAKA FISHERIES TRAINING CENTRE	500
	10	- KASAKA LOWER BASIC SCHOOL	400
	11	- CHAWAMA	300
	12	- KASENGELE	250
	13	- MUCHUTO	300
	14	- BUNDABUNDA P.(Z.N.S.)	600
		(C)CHIAWA CAMP AREA	
	15	- KANDOKO VILLAGE	300
	16	- MAUNDA VILLAGE	200
	17	- MUDZAWA VILLAGE	200
	18	- MUGULAMENO VILLAGE	250
	19	- MUSHONGANENDE VILLAGE	200
	20	- KABWANDU PRIMARY SCHOOL	400
TOTAL			5,680

2. 200 SITES FOR BOREHOLE CONSTRUCTION (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

2. 200 SITES FOR BOREHOLE CONSTRUCTION (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

2. 200 SITES FOR BOREHOLE CONSTRUCTION (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

2. 200 SITES FOR BOREHOLE CONSTRUCTION (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

2. 200 SITES FOR BOREHOLE CONSTRUCTION (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

3. ADDITIONAL 60 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (a)

PROVINCE	1. LUSAKA		
DISTRICT	NO.	SITE NAME	POPULATION
1-1. LUSAKA RURAL	1	MWANTALASHA	250
	2	MWANSHELELA	250
	3	CHILYABALA	200
	4	KAFUE MISSION SCHOOL	250
	5	CHINYUNYU RURAL HEALTH CENTRE	200
	6	RUFUNSA POLICE	200
	7	CHONGWE SHOW GROUND	250
	8	NCHUTE PRIMARY SCHOOL	250
	9	NCHUTE AGRICULTURAL STATION	200
	10	LUIMBA FARM BLOCK	250
	11	KABANANA I	200
	12	KABANANA II	300
	13	MWEMBESHI RESETTLEMENT I	300
	14	MWEMBESHI RESETTLEMENT II	250
	15	CHINYUNYU ROADS CAMP	250
	16	CHINYUNYU VET. CAMP	250
	17	CHINYUNYU PALACE	200
		T O T A L	4,050
1-2. LUANGWA	1	KAUNGA PRIMARY SCHOOL	250
	2	KATONDWE SEC. SCHOOL	300
	3	KAUNGA VILLAGE	250
		T O T A L	800

3. ADDITIONAL 60 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (b)

PROVINCE	1. CENTRAL (1)		
DISTRICT	NO.	SITE NAME	POPULATION
1-1. KABWE RURAL	1	CHITANDA RURAL HEALTH CENTER	250
	2	MALAMBANYAMA	300
	3	MWACHISOMPALA	200
	4	WAYA FISHING CAMP	350
	5	WAYA RURAL HEALTH CENTRE	300
	6	CHIPEMBI AGRICULTURAL CENTRE	400
	7	MUKWAMBE PRIMARY SCHOOL	250
	8	CHIKONKOMENE	200
	9	CHOMBELA	250
	10	KABANGALA	300
	11	KIZITO	200
	12	MEEMBE	200
	13	MUSOKA	250
	14	MUSWISHI	300
	15	SHALWABALA	300
	16	SHIYALA	350
	17	SHIFWANKULA	200
	18	MPUNDE	250
	19	MUKUBWE REST HOUSE	200
	20	CHISANGA PRIMARY SCHOOL	250
		T O T A L	5,300

3. ADDITIONAL 60 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (c)

PROVINCE	3. COPPERBELT		
DISTRICT	NO.	SITE NAME	POPULATION
1-1. NDOLA RURAL	1	MUSHILI, No. 2675	350
	2	MASAITI, No. 2751	300
	3	MASAITI, CHIBOTE	200
	4	MPONGWE, No. 2851	500
	5	ST. MARY'S MISSION	700
	6	IBUCHINGA, No. 3044	500
	7	MUSHILI	200
	8	KACHINDILA	200
	9	LUMPUMA	300
	10	LESA	400
	11	MALEMBEKA	500
	12	CHIBOTE	200
	13	DAGAMA HOME, No. 3080	300
	14	NAKANA	250
	15	COPPERBELT TEACHERS COLLAGE	200
	16	ARTHUR DAVISON HOSPITAL	350
	17	ENGWE, No. 3053	200
	18	IPUMBURARM	250
	19	MUKUMPU	200
	20	IPUMBU FARM	200
		T O T A L	6,300

4. 100 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (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

(Continued)

4. 100 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (a)

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

4. 100 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (b)

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

4. 100 SITES FOR REHABILITATION WORKS FOR EXISTING BOREHOLES (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. Borehole Structure (ø 6")

2. Borehole Structure (ø 4")

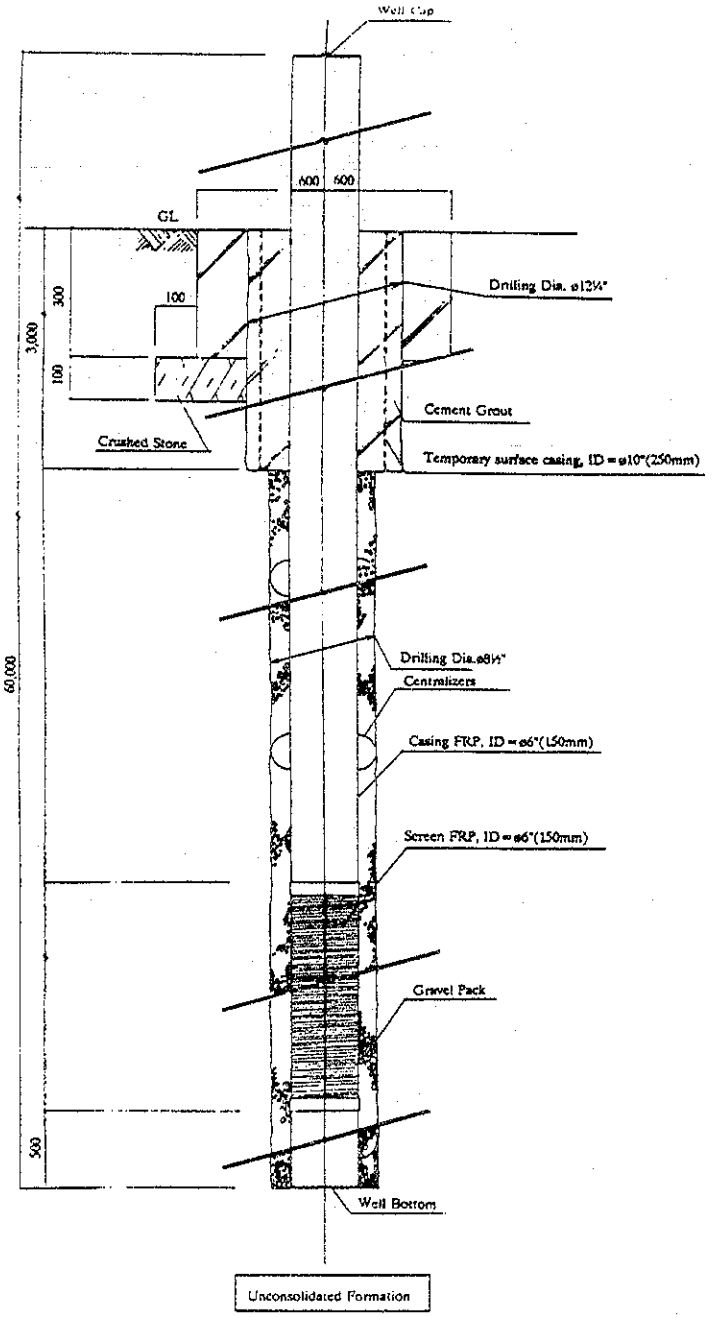
3. Borehole with Water Facility

4. Location of Project Operation Base at Kabwe

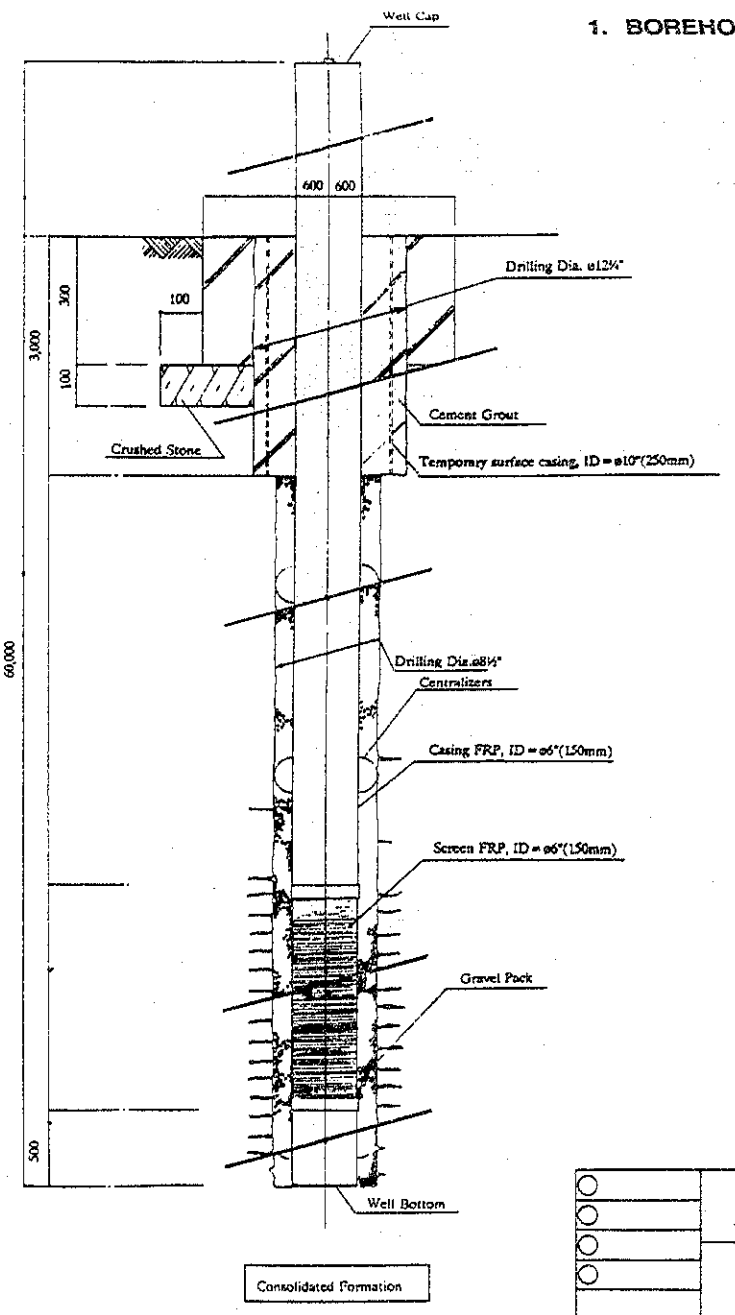
5. Location Plan of Project Operation Base

6. Plate for Cooperation Zambia - Japan

1. BOREHOLE STRUCTURE (6 ø")



Unconsolidated Formation

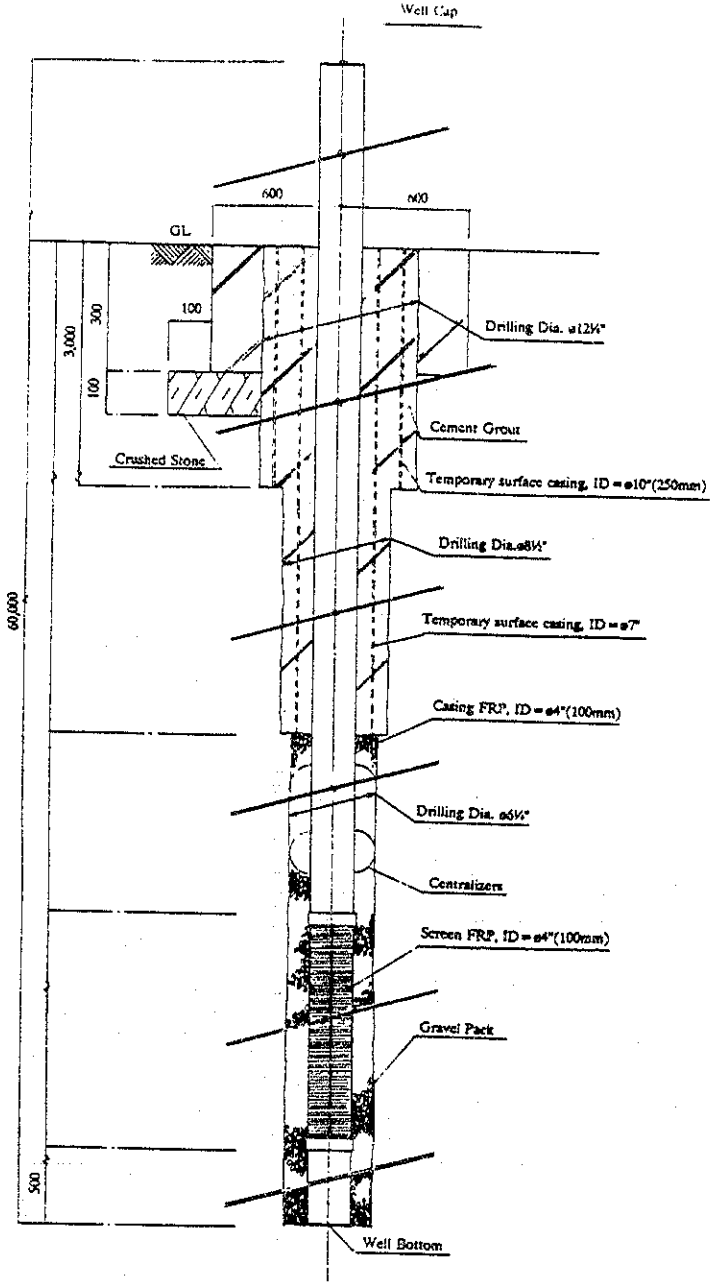


Consolidated Formation

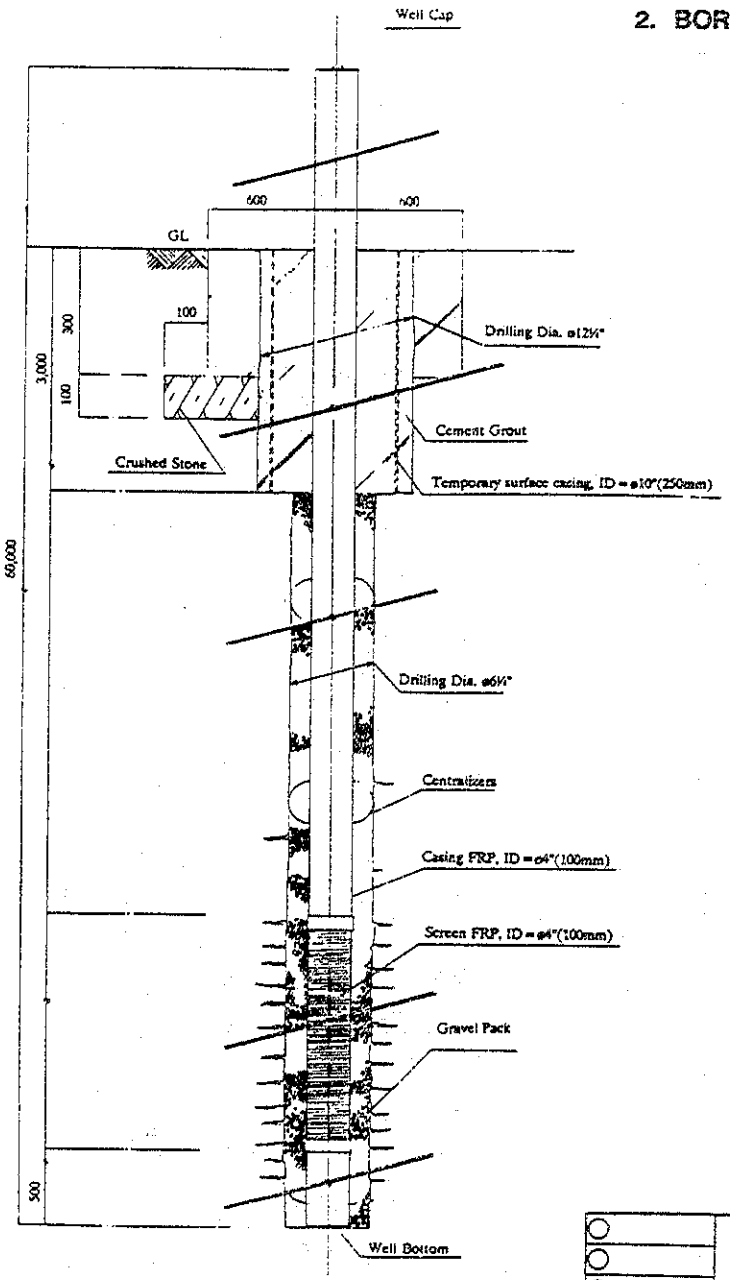
MINISTRY OF ENERGY AND WATER DEVELOPMENT
DEPARTMENT OF WATER AFFAIRS
THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

DESIGN OF 6" BOREHOLE STRUCTURE

2. BOREHOLE STRUCTURE (4 ø")



Unconsolidated Formation



Consolidated Formation

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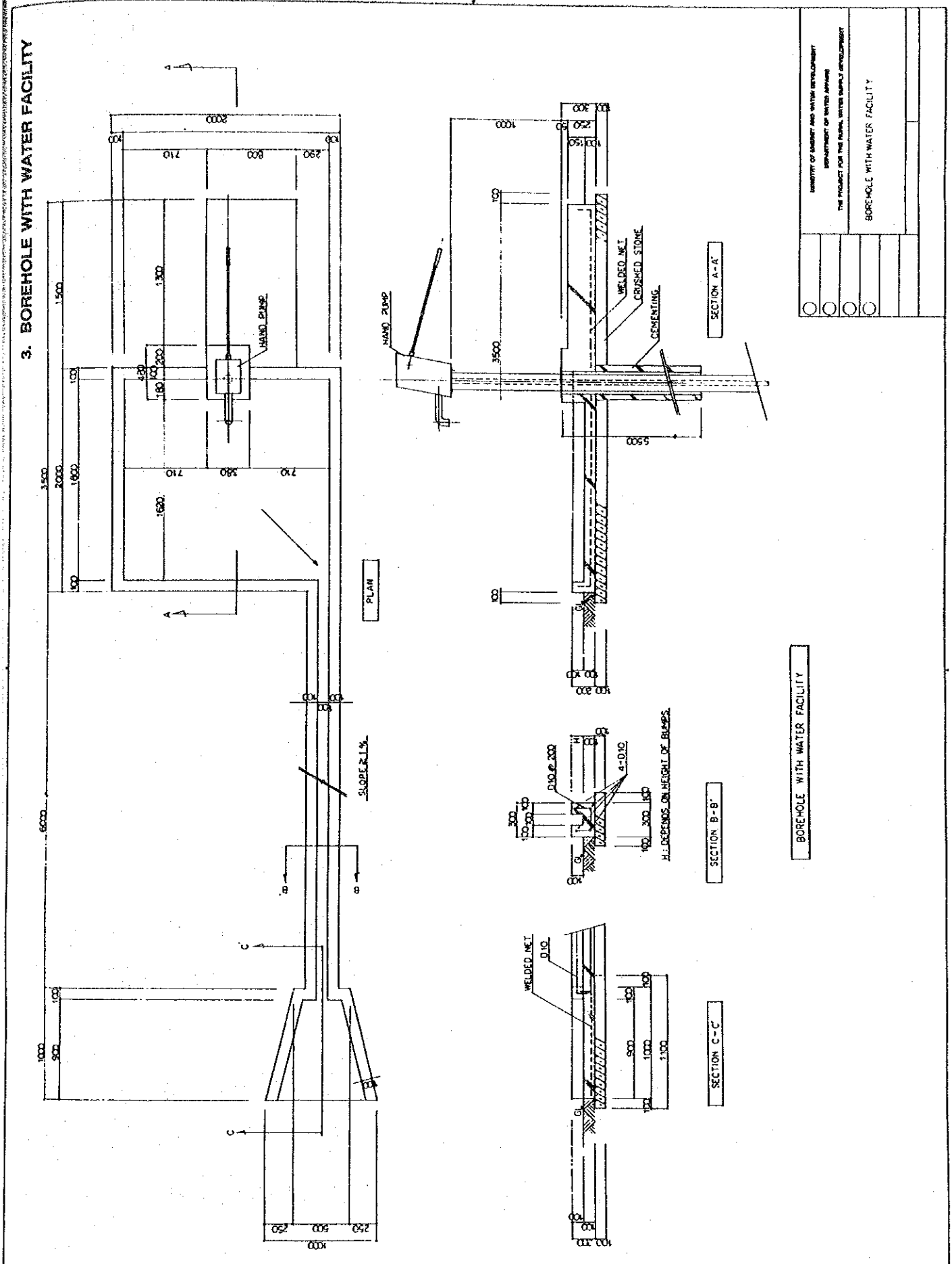
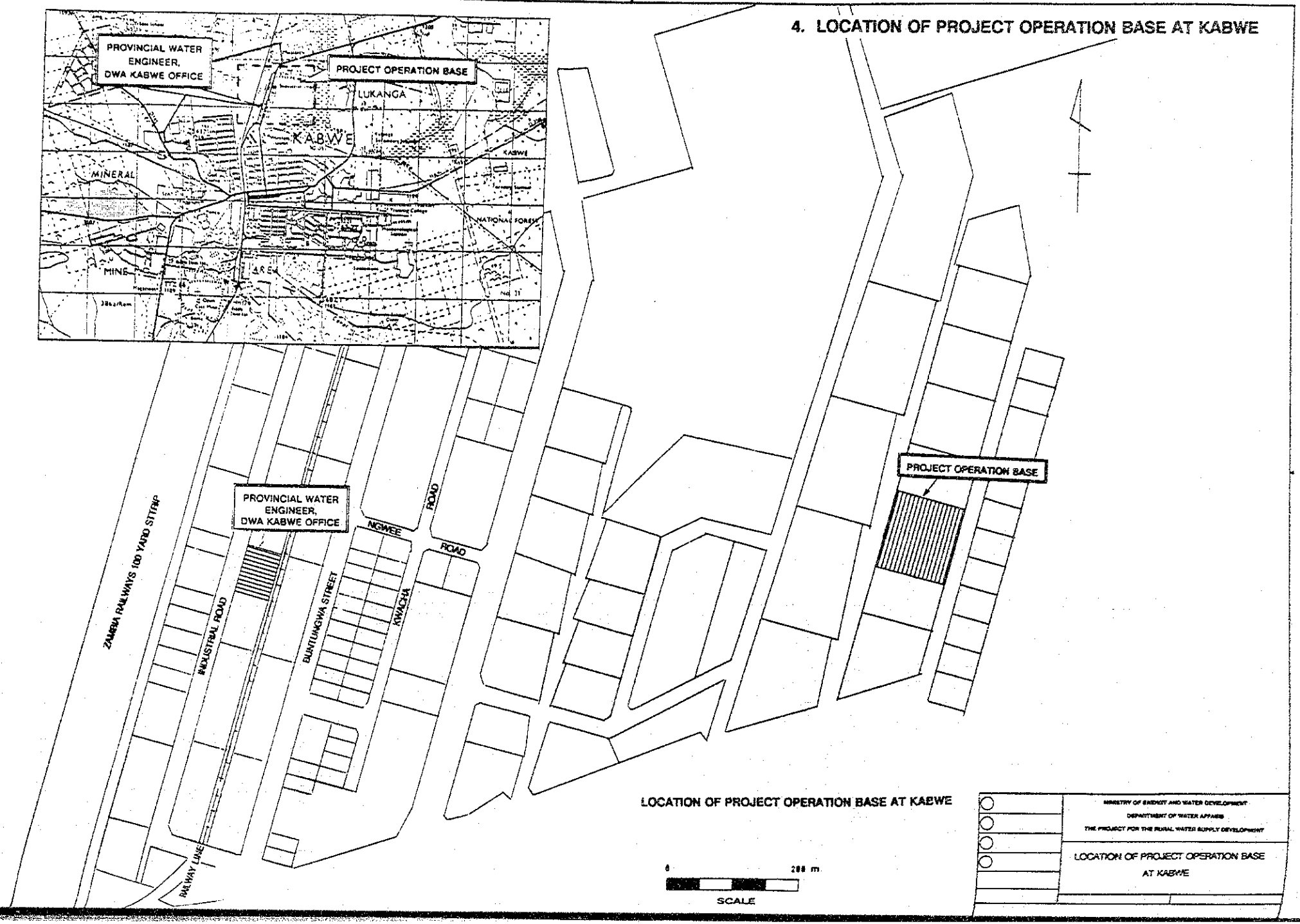
DEPARTMENT OF WATER AFFAIRS
THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

DESIGN OF 4" BOREHOLE STRUCTURE


3. BOREHOLE WITH WATER FACILITY
PLAN
SECTION A-A'
SECTION B-B'
SECTION C-C'
HAND PUMP
WELDED NET
CRUSHED STONE
CEMENTING
SLOPE 2.1%
H: DEPENDS ON HEIGHT OF BUMPS
BOREHOLE WITH WATER FACILITY

4. LOCATION OF PROJECT OPERATION BASE AT KABWE

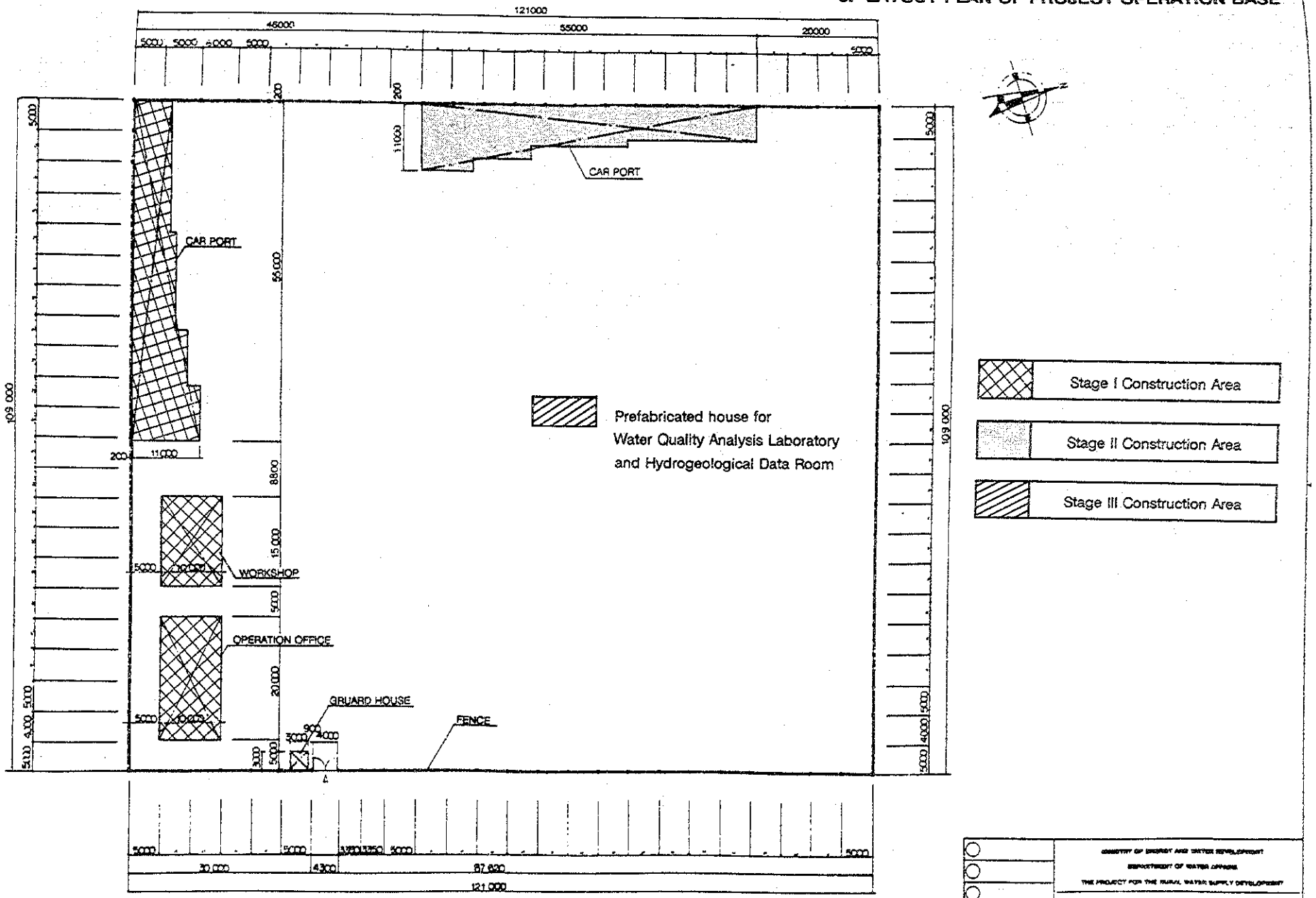


LOCATION OF PROJECT OPERATION BASE AT KABWE

MINISTRY OF ENERGY AND WATER DEVELOPMENT
DEPARTMENT OF WATER AFFAIRS
THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

LOCATION OF PROJECT OPERATION BASE AT KABWE

5. LAYOUT PLAN OF PROJECT OPERATION BASE



LAYOUT PLAN

MINISTRY OF ENERGY AND WATER DEVELOPMENT
DEPARTMENT OF WATER AFFAIRS
THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

LAYOUT PLAN

6. PLATE FOR COOPERATION ZAMBIA - JAPAN

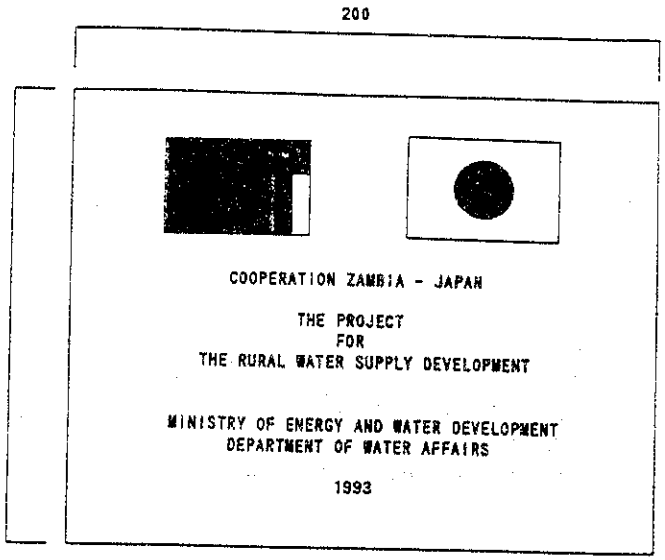
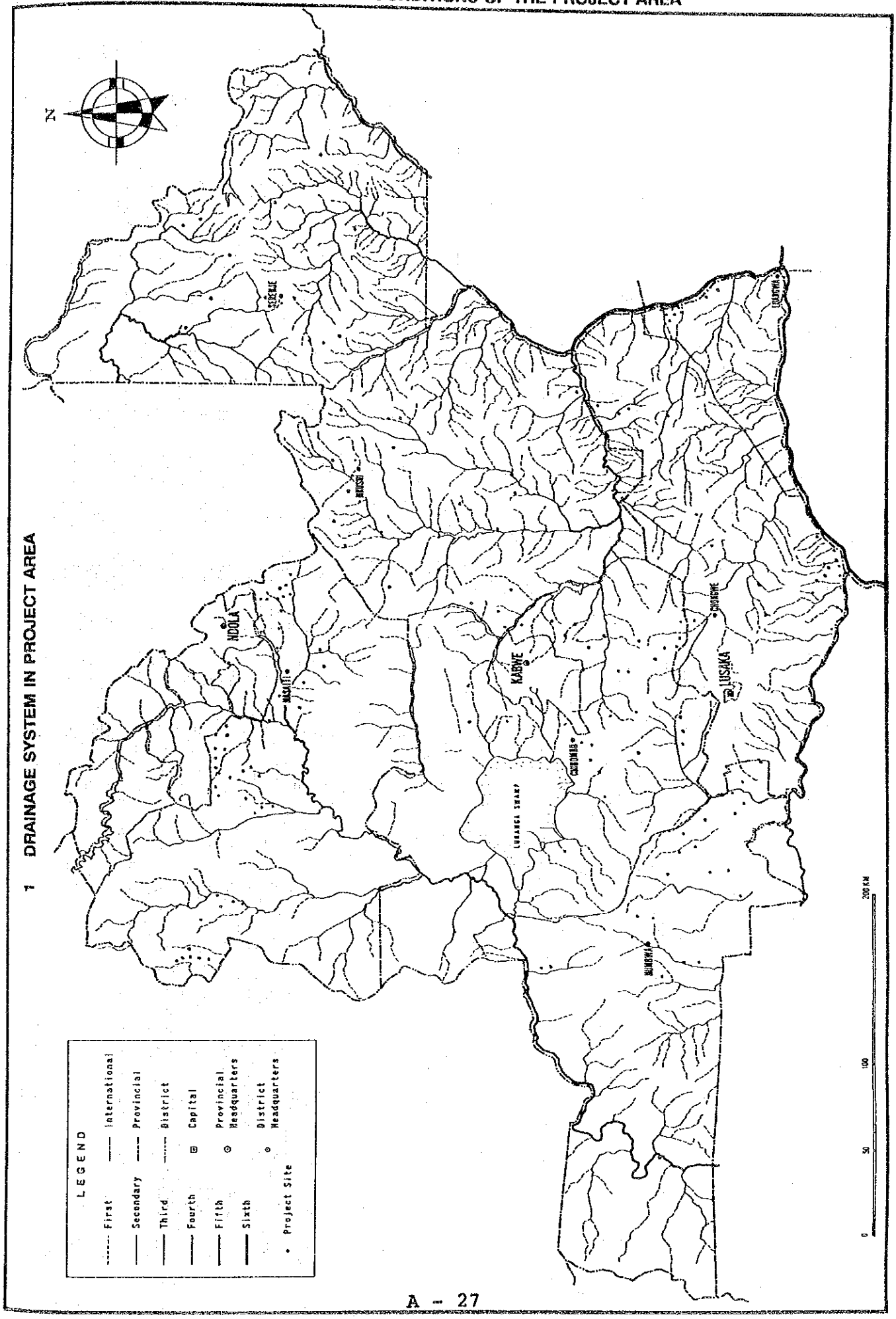


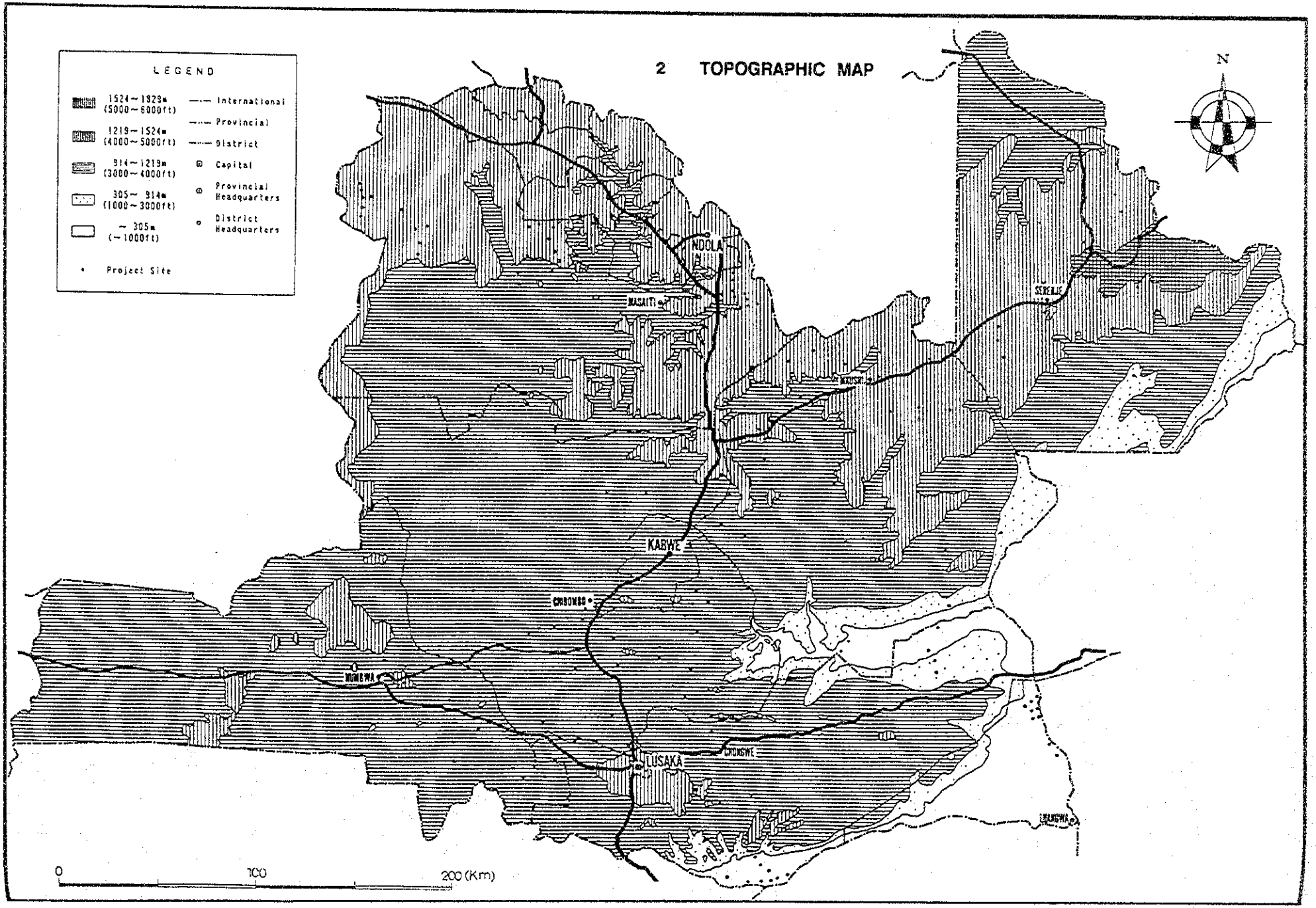
PLATE FOR PUMPING FACILITY

MINISTRY OF ENERGY AND WATER DEVELOPMENT
DEPARTMENT OF WATER AFFAIRS
THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT

PLATE FOR PUMPING FACILITY

1 DRAINAGE SYSTEM IN PROJECT AREA

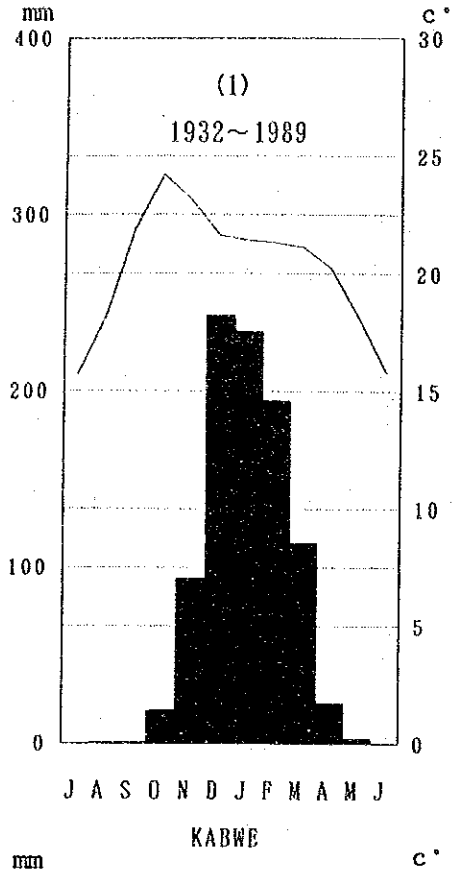


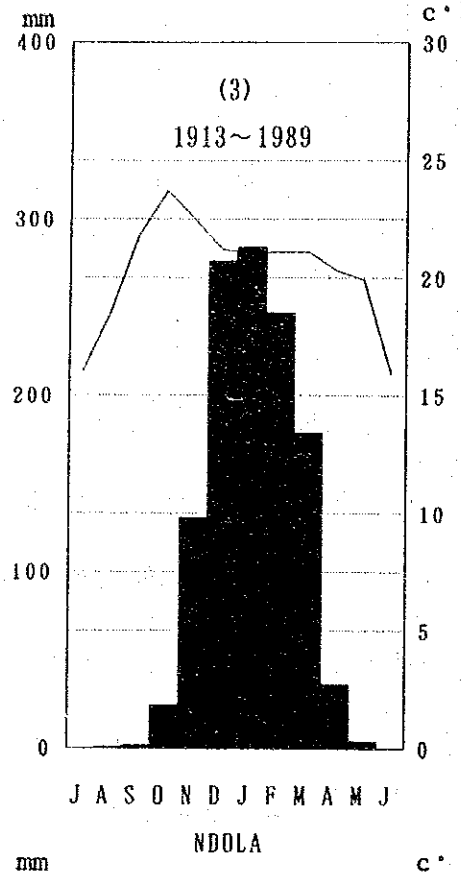

2 TOPOGRAPHIC MAP
LEGEND
1524~1829m (5000~6000ft)
1219~1524m (4000~5000ft)
914~1219m (3000~4000ft)
305~914m (1000~3000ft)
~305m (~1000ft)
Project Site
International
Provincial
District
Capital
Provincial Headquarters
District Headquarters
N
NDOLA
MASAITI
SERENJE
MKUSHI
KABWE
CHIBOMBO
MUMBWA
LUSAKA
CHIRUNDU
CHIRUNDU
0
100
200 (Km)

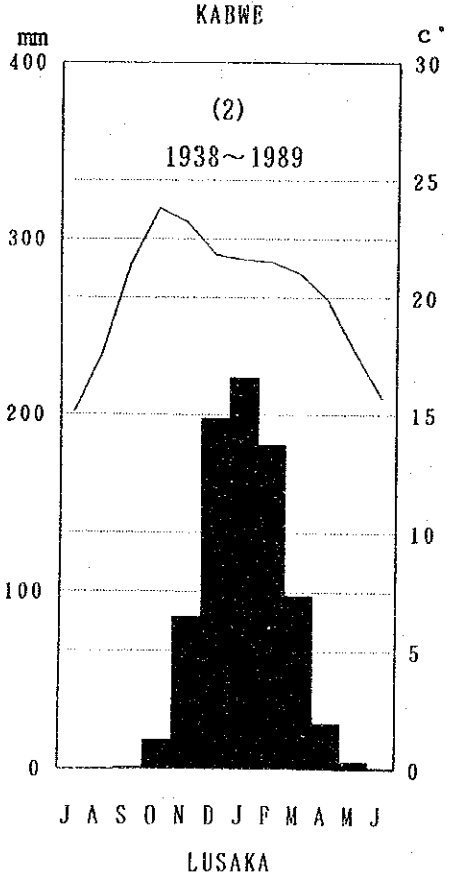
3 ANNUAL AVERAGE CLIMATOLOGIC DATA

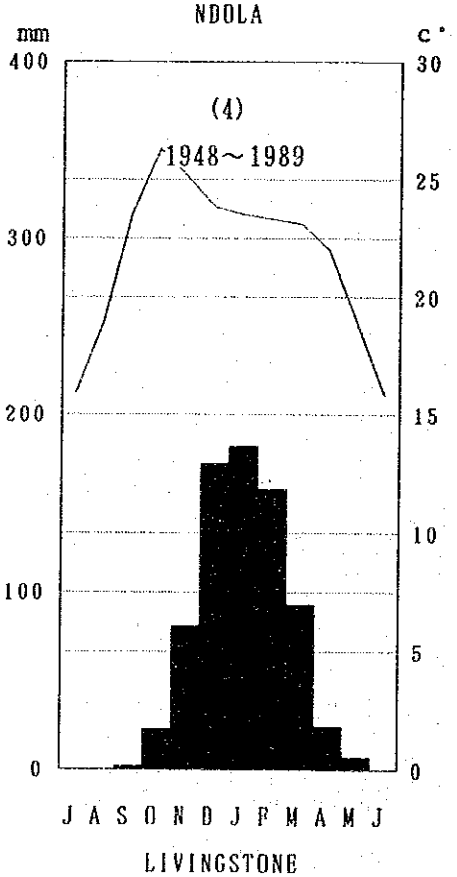
STATION	ITEMS	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	TOTAL
(1)KABWE	1) PRECIPITATION (mm)	0	1	1	19	94	243	234	195	114	23	3	0	928
(1932-1989)	2) TEMPERATURE (C°)	15.7	18.2	21.9	24.2	23.1	21.6	21.4	21.3	21.1	20.2	18.1	15.8	20.2
	3) RAINY DAYS (days/mon.)	0	0	0	3	11	19	19	17	11	3	1	0	84
	4) HUMIDITY (%)	51	47	41	42	61	75	81	77	77	71	65	55	62
	5) EVAPORATION (mm)	165	215	268	295	173	142	137	115	146	153	157	137	2103
	6) SUNSHINE DURATION (hr/day)	9.5	10.1	9.9	9.5	6.9	5.5	5.7	5.7	7.1	8.5	9.6	9.2	8.1
	7) WIND VELOCITY (knot)	6.3	6.9	7.0	6.2	4.7	3.1	3.7	3.5	4.4	5.1	5.2	5.6	5.2
(2)LUSAKA	1) PRECIPITATION (mm)	0	0	1	16	86	198	221	183	98	26	4	1	833
(1938-89)	2) TEMPERATURE (C°)	15.1	17.6	21.4	23.8	23.2	21.8	21.6	21.5	21.0	19.9	17.7	15.7	20.0
	3) RAINY DAYS (days/mon.)	0	0	0	3	11	18	20	14	12	4	2	0	84
	4) HUMIDITY (%)	53	47	39	41	58	76	77	72	68	68	61	57	60
	5) EVAPORATION (mm)	158	204	230	267	241	138	171	135	152	171	183	165	2215
	6) SUNSINE DURATION (hr/day)	9.4	9.9	9.9	9.3	7.4	5.5	5.8	6.0	6.6	7.8	8.9	8.8	7.9
	7) WIND VELOCITY (knot)	7.1	7.8	8.3	8.3	6.2	4.8	3.9	4.3	5.1	5.9	5.7	6.4	6.2
(3)NDOLA	1) PRECIPITATION (mm)	0	1	2	24	131	276	284	247	179	36	4	0	1183
(1903-1989)	2) TEMPERATURE (C°)	16.0	18.5	21.8	23.7	22.5	21.2	21.0	21.1	21.1	20.3	19.9	15.9	20.3
	3) RAINY DAYS (days/mon.)	0	1	1	3	12	20	20	19	15	5	1	0	97
	4) HUMIDITY (%)	52	45	41	43	65	79	82	82	77	71	61	58	63
	5) EVAPORATION (mm)	161	210	245	259	184	139	124	115	146	157	159	147	2046
	6) SUNSHINE DURATION (hr/day)	9.4	9.6	9.4	8.8	6.7	4.8	4.6	4.6	6.1	8.0	9.0	9.0	7.5
	7) WIND VELOCITY (knot)	5.1	5.8	6.5	6.0	4.8	3.9	3.7	3.2	3.5	4.1	4.0	4.6	4.6
(4)LIVINGSTONE	1) PRECIPITATION (mm)	0	0	2	23	81	172	182	158	93	24	7	0	742
(1948-1989)	2) TEMPERATURE (C°)	15.9	18.9	23.5	26.3	25.1	23.8	23.5	23.3	23.1	22.0	18.9	15.8	21.7
	3) RAINY DAYS (days/mon.)	0	0	1	3	11	16	17	15	9	4	1	0	77
	4) HUMIDITY (%)	46	38	32	35	56	70	74	76	67	59	51	50	55
	5) EVAPORATION (mm)	150	196	251	281	217	162	164	136	164	159	158	132	2170
	6) SUNSHINE DURATION (hr/day)	9.8	10.1	9.8	8.9	7.2	5.9	6.4	6.5	7.9	9.0	9.7	9.5	8.4
	7) WIND VELOCITY (knot)	4.6	5.1	5.9	5.7	5.0	3.9	4.3	4.2	4.5	4.3	3.9	4.3	4.6

4 MEAN ANNUAL TEMPERATURE AND RAINFALL









5 MONTHLY RAINFALLLS AT KABWE STATION (1970 - 1990)

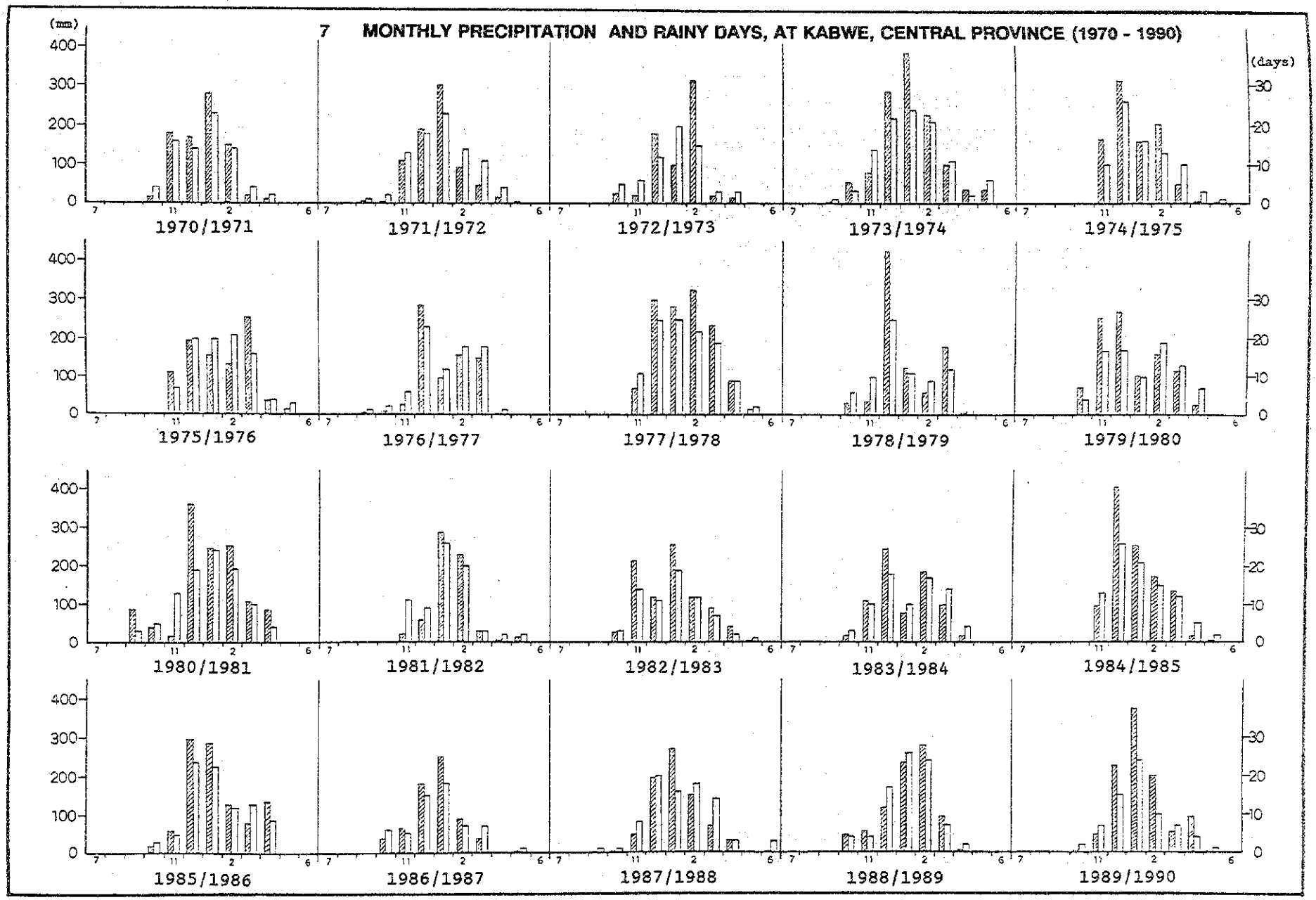
(Unit:mm)

Year	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Annual
1970/71	0.0	0.0	0.0	14.5	180.6	170.2	281.4	152.7	24.1	10.7	TR	0.0	834.2
1971/72	0.0	0.0	2.5	4.6	111.0	191.3	302.5	94.2	45.0	14.2	TR	0.0	765.3
1972/73	0.0	0.0	0.0	26.4	22.6	181.6	106.1	315.4	19.0	16.1	0.0	0.0	687.2
1973/74	0.0	0.0	0.7	54.0	82.0	286.2	386.0	227.2	99.4	36.8	36.6	0.0	1208.9
1974/75	0.0	0.0	0.0	0.0	165.1	265.4	161.0	207.7	49.0	6.3	2.5	0.0	857.0
1975/76	0.0	0.0	0.0	0.0	110.6	194.3	154.7	133.0	258.9	35.2	14.6	0.0	901.3
1976/77	0.0	0.0	0.8	37.4	27.3	285.1	98.1	157.8	149.5	0.2	0.0	0.0	756.2
1977/78	0.0	2.4	0.1	TR	67.7	298.8	284.4	327.7	238.9	89.6	11.9	0.0	1321.5
1978/79	0.0	0.0	0.0	31.6	34.2	426.9	122.4	61.6	80.2	6.5	0.0	0.0	763.4
1979/80	0.0	0.0	0.0	7.4	256.1	269.3	105.5	186.4	115.9	28.6	0.0	0.0	969.2
1980/81	0.0	0.0	8.8	40.0	160.8	360.0	248.7	254.3	111.3	86.0	0.0	0.0	1269.9
1981/82	0.0	0.0	0.0	0.0	20.3	59.4	287.5	229.5	31.7	9.5	12.7	0.0	650.6
1982/83	0.0	0.0	0.0	27.8	212.5	119.7	256.6	121.5	91.1	39.9	2.6	0.0	871.7
1983/84	0.0	0.0	0.0	18.9	111.8	246.0	76.8	181.8	99.7	13.0	0.0	0.0	748.0
1984/85	0.0	0.0	0.0	0.0	97.0	405.6	254.9	173.6	138.2	14.7	10.4	0.0	1094.4
1985/86	0.0	0.0	0.0	20.2	62.2	300.9	289.1	129.5	83.2	137.7	0.0	0.0	1022.8
1986/87	0.0	0.0	0.0	37.9	67.2	180.7	251.0	88.7	38.3	0.0	0.9	0.0	664.7
1987/88	0.0	0.0	1.5	2.5	47.0	197.2	169.3	148.3	69.3	2.9	0.0	2.8	640.8
1988/89	0.0	0.0	0.0	43.3	55.0	114.7	233.8	279.0	92.0	5.0	0.0	0.0	822.8
1989/90	0.0	0.0	0.0	1.7	46.5	179.6	376.6	200.0	53.4	96.4	1.7	0.0	955.9
Average	0.0	0.1	0.7	18.4	96.9	236.6	222.3	183.5	99.4	32.5	4.7	0.1	890.2
Rainy days	0.0	0.1	0.4	2.7	10.0	18.8	19.5	16.0	10.5	3.5	1.0	0.2	82.7

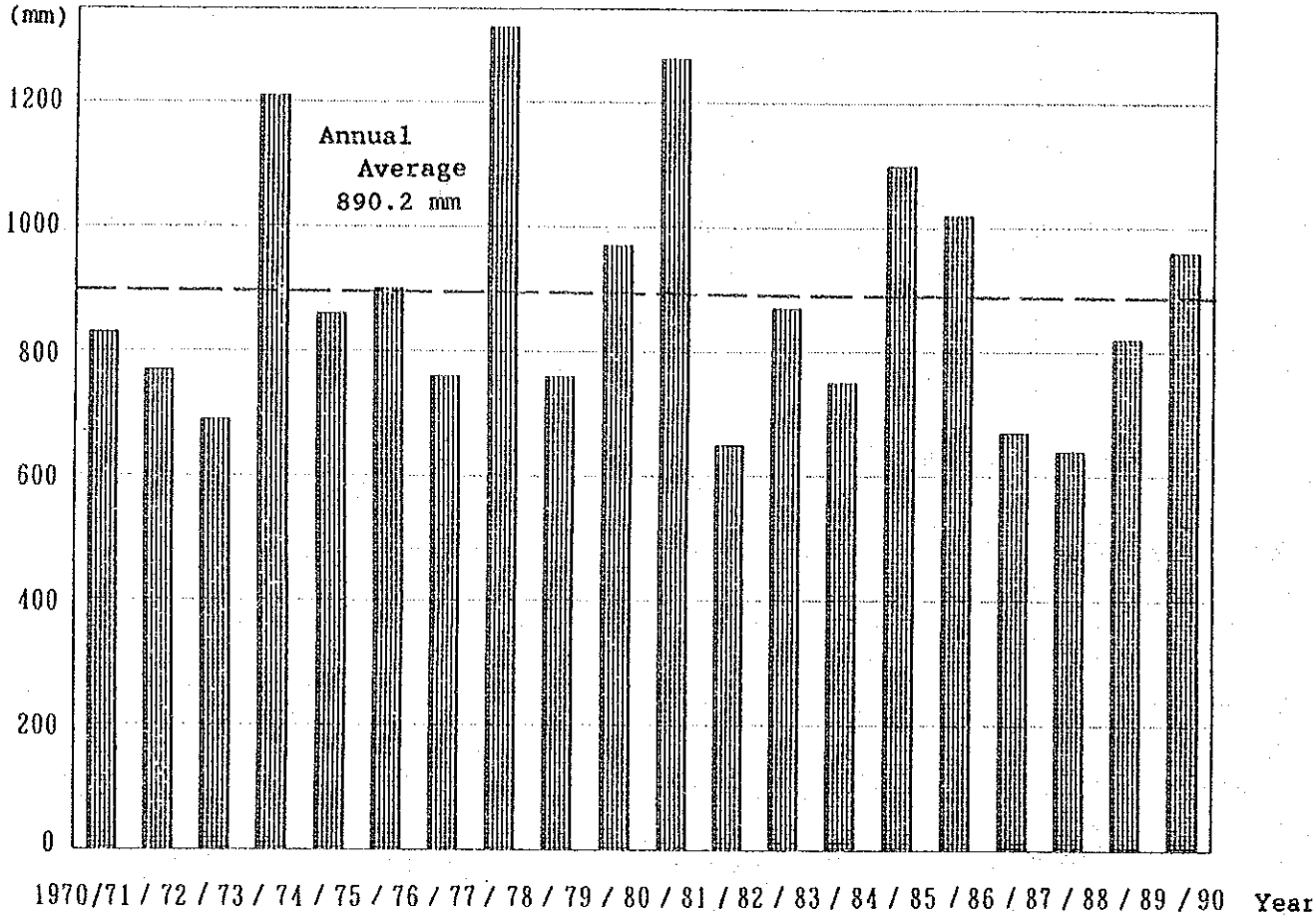
6 MONTHLY RAINY DAYS AT KABWE STATION (1970 - 1990)

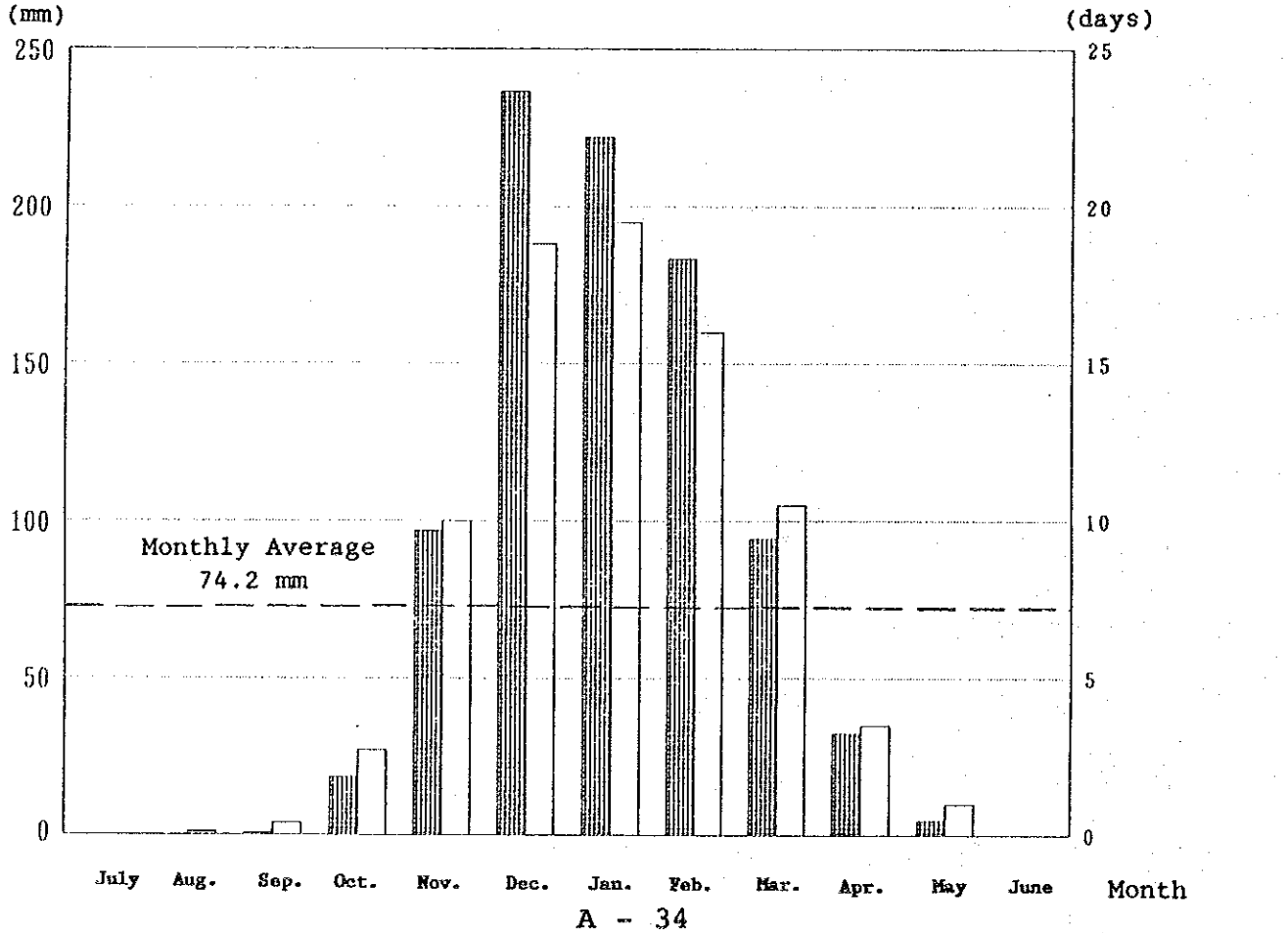
(Unit:days)

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Annual
1970／71	0	0	0	4	16	14	23	14	4	2	0	0	77
1971／72	0	0	1	2	13	18	23	14	11	4	0	0	86
1972／73	0	0	0	5	6	12	20	15	3	3	0	0	64
1973／74	0	0	1	3	14	22	24	21	11	2	6	0	104
1974／75	0	0	0	0	10	26	16	13	10	3	1	0	79
1975／76	0	0	0	0	7	20	20	21	16	4	3	0	91
1976／77	0	0	1	2	6	23	12	18	18	1	0	0	81
1977／78	0	1	1	0	11	25	25	22	19	9	2	0	115
1978／79	0	0	0	6	10	25	11	9	12	1	0	0	74
1979／80	0	0	0	4	17	17	10	19	13	7	0	0	87
1980／81	0	0	3	5	13	19	24	19	10	4	0	0	97
1981／82	0	0	0	0	11	9	26	20	3	2	2	0	73
1982／83	0	0	0	3	14	11	19	12	7	2	1	0	69
1983／84	0	0	0	3	10	18	10	17	14	4	0	0	76
1984／85	0	0	0	0	13	26	21	15	12	5	2	0	94
1985／86	0	0	0	3	5	24	23	12	13	9	0	0	89
1986／87	0	0	0	6	5	15	18	7	7	0	1	0	59
1987／88	0	0	1	1	8	20	16	18	14	3	0	3	84
1988／89	0	0	0	4	4	17	26	24	7	2	0	0	84
1989／90	0	0	0	2	7	15	24	10	7	4	1	0	70
Average	0	0.1	0.4	2.7	10.0	18.8	19.5	16.0	10.5	3.5	1.0	0.2	82.7

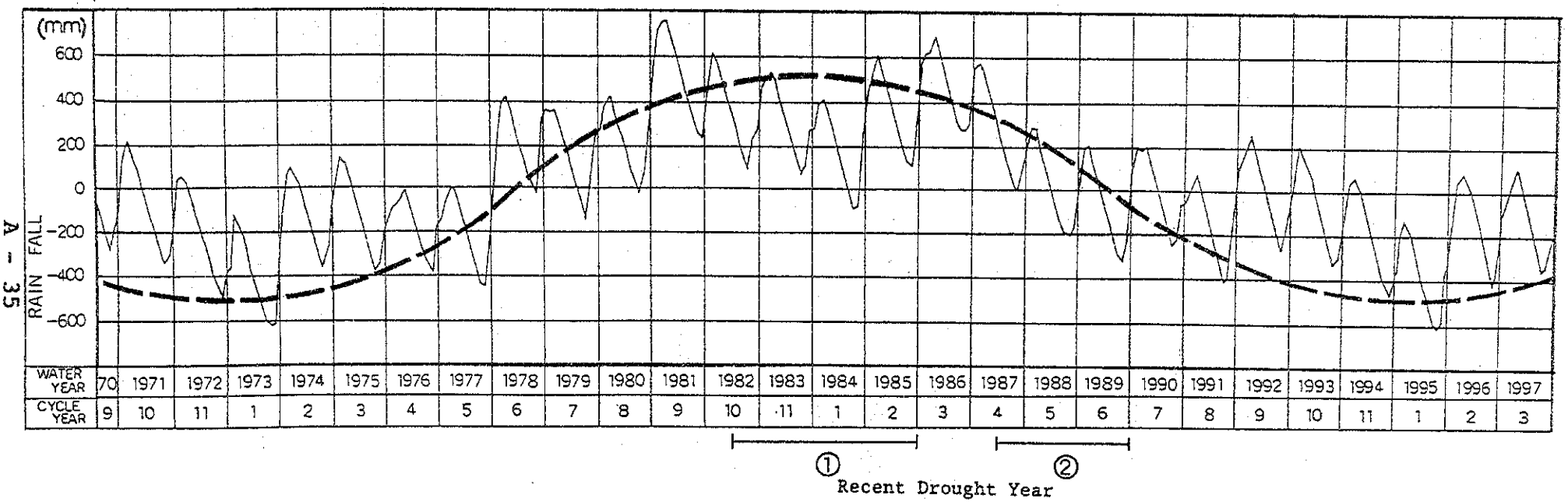

7 MONTHLY PRECIPITATION AND RAINY DAYS, AT KABWE, CENTRAL PROVINCE (1970 - 1990)
(mm)
(days)
1970/1971
1971/1972
1972/1973
1973/1974
1974/1975
1975/1976
1976/1977
1977/1978
1978/1979
1979/1980
1980/1981
1981/1982
1982/1983
1983/1984
1984/1985
1985/1986
1986/1987
1987/1988
1988/1989
1989/1990

8 ANNUAL PRECIPITATION AT KABWE, CENTRAL PROVINCE (1970 - 1990)
AND MONTHLY PRECIPITATION & RAINY DAYS (1970 - 1990)



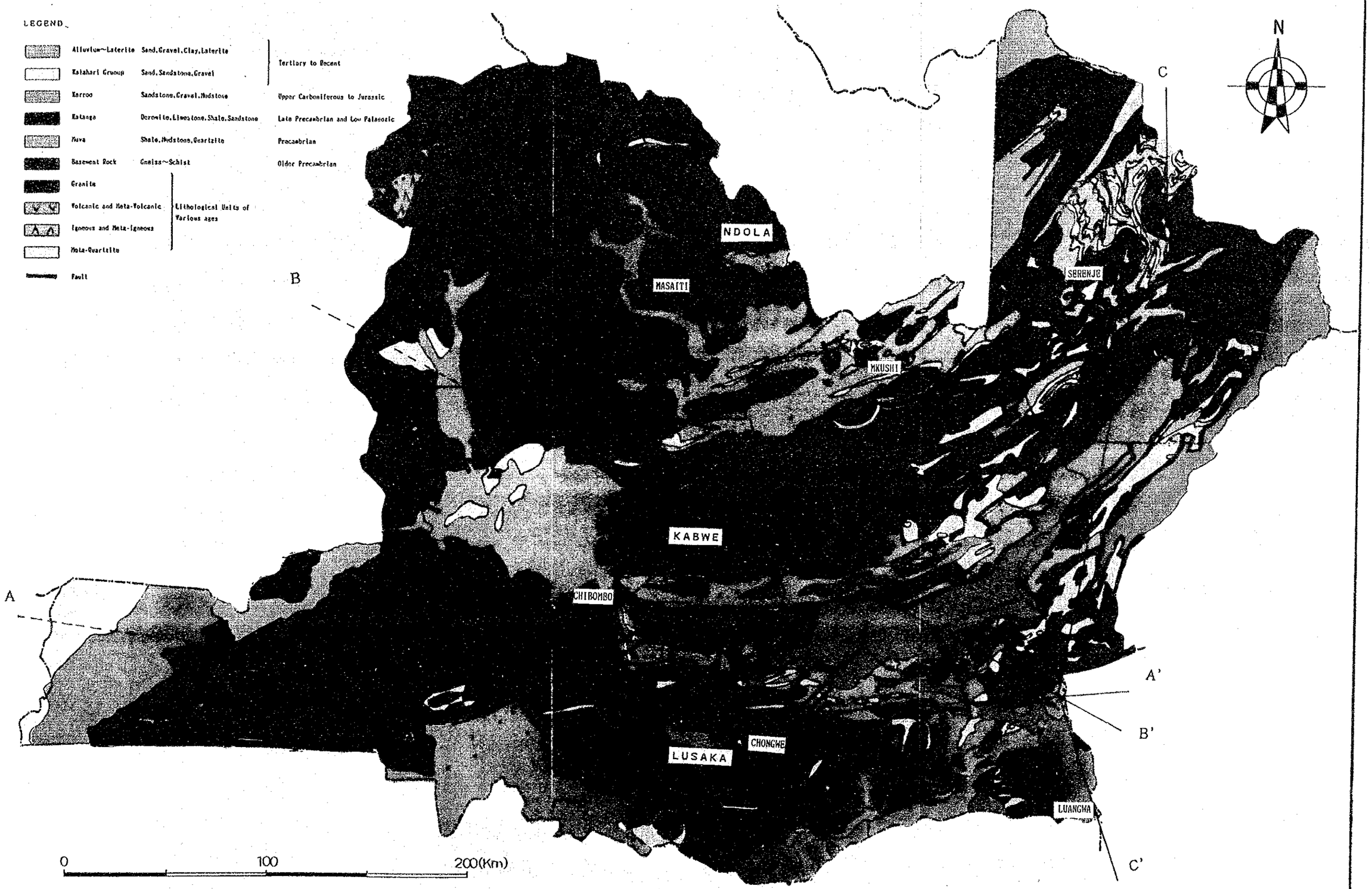


9 A LONG RANGE PRECIPITATION CYCLE AT KABWE, CENTRAL PROVINCE (1971-1997)

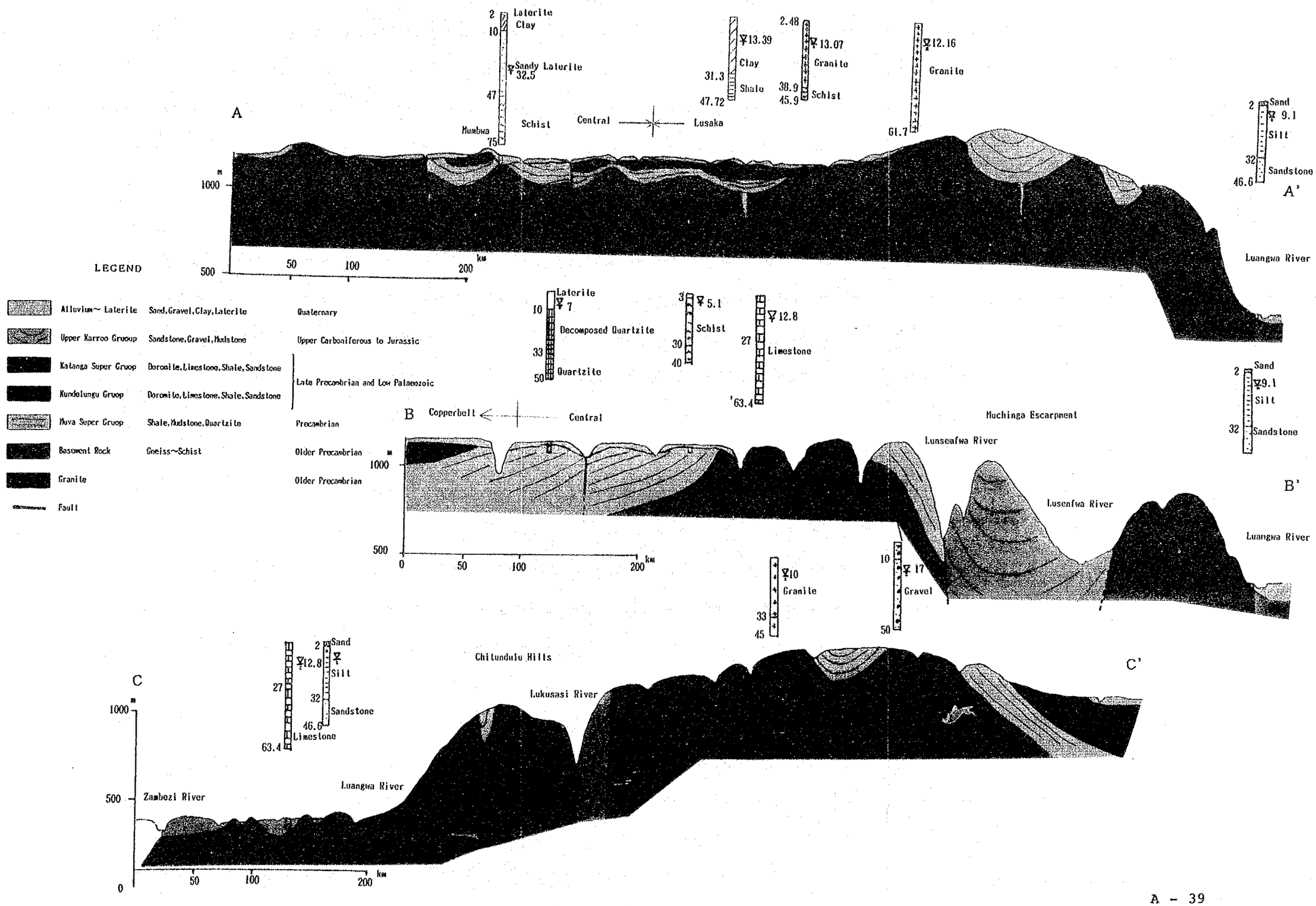


LEGEND

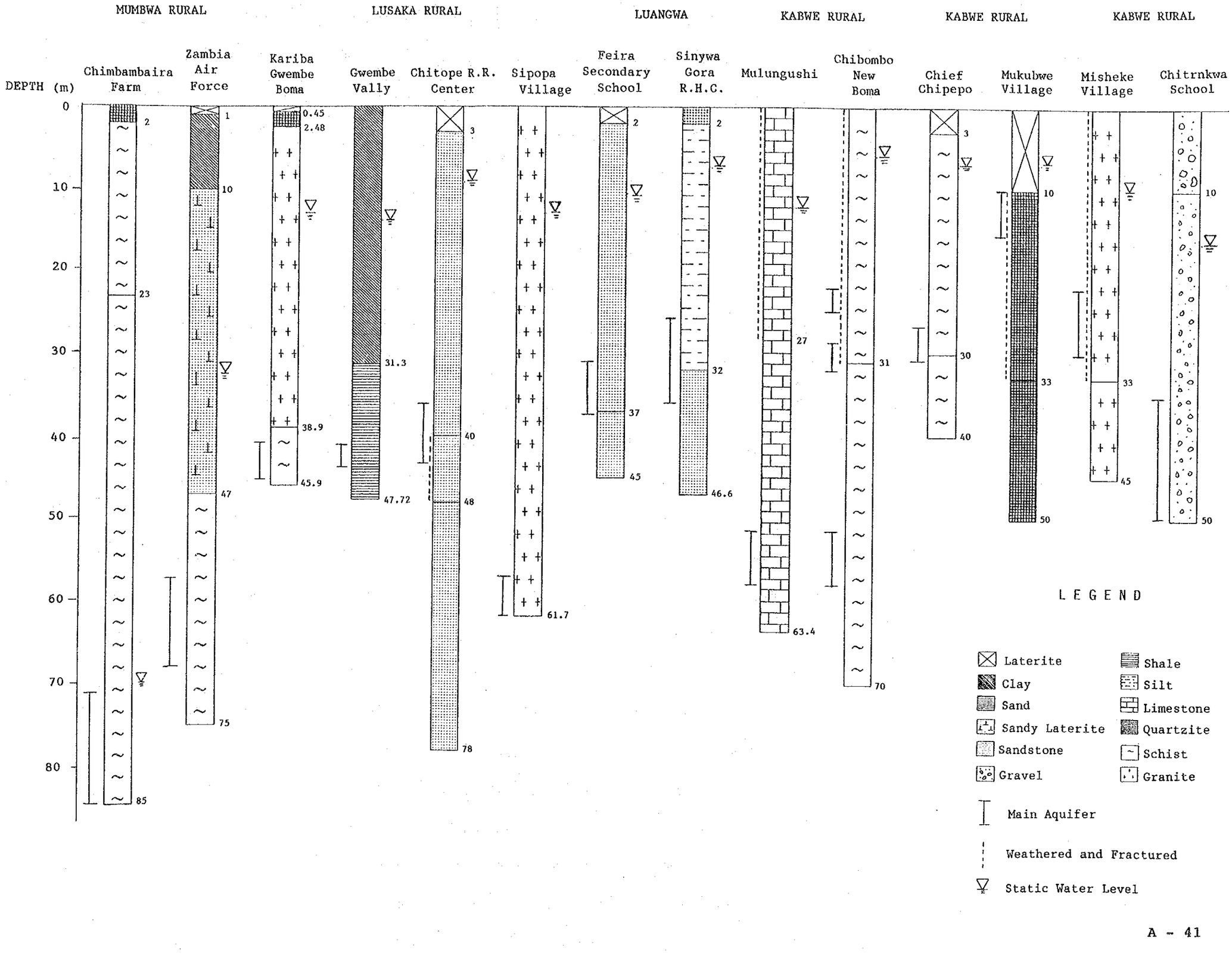
	Alluvium~Laterite	Sand, Gravel, Clay, Laterite	Tertiary to Recent
	Kalahari Group	Sand, Sandstone, Gravel	
	Karroo	Sandstone, Gravel, Mudstone	Upper Carboniferous to Jurassic
	Katanga	Dolomite, Limestone, Shale, Sandstone	Late Precambrian and Low Palaeozoic
	Kuva	Shale, Mudstone, Quartzite	Precambrian
	Basement Rock	Gneiss~Schist	Older Precambrian
	Granite		Lithological Units of Various ages
	Volcanic and Meta-Volcanic		
	Igneous and Meta-Igneous		
	Meta-Quartzite		
	Fault		

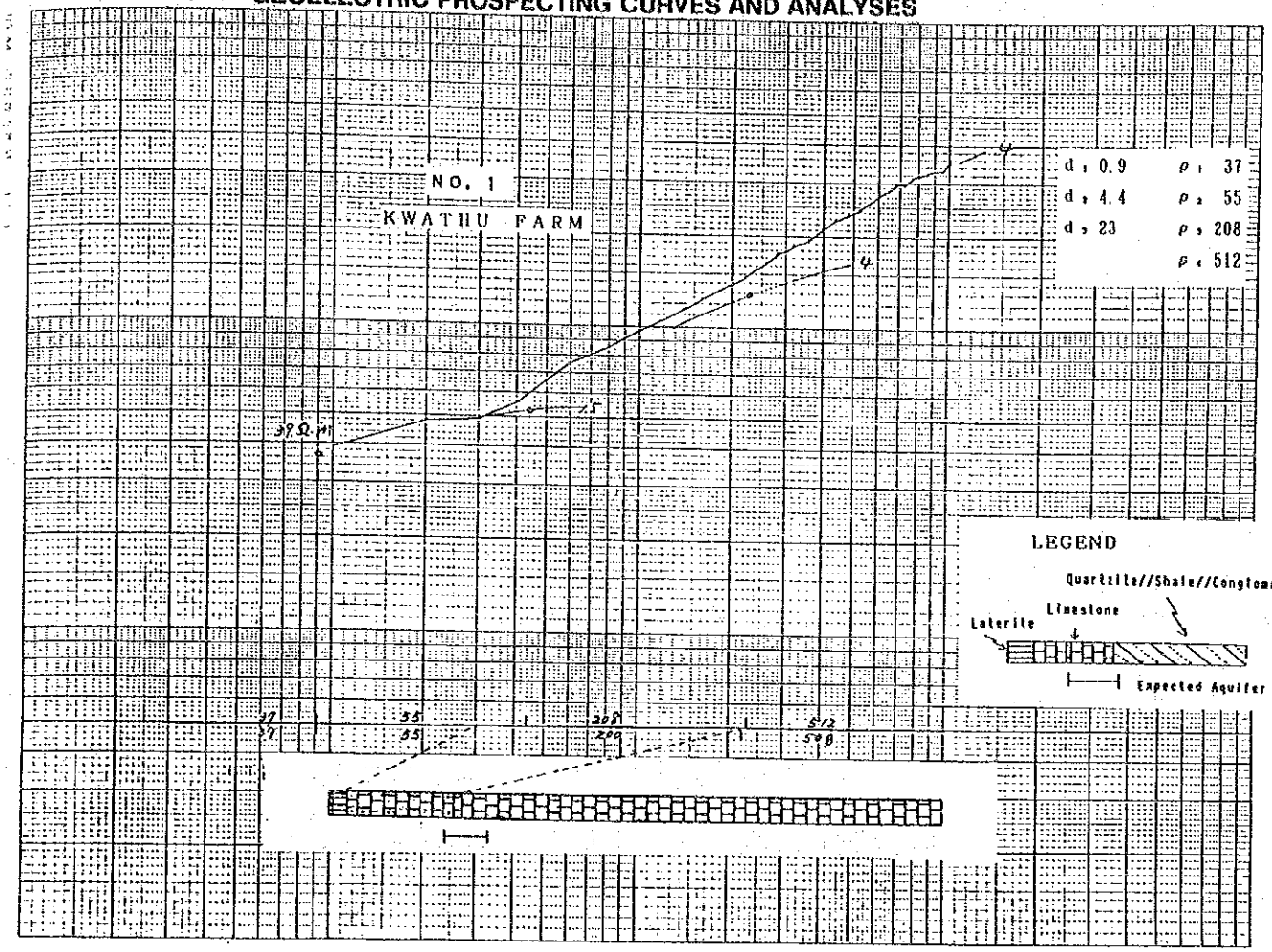


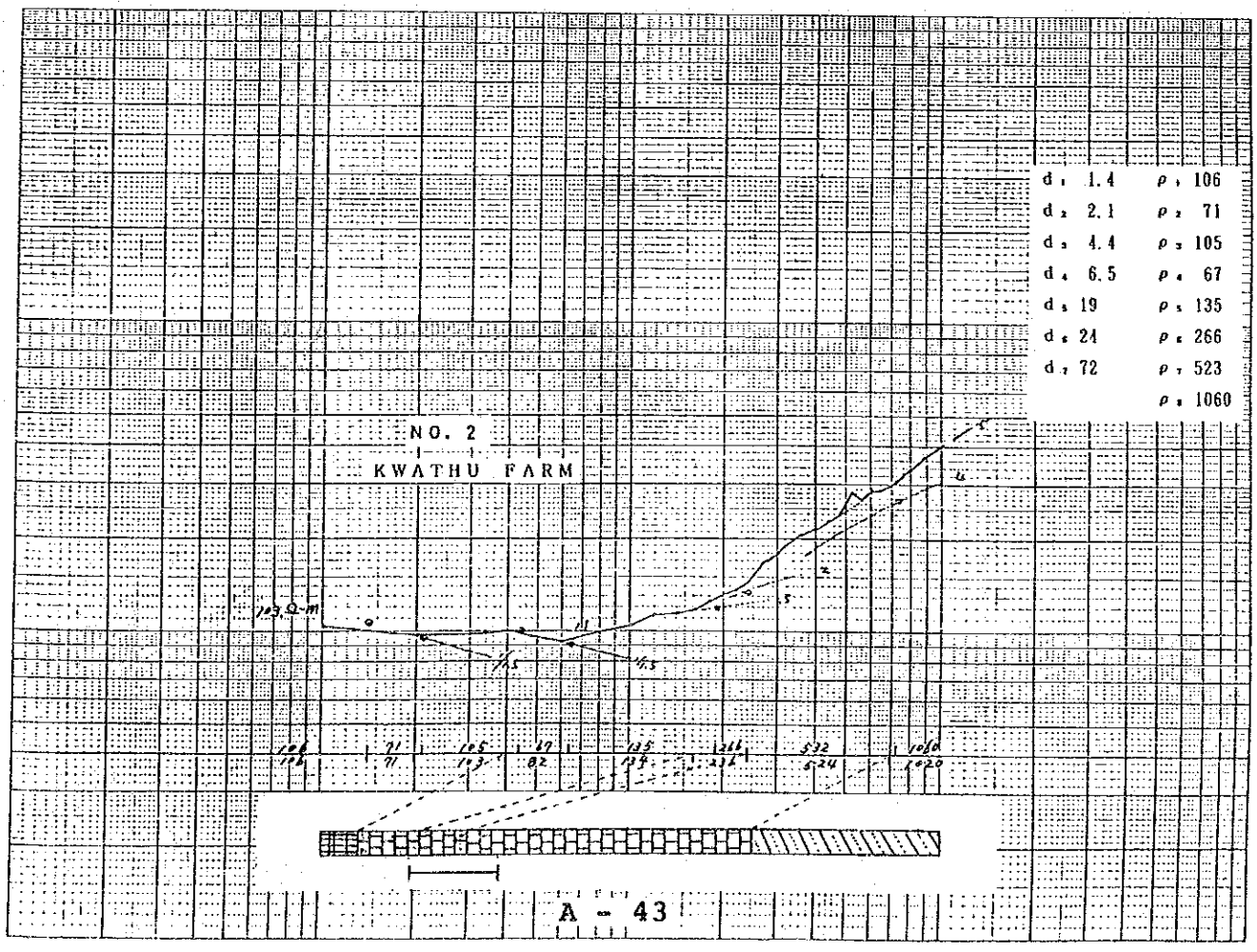
11 HYDROGEOLOGICAL FEATURES IN PROJECT AREA :SECTIONAL VIEW

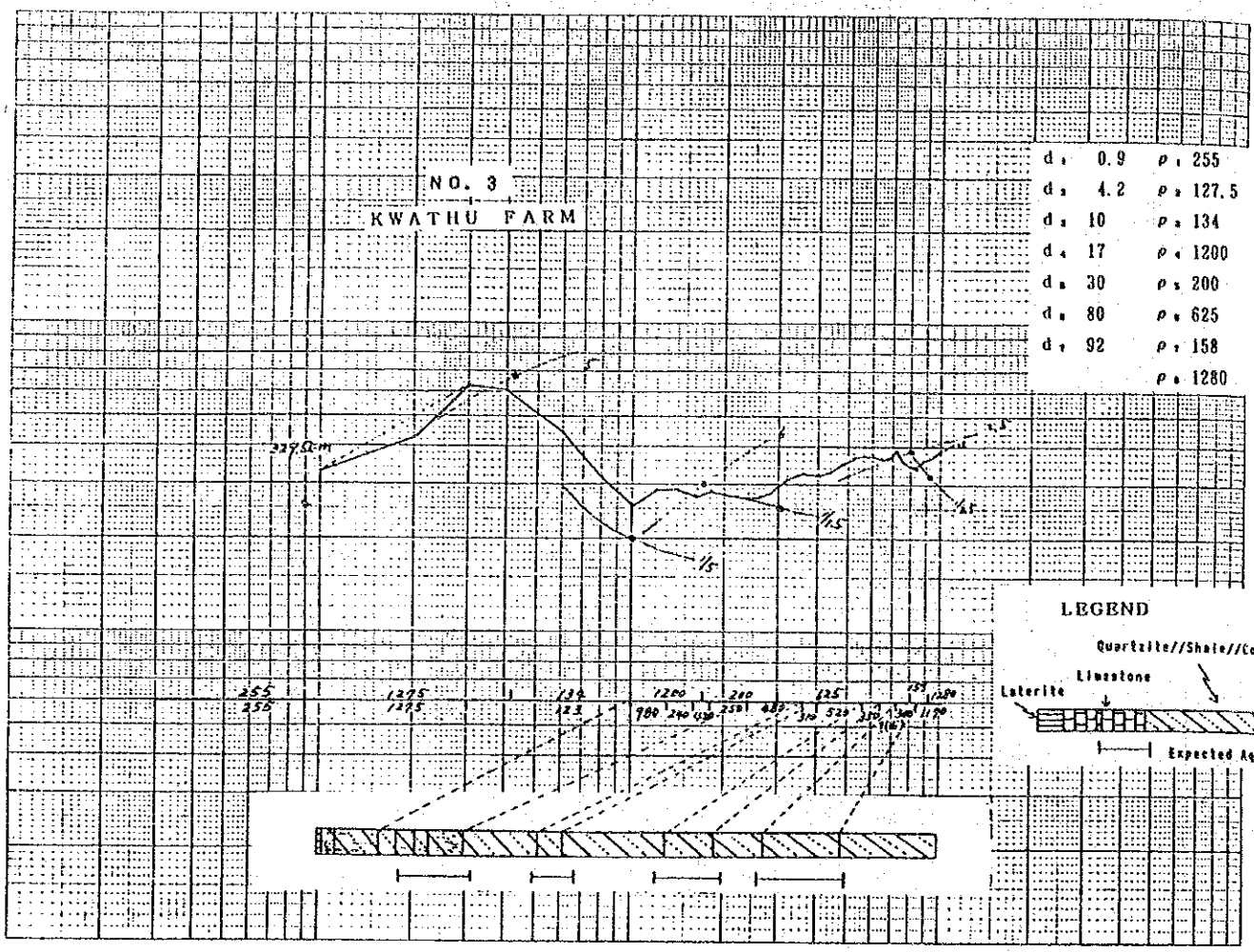


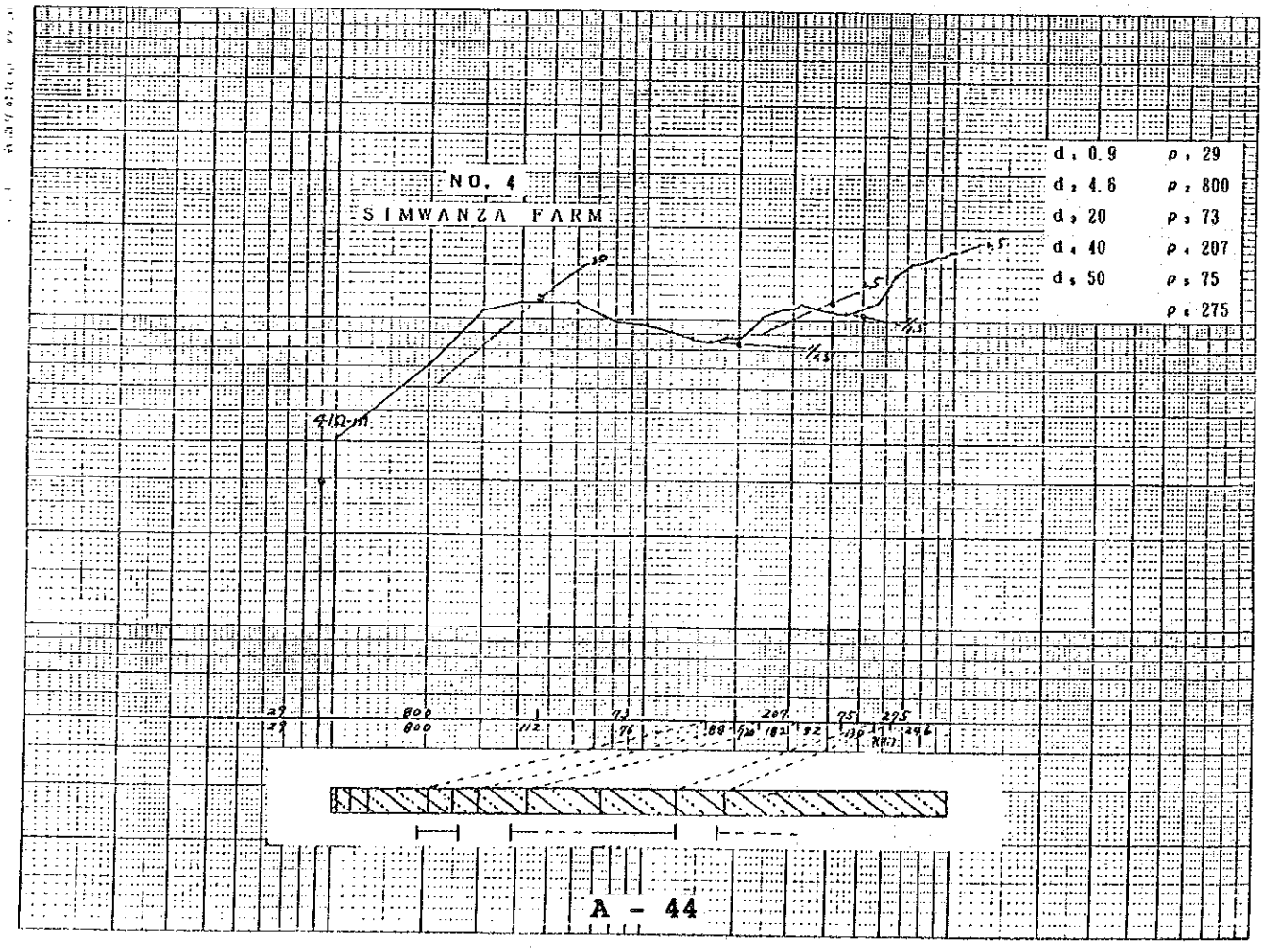
LITHOLOGY OF BOREHOLES IN THE PROJECT AREA



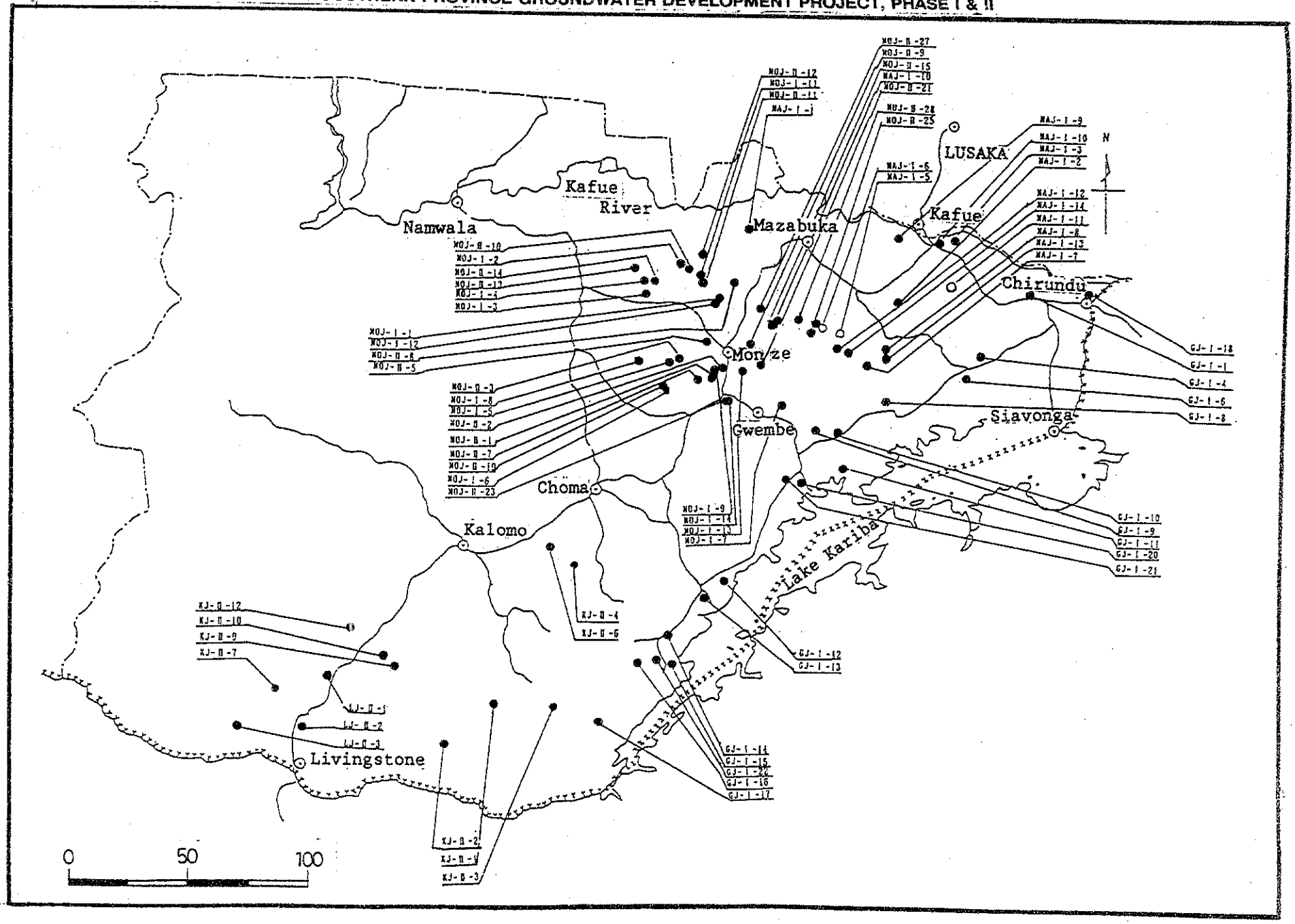

NO. 1
KWATHU FARM
d , 0.9 ρ , 37
d , 4.4 ρ , 55
d , 23 ρ , 208
ρ , 512
LEGEND
Quartzite//Shale//Conglomerate
Limestone
Laterite
Expected Aquifer

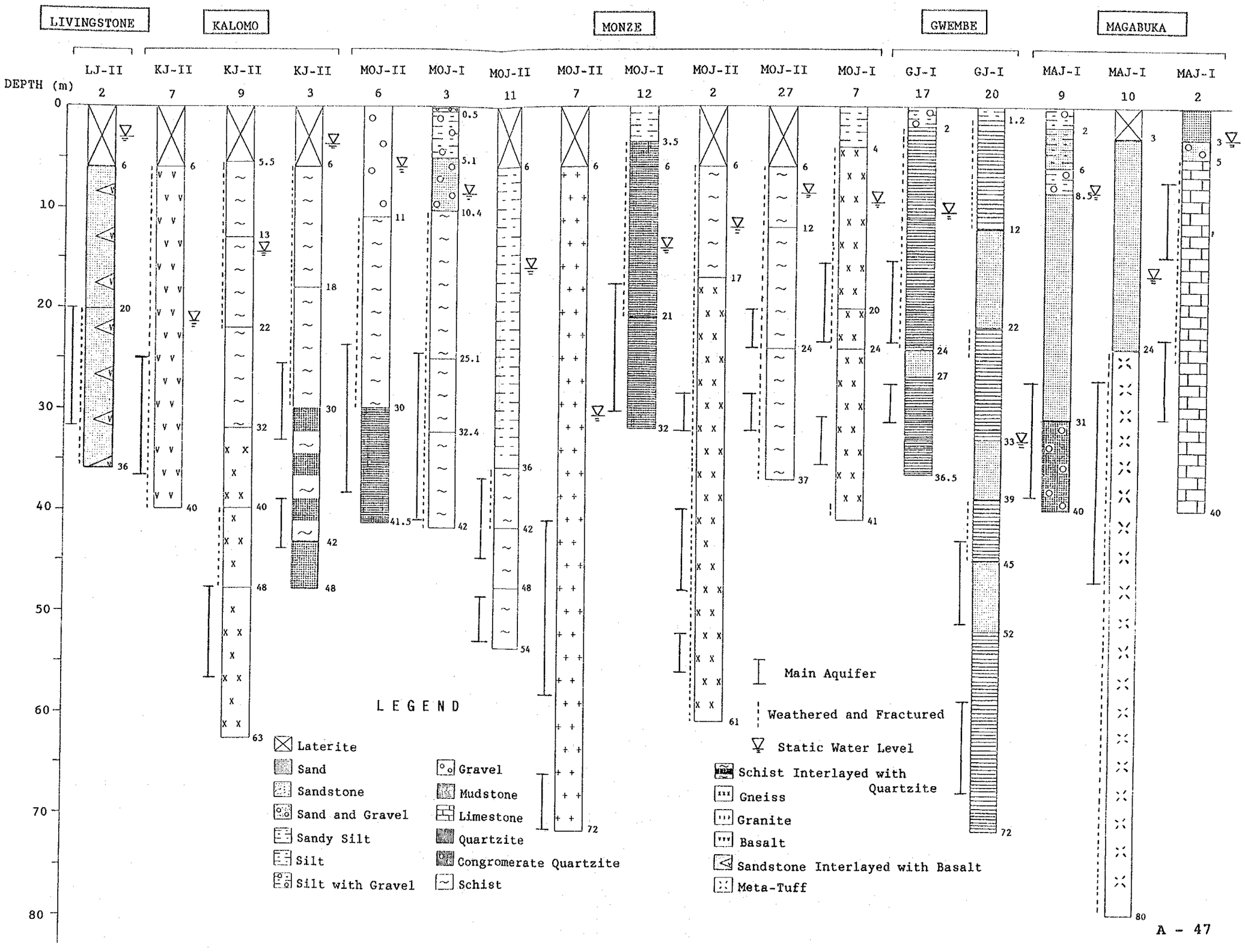

NO. 2
KWATHU FARM
d , 1.4 ρ , 106
d , 2.1 ρ , 71
d , 4.4 ρ , 105
d , 6.5 ρ , 67
d , 19 ρ , 135
d , 24 ρ , 266
d , 72 ρ , 523
ρ , 1060


NO. 3
KWATHU FARM
d₁ 0.9 ρ₁ 255
d₂ 4.2 ρ₂ 127.5
d₃ 10 ρ₃ 134
d₄ 17 ρ₄ 1200
d₅ 30 ρ₅ 200
d₆ 80 ρ₆ 625
d₇ 92 ρ₇ 158
ρ₈ 1280
227 Ω-m
LEGEND
Quartzite//Shale//Conglomerate
Limestone
Laterite
Expected Aquifer


NO. 4
SIMWANZA FARM
d₁ 0.9 ρ₁ 29
d₂ 4.6 ρ₂ 800
d₃ 20 ρ₃ 73
d₄ 40 ρ₄ 207
d₅ 50 ρ₅ 75
ρ₆ 275
41 Ω-m

14 LOCATION MAP OF BOREHOLES SOUTHERN PROVINCE GROUNDWATER DEVELOPMENT PROJECT, PHASE I & II




LIVINGSTONE
KALOMO
MONZE
GWEMBE
MAGABUKA
LJ-II
KJ-II
KJ-II
KJ-II
MOJ-II
MOJ-I
MOJ-II
MOJ-II
MOJ-I
MOJ-II
MOJ-II
MOJ-I
GJ-I
GJ-I
MAJ-I
MAJ-I
MAJ-I
DEPTH (m)
2
7
9
3
6
3
11
7
12
2
27
7
17
20
9
10
2
0
10
20
30
40
50
60
70
80
Main Aquifer
Weathered and Fractured
Static Water Level
Schist Interlayed with Quartzite
Gneiss
Granite
Basalt
Sandstone Interlayed with Basalt
Meta-Tuff
LEGEND
Laterite
Sand
Sandstone
Sand and Gravel
Sandy Silt
Silt
Silt with Gravel
Gravel
Mudstone
Limestone
Quartzite
Congromerate Quartzite
Schist

16 HYDROGEOLOGICAL EVALUATION OF JAPANESE PROJECT IN SOUTHERN PROVINCE (1)

Division	Borehole No.	Drilling Year	Well Dia. (mm)	Total Depth (m)	Pumping Rate l/min	S.W.L. (m)	P.W.L. (m)	Drow Down (m)	Spcific Capcity m³/d/m	Screen Depth (m)	Aquifer	Laterite (m)
MONZE	MOJ-Ⅰ-1	1987	100	70.0	DRY						Mudstone	3.5
	MOJ-Ⅰ-2	1987	150	78.5	6.3	5.0	36.3	31.3	0.29	13～16 25～28 34～37 40～43 49～58	Schist	0.3
	MOJ-Ⅰ-3	1987	100	42.0	25	8.0	23.1	15.1	1.66	25～41	Schist	10
	MOJ-Ⅰ-4	1987	100	40.0	43	10.0	21.8	11.8	5.24	23～29	Schist	1
	MOJ-Ⅰ-5	1987	100	36.0	33	9.4	21.6	12.2	3.89	23～35	Schist	3
	MOJ-Ⅰ-6	1986	100	40.0	43	3.6	22.1	17.5	3.36	15～19 23～35	Gneiss	3
	MOJ-Ⅰ-7	1986	100	40.5	36	9.4	23.3	13.9	3.74	16～24 32～36	Gneiss	4
	MOJ-Ⅰ-8	1986	100	32.0	11	3.1	20.9	17.8	0.89	7～19	Sand, Schist	9
	MOJ-Ⅰ-9	1986	100	52.5	50	4.3	31.1	26.8	2.7	8～12 32～44	Schist	3
	MOJ-Ⅰ-10	1987	150	42.0	47	6.5	22.3	15.8	4.29	15～21 27～36	Schist	0
	MOJ-Ⅰ-11	1987	100	60.5	20	12.1	20.8	8.7	3.31	40～60	Schist	4
	MOJ-Ⅰ-12	1987	100	31.0	150	14.1	21.6	7.5	28.8	18～30	Schist	4
	MOJ-Ⅰ-13	1987	100	40.5	25	12.8	20.5	7.7	4.81	24～40	Gneiss	3
	MOJ-Ⅰ-14	1987	100	40.5	200	1.2	12.1	10.9	26.41	32～40	Schist～Gneiss	3

16 HYDROGEOLOGICAL EVALUATION OF JAPANESE PROJECT IN SOUTHERN PROVINCE (2)

Division	Borehole No.	Drilling Year	Well Dia. (mm)	Total Depth (m)	Pumping Rate l/min	S.W.L. (m)	P.W.L. (m)	Drow Down (m)	Spcific Capcity m³/d/m	Screen Depth (m)	Aquifer	Laterite (m)
MONZE	MOJ-Ⅱ-1	1989	100	49.0	18	6.2	31.6	25.4	1.02	16～25 36～44	Schist	2
	MOJ-Ⅱ-2	1989	100	61.0	33	11.3	32.5	21.2	2.24	28～32 40～48 52～56	Schist	5
	MOJ-Ⅱ-3	1989	150	43.0	72	10.1	11.4	1.3	79.75	14～18 30～43	Quartzite	3
	MOJ-Ⅱ-4	1990	100	32.5	12	3.0	26.8	23.8	0.72	15～26 31～36	Schist	5
	MOJ-Ⅱ-5	1990	100	40.0	35	5.7	20.1	14.4	3.5	29～41	Schist	6
	MOJ-Ⅱ-7	1990	100	72.0	6.7	30.5	40.3	9.8	0.98	42～58 66～72	Granite	6
	MOJ-Ⅱ-8	1990	100	57.5	15	18.4	31.2	12.8	1.69	24～28 32～36 40～48	Schist	12
	MOJ-Ⅱ-9	1989	100	78.0	DRY						Granite	3
	MOJ-Ⅱ-10	1990	100	37.0	54	6.6	14.8	8.2	10.8	20～32	Schist	5
	MOJ-Ⅱ-11	1989	100	54.0	20	15.3	37.0	21.7	1.33	37～45 49～53	Schist	6
	MOJ-Ⅱ-12	1989	100	43.0	38	12.7	26.5	13.8	3.97	32～44	Silt	6
	MOJ-Ⅱ-13	1990	100	60.0	17	13.4	36.9	23.5	1.04	35～54	Quartzite	6
	MOJ-Ⅱ-14	1990	100	48.0	32	21.8	24.2	2.6	17.7	26～31 35～44	Schist	6
	MOJ-Ⅱ-15	1990	100	60.0	DRY						Schist	10

16 HYDROGEOLOGICAL EVALUATION OF JAPANESE PROJECT IN SOUTHERN PROVINCE (3)

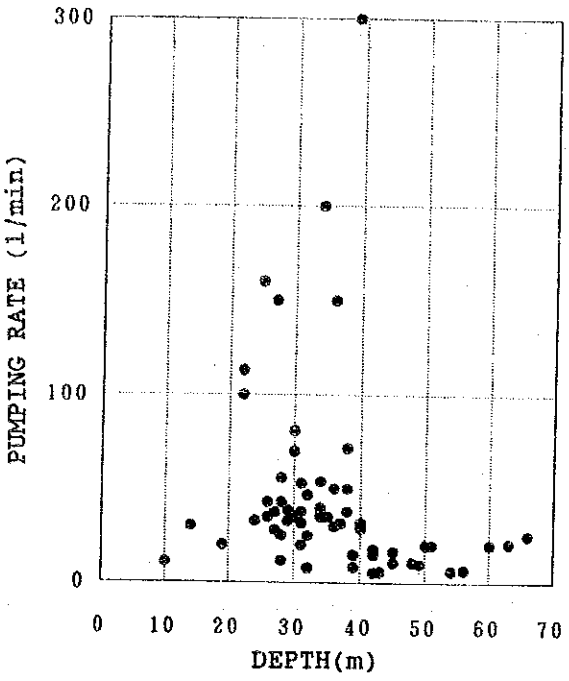
Division	Borehole No.	Drill-ing Year	Well Dia. (mm)	Total Depth (m)	Pumping Rate l/min	S.W.L. (m)	P.W.L. (m)	Drow Down (m)	Spcific Capcity m³/d/m	Screen Depth (m)	Aquifer	Laterite (m)
MONZE	MOJ-II-19	1990	100	50.0	11	7.9	19.1	9.2	1.72	26~34 38~46	Schist	10
	MOJ-II-21	1990	100	39.5	38	12.7	26.5	13.8	3.96	15~23 26~35	Schist	15
	MOJ-II-23	1989	100	37.0	35	5.6	12.8	7.2	7.00	20~32	Schist	7
	MOJ-II-25	1989	100	57.0	30	21.4	30.7	9.3	4.65	24~40	Schist	10
	MOJ-II-27	1989	100	37.5	100	8.7	8.8	0.1	1440	20~24 28~32	Schist Quartzite	6
	MOJ-II-28	1989	100	40.0	30	2.4	28.8	26.4	1.64	8~20	Schist	4
GWEMBE	GJ-I-1	1987	100	78.0	DRY						Shale	6
	GJ-I-4	1987	100	79.0	DRY						Shale	3
	GJ-I-6	1987	100	70.0	21	7.0	28.6	21.6	1.40	18~25 57~69	Shale	3 9
	GJ-I-8	1986	100	60.0	6	8.5	45.3	37.2	0.23	35~31	Mudstone	0.9
	GJ-I-9	1986	100	60.0	10	13.9	20.9	7.0	2.1	23~31 43~55	Mudstone	2
	GJ-I-10	1986	100	56.0	8	3.5	43.7	40.2	0.29	27~43	Mudstone	0.5
	GJ-I-11	1986	100	72.5	25	40.06	40.13	0.07	514	60~72	Mudstone	2
	GJ-I-12	1986	100	45.0	40	10.1	13.4	3.3	17.4	20~24 28~40	Sandstone Mudstone	2
	GJ-I-13	1986	100	40.5	50	9.2	12.9	3.7	19.4	32~44	Mudstone	6

16 HYDROGEOLOGICAL EVALUATION OF JAPANESE PROJECT IN SOUTHERN PROVINCE (4)

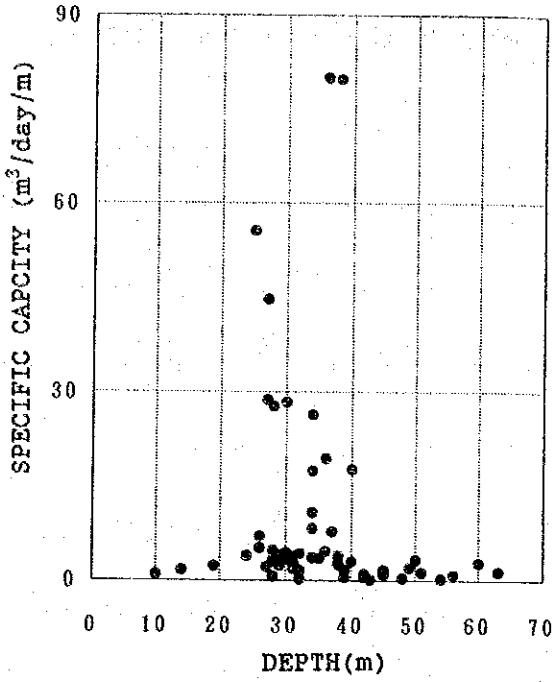
Division	Borehole No.	Drill-ing Year	Well Dia. (mm)	Total Depth (m)	Pumping Rate l/min	S.W.L. (m)	P.W.L. (m)	Drow Down (m)	Spcific Capcity m³/d/m	Screen Depth (m)	Aquifer	Laterite (m)
GWEMBE	GJ-I-14	1986	100	36.5	70	9.2	12.7	3.6	28.4	16~20 29~32	Shale	0
	GJ-I-15	1986	100	82.0	15	8.3	28.5	20.2	1.1	34~60	Sandstone Shale Mudstone	6
	GJ-I-16	1986	100	40.5	35	8.8	21.2	12.4	3.7	12~16 28~36	Sand, Gravel Sandstone	12
	GJ-I-17	1986	100	36.5	160	11.3	15.4	4.1	55.7	16~29 28~32	Mudstone	2
	GJ-I-18	1986	100	79.0	DRY						Mudstone	0.5
	GJ-I-20	1986	100	72.0	20	32.9	43.2	10.3	2.8	43~51 59~67	Mudstone Sandstone	1.2
	GJ-I-21	1987	100	48.0	150	29.3	32.0	2.7	80.1	31~43 32~36	Sandstone	0.5
	GJ-I-22	1986	150	48.0	300	4.9	6.7	1.8	235	36~45	Sandstone	0.3
MAZABUKA	MAJ-I-2	1987	100	40.0	37.5	2.9	27.9	25.0	2.16	7~16 23~31	Limestone	5
	MAJ-I-3	1987	100	73.0	DRY						Gneiss	0
	MAJ-I-5	1987	100	36.0	39	6.6	20.6	14.0	4.02	23~35	Quartzite	3
	MAJ-I-6	1987	100	36.0	20	5.3	16.9	10.6	2.48	23~35	Schist	3
	MAJ-I-7	1987	100	37.0	113	20.3	21.4	1.0	160	20~32	Gneiss	3
	MAJ-I-8	1987	100	73.0	DRY						Gneiss	3
	MAJ-I-9	1987	100	40.0	53	8.4	35.3	26.9	2.84	27~39	Quartzite	8.5

16 HYDROGEOLOGICAL EVALUATION OF JAPANESE PROJECT IN SOUTHERN PROVINCE (5)

Division	Borehole No.	Drill -ing Year	Well Dia. (mm)	Total Depth (m)	Pumping Rate l/min	S.W.L. (m)	P.W.L. (m)	Drow Down (m)	Spcific Capcity m³/d/m	Screen Depth (m)	Aquifer	Laterite (m)
MAZABUKA	MAJ-I-10	1987	100	79.5	5.6	16.9	31.1	14.2	0.56	27~47	Meta-Basalt	3
	MAJ-I-11	1987	100	40.0	32	9.2	33.0	23.8	1.93	23~39	Graniticgneiss	0
	MAJ-I-12	1987	100	68.5	—	1.5	—	—	—	15~35	Schist	2
	MAJ-I-13	1987	100	33.5	20	4.3	17.1	12.7	2.26	9~21	Gneiss	3
	MAJ-I-14	1987	100	70.0	D R Y						Gneiss	0.5
KALOMO	KJ-II-1	1990	100	61.5	D R Y						Granite	6
	KJ-II-2	1990	100	60.0	8.7	23.2	45.4	22.2	0.564	29~48	Quartzite	6
	KJ-II-3	1990	100	48.0	29	4.0	17.7	13.7	3.05	26~34 37~43	Schist Quartzite	7
	KJ-II-4	1990	100	42.0	35	4.0	10.2	6.2	8.13	26~38	Schist	6
	KJ-II-6	1990	100	41.5	81	6.0	32.2	26.2	4.45	24~38	Schist Quartzite	12
	KJ-II-7	1990	100	30.0	56	3.4	6.3	2.9	27.8	24~32	Basalt	6
	KJ-II-9	1990	100	63.0	11	13.6	51.9	38.3	0.414	48~57	Schist~Gneiss	6
	KJ-II-10	1990	100	61.5	D R Y						Graniticgneiss	6
	KJ-II-12	1990	100	42.0	32	10.9	16.8	5.9	7.81	26~57	Schist~Gneiss	6
LIVING-STONE	LJ-II-1	1990	100	60.0	D R Y						Silt	6
	LJ-II-2	1999	100	36.0	28	21.3	22.2	0.9	44.8	21~32	Sandstone Basa	6
	LJ-II-3	1990	100	60.0	D R Y						Silt	8

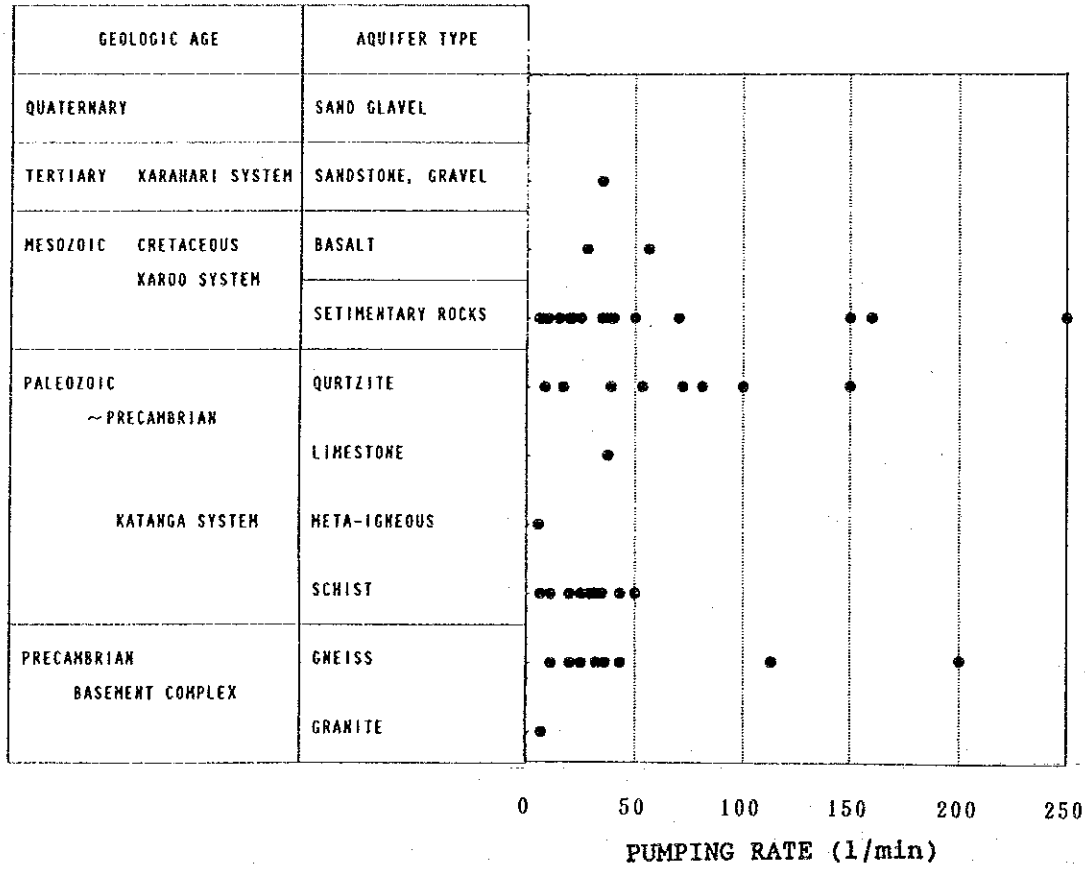


17 GRAPHSHOWING RELATIONS BETWEEN PUMPING RATE AND AQUIFER DEPTHS



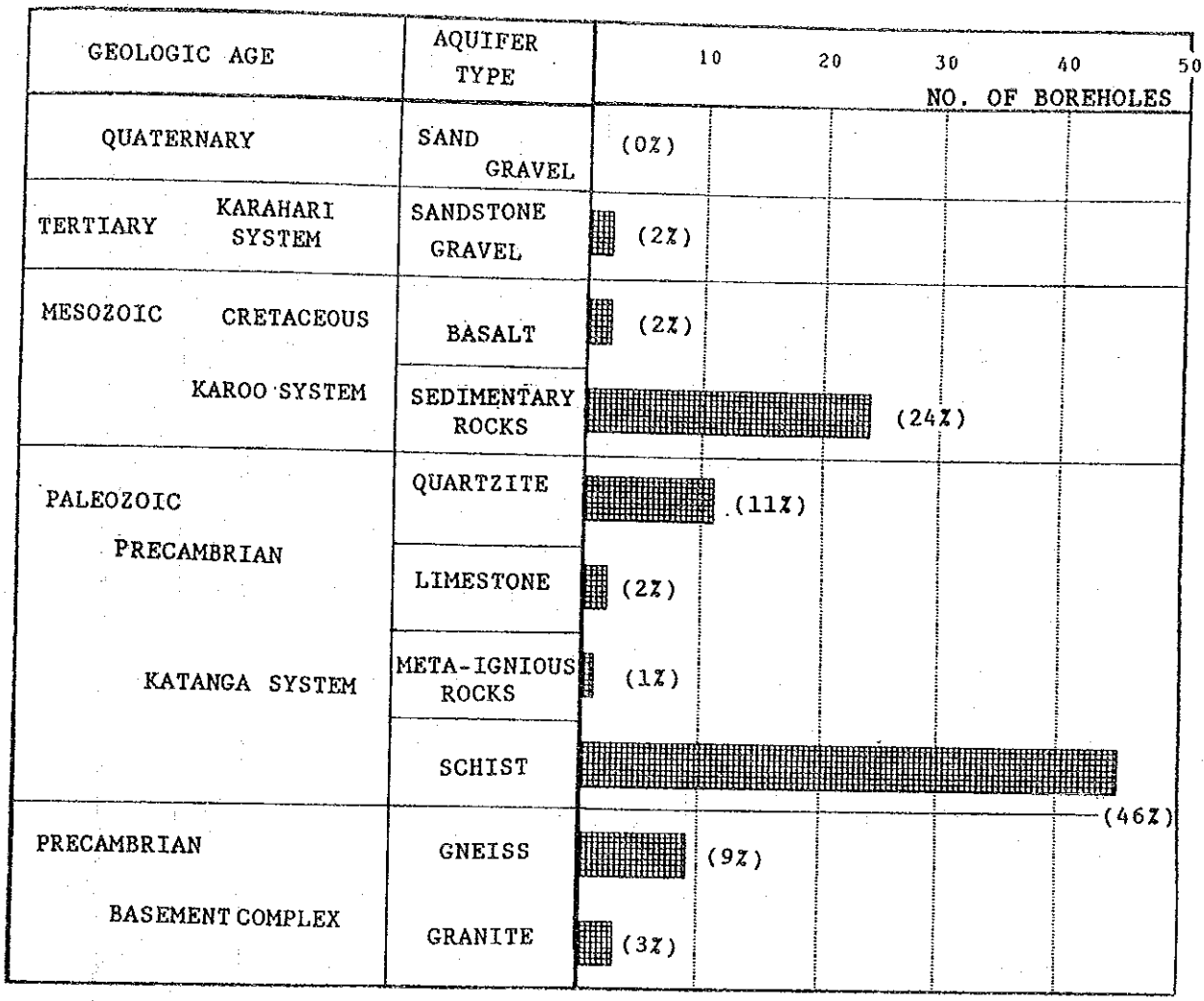
18 GRAPH SHOWING RELATIONS BETWEEN SPECIFIC CAPACITY AND AQUIFER DEPTHS

(SOURCE: SOUTHERN PROVINCE GROUNDWATER DEVELOPMENT PROJECT, PHASES I & II)



19 GRAPH SHOWING RELATIONS BETWEEN AQUIFER AND PUMPING RATE
(SOURCE: SOUTHERN PROVINCE GROUNDWATER DEVELOPMENT PROJECT, PHASES I & II)

20 DIAGRAM SHOWING TYPES OF AQUIFERS ENCOUNTERED IN SOUTHERN PROVINCE



21 WATER SAMPLING DATA IN PROJECT AREA

NO.	NAME OF SITE / SUMPLING DATE	CATEGORY	pH	Cl- (mg/l)	TOTAL HARDNESS (mg/l)	Ca (mg/l)	Mg (mg/l)	So^4- (mg/l)	M-ALKALINITY (mg/l)	NH^4-N (mg/l)	NO^2-N (mg/l)	NO^3-N (mg/l)	F- (mg/l)	T-Fe (mg/l)	COLIFORM (N/ml)	ELECTRIC CONDUCTIVITY (us/cm)
1.	Lusaka 11th Dec.	Groundwater	6.93	15.2	294	76.4	25.0	9.5	244	<0.08	3.5	<0.01	<0.5	<0.03	0	600
2.	Chibombo 13th Dec.	Groundwater	7.18	9.1	327	86.0	27.2	9.4	311	<0.08	1.5	<0.01	<0.5	0.04	0	520
3.	Kaunga 28th Nov.	Groundwater	7.09	1.9	112	25.2	11.9	<5	122	<0.08	<0.1	<0.01	<0.5	0.07	3	290
4.	Kabwe 4th Dec.	Groundwater	7.14	2.1	201	56.0	14.8	<5	198	<0.08	0.4	<0.01	<0.5	<0.03	10	420
5.	Chongwe 12th Dec.	Groundwater	7.36	26.6	267	72.8	20.6	13.5	271	<0.08	0.1	<0.01	<0.5	0.30	15	550
6.	Ndola 6th Dec.	Groundwater	7.35	13.2	274	50.4	35.9	30.0	228	<0.08	0.1	<0.01	<0.5	0.03	0	440
7.	Serenje 6th Dec.	Groundwater	7.12	1.0	6.0	0.8	0.9	<5	35	<0.08	<0.1	<0.01	<0.5	0.90	2	220
8.	Luangwa 28th Nov.	Steram	6.91	2.2	55.6	12.0	6.2	7.0	46	<0.08	<0.1	<0.01	<0.5	0.16	3	130
STANDARD		WHO	7.0-8.5	200-400	100-500	75	50	200	-	0.5	-	40 - 80	1.0-1.5	0.3	MPN 10	2,000
		JAPAN	5.8-8.6	200	300	-	-	200	-	SHALL NOT BE PETECTED IN SAME SAMPLE		10	0.8	0.3	NEGATIVE	-

JICA