DEPARTMENT OF WATER AFFAIRS
MINISTRY OF ENERGY AND WATER DEVELOPMENT
THE REPUBLIC OF ZAMBIA

BASIC DESIGN STUDY REPORT ON THE RURAL WATER SUPPLY DEVELOPMENT PROJECT IN SOUTHERN PROVINCE IN THE REPUBLIC OF ZAMBIA

JANUARY 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN TECHNO CO., LTD.

DEPARTMENT OF WATER AFFAIRS
MINISTRY OF ENERGY AND WATER DEVELOPMENT
THE REPUBLIC OF ZAMBIA

BASIC DESIGN STUDY REPORT
ON
THE RURAL WATER SUPPLY DEVELOPMENT PROJECT
IN
SOUTHERN PROVINCE
IN
THE REPUBLIC OF ZAMBIA

JANUARY 1997

JAPAN INTERNATIONAL COOPERATION AGENCY
JAPAN TECHNO CO., LTD.

PREFACE

In response to a request from the Government of the Republic of Zambia, the Government of Japan decided to conduct a basic design study on the Rural Water Supply Development Project in Southern Province and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Zambia a study team from August 25 to October 3, 1996.

The team held discussions with the officials concerned of the Government of Zambia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Zambia in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Zambia for their close cooperation extended to the teams.

January, 1997

Kimio Fujita
President
Japan International Cooperation Agency

January, 1997

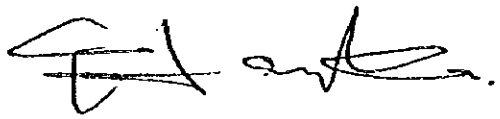
LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Rural Water Supply Development Project in Southern Province in the Republic of Zambia.

This study was conducted by Japan Techno Co., Ltd., under a contract to JICA, during the period from August 12, 1996 to January 31, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Zambia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

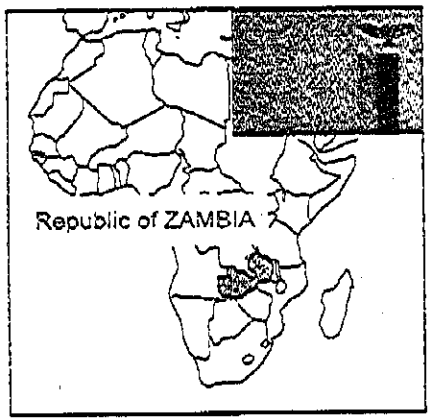
Finally, we hope that this report will contribute to further promotion of the project.

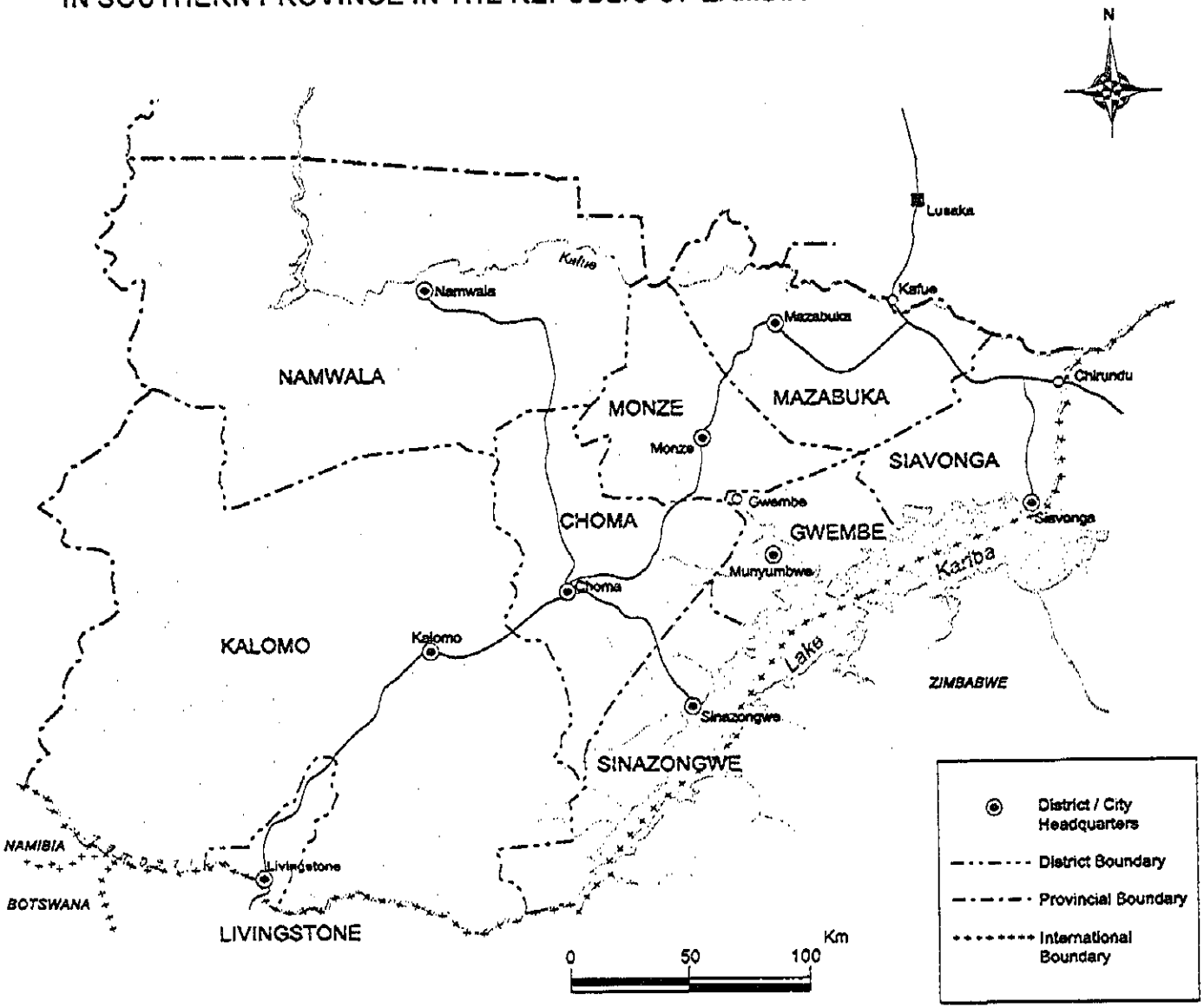
Very truly yours,



Yoshitaka Hamanaka
Project Manager
Basic Design Study Team on the Rural Water Supply Development Project in Southern Province in the Republic of Zambia
Japan Techno Co., Ltd.

BASIC DESIGN STUDY ON THE RURAL WATER SUPPLY DEVELOPMENT PROJECT IN SOUTHERN PROVINCE IN THE REPUBLIC OF ZAMBIA





CONTENTS

LIST OF FIGURE

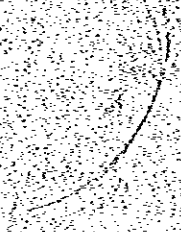
LIST OF TABLE

ABBREVIATIONS

CMMU	Community Management and Monitoring Unit
CSO	Central Statistics Office
DISS	Department of Infrastructure and Support Services
DWA	Department of Water Affairs
ECZ	Environmental Council of Zambia
GDP	Gross Domestic Product
GNP	Gross National Product
GTZ	Deutsche Gesellschaft für Technishe Zusammenarbeit
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Food and Fisheries
MCDSW	Ministry of Community Development and Social Welfare
MENR	Ministry of Environment and Natural Resources
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
MMD	Movement for Multi-Party Democracy

MOH	Ministry of Health
MWS	Ministry of Works and Supply
NCDP	National Commission for Development Planning
NDSR	National Council for Scientific Research
NORAD	Norwegian Agency for Development Planning
NWASCO	National Water and Sanitation Council
PCU	Project Coordination Unit
unicef	United Nations Children's Fund
UNIP	United National Independence Party
USAID	United States Agency for International Development
VLOM	Village Level Operation and Maintenance
WASHE	Water, Sanitation and Health Education
WHO	World Health Organization
WSDG	Water Sector Development Group

CHAPTER 1 BACKGROUND OF THE PROJECT



Chapter 1 Background of the Project

1-1 Background of the Project

The Republic of Zambia (hereinafter referred to as "Zambia") is an inland country located in southern part of the African Continent, covers an area of 752,610 km^2 with the population about 9.2 million (as of 1994) and has the annual population growth rate of 2.83% (as of 1994). Most part of the country consists of the highlands of 1,000 to 1,300 m above sea level and belongs to the tropical savanna climate. The rainy season (from December to March) and the dry season (from April to November) are clearly divided. The annual precipitation is from 400 to 1,000 mm in southern part and from 1,000 to 1,500 mm in the northern part. The average annual precipitation of Capital Lusaka is 836 mm.

Being blessed with mineral resources and world famous production center of copper and cobalt, Zambia constitutes a typical mono-culture economy in which about 90% of export depends on copper. However, with the effects of the floundering copper price since 1975 and the worldwide economic depression in 1980s, Government of Zambia was forced to face with problems such as the increasing debts from foreign countries, financial deficiency, and the acceleration of inflation. As a result, Zambia is suffering from social problems including the lowered level of national living standard and the increase of unemployment.

Reflecting these situations, a national trend and movement demanding democratization and multiple political party system have occurred. Thus the United National Independence Party (UNIP) led by the previous President Kaunda, which had been governing the country with one political party since the independence of the country, suffered a crushing defeat in the 1991 election. Then a Movement for Multi-Party Democracy (MMD) led by the present President Chiluba started the new administration with all the national expectations. This change of regime was highly evaluated by various countries as the model of democratic administration change in Africa.

The MMD has been actively introducing the structural adjustment plan by the World Bank. On one hand, the MMD has been putting its efforts on reconstructing the financial situations by devaluation of the currency, eliminating the price control other than of foods and fertilizers, and liberalizing the trade. On the other hand, it has tried

to activate the private sectors by promoting the realization of small Government as well as the public and the private investments. However, with the price increase caused by the liberalized price and the fall in exchange, the effects of the above mentioned measures were absorbed. Thus the economic reconstruction could not achieve the results. In addition, with the effect of the severe drought attacked five provinces of Southern, Western, Eastern, Lusaka, and Central from 1991 to 1992, the plummeted yield of agricultural production resulted in the lack of foods in urban areas and accelerated the inflation. This made it still worse to reflect the effect of economic liberalization to increase the employment and production. Although the inflation rate dropped to about 34% in 1995, the difficult situation of national economy has not changed with the continued increase of debts from foreign countries caused by lack of foreign currency. The per capita GNP of Zambia is 380 dollars (as of 1993) and the average annual economic growth rate is -3.0% (as of 1992).

In Southern Province, which includes the Project sites, has a population of about 1.1 million (estimation in 1996), among which nearby 80% live in local area. Provision of water supply services to these local residents has been promoted by the Department of Water Affairs (DWA) of the Ministry of Energy and Water Development (MEWD), as the executing agency and has cooperation from various foreign countries.

Southern Province experienced drought for three years from 1981, when the wells and the streams used by the residents as the water sources were dried up. Government of Zambia requested to construct 222 new borehole water supply facilities fitted with handpumps and rehabilitate existing 100 borehole water supply facilities to Government of Japan, and it was implemented as the "Ground Water Development Project in Southern Province Phase I and II" under the Japan's Grant Aid Assistance in 1985 and 1988. Although the urgent needs for the water supply facilities in Southern Province were relieved by those projects, the number of water supply facilities were still insufficient. In addition, because of the serious droughts occurred in 1991 and 1992, the residents of the above mentioned area suffered from the dried ups of streams and shallow wells which they depended on as the water sources for their drinking and living water. While DWA recognizes the needs to construct new boreholes and rehabilitate existing boreholes in order to improve the water supply situations in local area, it is difficult for DWA to operate appropriate undertakings because of insufficient number of staffs, equipment, and materials caused by impeding budget. Thus the improvement of inferior water supply situation and the strengthening of the ability of executing agency are urgently needed.

According to the above mentioned circumstances, Zambia formulated a plan to improve the water supply situation in rural area in Southern Province by constructing 500 borehole water supply facilities and requested to Government of Japan for Grant Aid Assistance in March 1995, since Japanese Government had previously provided the cooperation in the field of rural water supply including Southern Province. In addition to the construction of 500 water supply facilities, this request extended to wide range including the procurement of the spare parts and consumables to maintain and rehabilitate the equipment for groundwater development, such as the borehole drilling machines procured under the previous Japanese Project, the supporting vehicles, equipment and materials as to promote the community participation as well as the construction of buildings to be the base facilities for community participation and health education activities. However, the drought continued during the request was on going. In order to promptly construct the water supply facilities in the areas suffering from severe damages, Government of Zambia requested again the plan focusing on the construction of water supply facilities in 77 villages that had no borehole and needed water supply facilities urgently in January 1996. To respond to the request, Government of Japan dispatched the Preliminary Study team from Japan International Cooperation Agency (JICA) in May 1996 to study and discuss the urgency to improve water supply situation of the area suffering from the damages of drought, the list of the villages to be covered by the Project, utilization plan for the requested equipment and materials, and the evaluation of previous Japanese Grant Aid which had been conducted in Southern Province twice, as well as confirmed the appropriateness of this request and the scope of work.

1-2 Outline of the Request

The request for "the Rural Water Supply Development Project in Southern Province in the Republic of Zambia (hereinafter referred to as "the Project")" contained to construct 77 borehole water supply facilities fitted with handpumps in 77 villages located in Southern Province at the rate of one borehole water supply facility per one village, to procure spare parts for the existing borehole drilling machines and related equipment as well as the materials to construct boreholes, and to procure equipment and materials for promoting community participation and operation and maintenance. As a result of examining the appropriateness of the Project based on the discussions between the Basic Design Study team and Government of Zambia, the technical survey in the Project area and the collected information, the requested contents were determined to be changed as follows.

(1) Study sites and the number of borehole water supply facilities to be constructed

During the Basic Design Study, as a result of the discussions with DWA, the executing agency of the Project, the District councils in Southern Province and parties relating to the promotion of community participation in water supply and sanitation sector, it was found that several villages among 77 which had been agreed as the Project areas at Preliminary Study had already been moved to the stage where the construction of boreholes were requested to NGOs and were going to be implemented, since those villages had quite serious damages of drought and urgently needs water supply facilities. However, Government of Zambia requested to have continuous cooperation from Japan to improve inadequate water supply situation for the remaining villages among the 77 and those excluded to be included in the Project at the Preliminary Study but to have inferior water supply facilities.

With regard to the request for change of the Project areas by Zambia side, the Basic Design Study team and JICA Zambia office discussed and settled following courses for the continuation of the implementation of the Project and Government of Zambia agreed to adopt them, i.e. (1) excluding the sites from the Project where the NGOs had provided cooperation, and (2) the Japanese side makes final decision on the Project sites based on the results of the site survey regarding the present conditions such as water supply situation and the degree of distress, accessibility, hydrogeological conditions, population, public facilities, and the extent of the villages to be conducted to the villages listed by DWA as those replacing the original ones. The policies for selection of the Project sites to construct borehole water supply facilities and the number of facilities as well as the contents of the Project are explained in "2-3 Basic Design".

It was agreed before dispatching the Basic Design Study team to conduct site survey as many as possible in order to re-exam and confirm the necessary number of borehole water supply facilities in accordance with the Project Implementation Policy in which the Basic Design Study was planned to finalize the necessary number of borehole water supply facilities in each village without being limited to the figure of 77 and to consider the possibility to change the Project sites. For this reason, the number of the villages to conduct field survey became 104 by adding the newly requested villages. Figure 1-1 shows the location map of the villages executed survey during the Basic Design Study.

(2) Equipment and materials to be procured

The basic policies on implementation of construction is to utilize equipment procured under previous Japan's Grant Aid Assistance to raise the effects of cooperation and the ratio of expenses versus effects. The actual implementation plan is to procure spare parts necessary to service the drilling machines procured under previous Japan's Grant Aid Assistance to utilize for the construction work by the Japanese Contractor. The plan also contains to return the equipment after servicing them at the completion of the construction work. Based on these premises, the request was made not for the procurement of new drilling machines but for the spare parts for existing drilling machines. Other than those mentioned above, the requests were also made for the related materials to construct borehole water supply facilities, supporting vehicles, workshop equipment, and the vehicles for operation and maintenance and community participation.

As a result of the survey at the above mentioned 104 villages during the Basic Design Study, the number of sites to construct borehole water supply facilities has increased compared with the original number of the Project sites. Therefore the volume of equipment and materials for construction of borehole water supply facilities and the supporting vehicles for construction work were increased subsequently. However, since the increase of the equipment and materials and the supporting vehicles has occurred accompanying the increase of the Project sites, it is not deviated from the intention of the Project in the Preliminary Study. The final selection of the Project sites and procurement plan are explained in detail in Chapter 3.

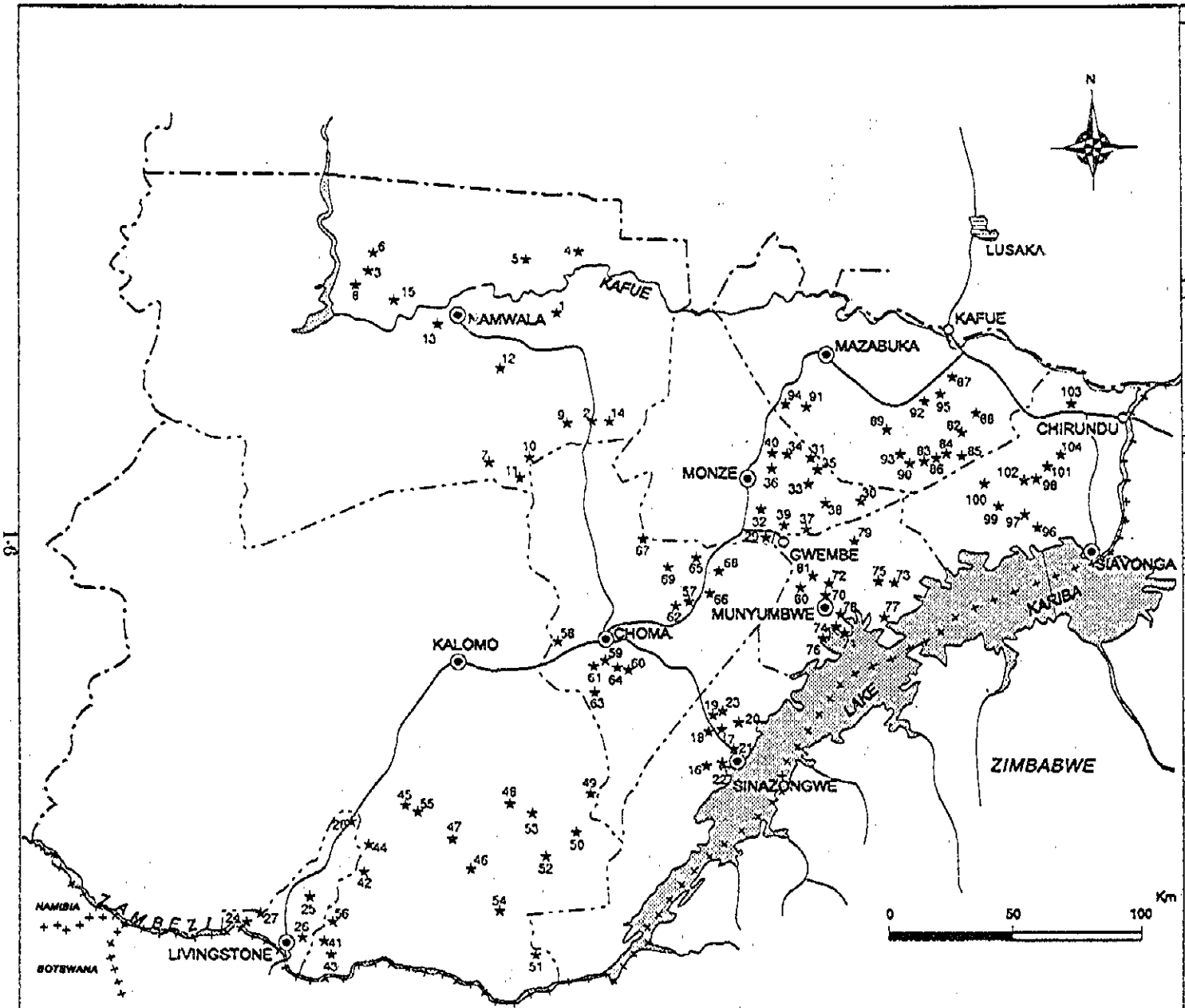


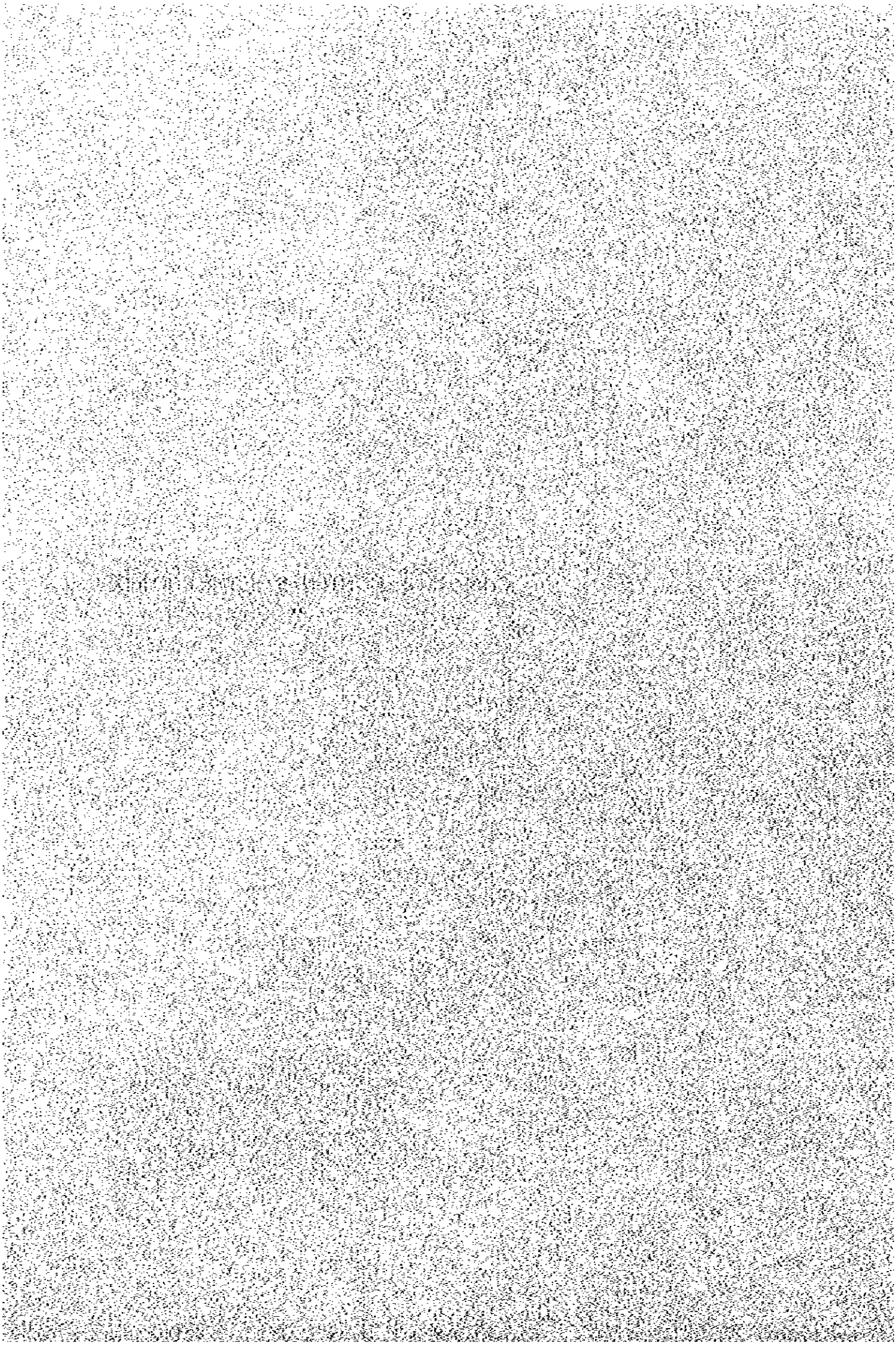
Fig. 1-1 LOCATION MAP OF REQUESTED VILLAGES

NAMWALA
1. Shimayoba Sch.
2. Sigwidi Village
3. Chief Kaingu
4. Chief Muwezwa
5. Bayangwe Village
6. Nkobo Village
7. Tampwe Village
8. Naumba Village
9. Masompe Village
10. Mobola Village
11. Kabwe School
12. Ngabo Dettlement
13. Namulumbwe Vill.
14. Nachumba Village
15. Bachele Village
SINAZONGWE
16. Mweezya Sch.
17. Syansimuna Village
18. Mazyamuna Village
19. Fodwi Village
20. Simapumba Village
21. Syankuku Village
22. Simumpande Village
23. Syankumba Village
LIVINGSTONE
24. Simonga Village
25. Kasiya R.H.C.
26. Maponzi/Nansanzu
27. Katiba Village
28. Makoli Vill. /Mandandi Vill.
MONZE
29. Mukwelele Village
30. Chigabwa Village
31. Maambo Lukubi Vill.
32. Chikonga Village
33. Mpokota Village
34. Mwanza West Clinic
35. Nangweluka Village
36. Cheepahabulembe Vill.
37. Muvwanga Village
38. Simuzingine Village
39. Chinongwe Village
40. Simuumba Village
KALOMO
41. Syanjase Village
42. Mpola Village
43. Chibule Village
44. Sinanfu Village
45. Siabozu Village
46. Syejumba Village
47. Nkungwa School
48. Polo Village
49. Konayuma Village
50. Sienkope Village
51. Siampondo Village
52. Chikuyu Village
53. Kayuni Village
54. Chana Village
55. Siandwazi Village
56. Chibalani Village

CHOMA
57. Hinamanjolo Village
58. Sibanyati Settlement
59. Sepande Village
60. Singani Upper School
61. Munaputi Village
62. Maluma Village
63. Nakeempa RHC
64. Siakakole Village
65. Simbulo Pri. School
66. Muzoka Village
67. Munyama Health Post
68. Mulongo Village
69. Simudima Pri. School
GWEMBE
70. Halumya Village
71. Siancheoka Village
72. Fumbo Pri. School
73. Gulumunyanga Sch.
74. Sinafala Turn Off
75. Chisabuka Village
76. Sinafala Village
77. Mabula Pri. School
78. Siabwango
79. Hazobwe Village
80. Hacheelo Village
81. Hachangu Village
MAZABUKA
82. Mukwola School
83. Malala Village
84. Ngandu Haveenzu Vill.
85. Chisekwa Village
86. Mulando Village
87. Mwendankama Vill.
88. Bonbo Village
89. Kaunga Pri. School
90. Muvela Village
91. Mweemba Pri. School
92. Mulawo Pri. School
93. Nadezwe Agri. Camp
94. Makangala Village
95. Naluama Pri. School
SIAVONGA
96. Simamba/Matero
97. Mancharmwa
98. Siamwiinga Village
99. Dibwi
100. Dambwo / Syakalinda
101. Chinyama / Jamba
102. Siamwinga Pri. School
103. Zemba Zemba Village
104. Mangaba Village

- District / City Headquarters
- District Boundary
- Provincial Boundary
- International Boundary

CHAPTER 2 CONTENTS OF THE PROJECT



Chapter 2 Contents of the Project

2-1 Objectives of the Project

It is mentioned in the "National Water Policy" that the overall goal on the water supply and sanitation sector in the rural area is to realize "universal access to safe, adequate and reliable Water Supply and Sanitation Services". The followings are the policy measures and strategies which are aimed at achieving this goal:

① Ensuring that Rural Water Supply and Sanitation (RWSS) Programme is Community-based
② Developing a well defined investment programme for sustainable RWSS
③ Promoting appropriate technology and research activities in RWSS
④ Developing an emergency and contingency plans to mitigate impacts of drought and floods in rural areas
⑤ Developing a cost recovery approach as an integral part of a RWSS which will ensure sustainability
⑥ Development and Implementation of well articulated Training Programme

Southern Province of the Republic of Zambia has been seriously suffering from damages caused by drought. The objectives of the Project are to construct borehole water supply facilities for realization of safe and stable water supply for the residents in rural areas of Southern Province having difficulties in taking water due to lack of boreholes and to procure equipment and materials necessary for the community participation and maintenance promotion activities in village level which plays main role for sustainable operation and maintenance of water supply facilities with their self-efforts.

2-2 Basic Concept of the Project

2-2-1 Confirmation and Examination of the Requested Contents

(1) Study sites and number of borehole water supply facilities to be constructed

Since some of the villages requested at the Prelliminary Study needed immediate

measures to prevent residents from poor water supply situation, it was found that water supply facilities were already constructed or construction plan was promoted for these villages by NGOs at the time of the Basic Design Study. With this regard, Zambian side explained to the Study Team that there were still many other villages needed emergency measures for water supply as well as the requested villages. Therefore, subtracting the villages where NGO's are providing cooperation and adding newly requested villages, Government of Zambia requested to construct borehole water supply facilities for 104 villages.

(2) Drilling machine and its supporting vehicle

It was discussed during Prelliminary Study that DWA should provide 3 drilling machines placed in the Central Province which were procured under previous Japan's Grant Aid Assistance for the construction of boreholes in this Project as well as procurement of spare parts for them and for 2 drilling machines in Southern Province. However, since the number of the villages to be covered by the Project were increased from 77 to 104, it seemed rather difficult to implement construction of boreholes for all the villages with only 3 drilling machines even if the construction period would be divided into two fiscal years. For this reason, the Study Team examined to use 2 drilling machines placed in Southern Province in addition to 3 machines mentioned above. Furthermore, the Study Team examined on procurement of requested supporting vehicles as well as their spare parts taking actual conditions into consideration.

(3) Equipment for operation and maintenance

The Study Team surveyed and examined on needs and means of vehicles for operation and maintenance, equipment and materials for community participation and maintenance promotion related to the WASHE activities and tools for maintenance of handpumps which were requested in the Preliminary Study.

2-2-2 Basic Concept

The number of beneficiaries by the construction of water supply facilities in this Project is approximately 59,000 and the average population of each village is about 580. The residents in the Project sites have been suffering from insufficient living and drinking water in qualitatively and quantitatively due to the meteorological and geographical conditions. Thus the construction of borehole water supply facilities will improve the water supply and sanitation circumstances for the residents in the Project sites.

The Project is based on the concept of decentralization and community participation to be achieved mainly by the WASHE activities. At the time of decision on the drilling point of boreholes and water supply facilities, community participation is necessary. The sense of ownership toward the constructed water supply facilities and awareness for importance of safe and stable water and sanitation shall be enhanced by community participation and thus strengthen community-oriented operation and maintenance system for the water supply facility.

(1) Water source

The residents in the Project sites use various water sources such as shallow wells, wadi, pond, river, lake, and very scarcely boreholes (Appendix-7 shows the portion of water sources being in use). Water sources besides boreholes are generally affected by drought easily and have high risk of contamination of water. Boreholes, which are affected less by drought and their water quality is normally safe and stable, are used as water sources in this Project.

The geology of aquifer in the Project sites are ① Basalt Lava in Upper Karoo Group, ② Lower Karoo Group, ③ Katanga Group, ④ Precambrian. The Project plans to use fissure water from these stratum. The boreholes drilled in the Project for Groundwater Development implemented in Southern Province under previous Japan's Grant Aid Assistance objected the same aquifer mentioned above as water sources. The range of pumping rate of success boreholes were from 5.6 to 300 litres/min. and more than 85% of them could yield 10 litres/min. Therefore, this Project is designed with success rate of drilling as 85% and yield of successful borehole as 10 litres/min. estimated from the previous data. Though the planned pumping rate of a borehole is 12.5 litres/min., at least 10 litres/min. is needed as

yield from a success borehole. Annex shows detailed data on the boreholes drilled in the Project for Groundwater Development.

(2) Water supply system

The handpump type water supply facility was requested from the beginning of the Project. Since some Project sites have population of 1,000 or more, the Study Team examined a possibility to use motor pump with pipelines. However, it was confirmed that handpump type water supply system was appropriate due to insufficiency of electricity, difficulty of fuel supply, and the location of houses which are scattering in the Project sites.

(3) Project sites

The Study Team surveyed the requested 104 villages and decided Project sites which meet the following conditions:

1) Quality of water taken from existing water sources is in bad condition.
2) The site is far from water source (the site having borehole water supply facility but being in short water supply can be the Project site.)
3) The site is secured from the hydrogeological difficulties.
4) The site is free from difficulty in approach road in the dry season.
5) The community has awareness of importance of safe and stable water supply and sanitation.

(4) Number of water supply facilities to be constructed

The Study Team conducted field survey regarding population, number of public facilities, scale of villages, hydrogeological conditions and consciousness of residents at the requested villages. The Team finally examined the necessary number of boreholes based on the DWA's policy for rural water supply as sharing one borehole water supply facility by a population of 250 as well as the result of the field survey.

2-3 Basic Design

2-3-1 Design Concept

The Project is to construct borehole water supply facilities (fitted with handpumps) in the rural areas of Southern Province and to procure equipment and materials for the construction work as well as for the operation and maintenance of the to-be constructed water supply facilities in the Project. The design concept is explained as below:

(1) Design concept

1) The water supply rate

The water supply rate in the Project is consonant to the Zambian standard water supply rate in rural areas, i.e. 30 litres per capita per day. The residents living in the Project area use water for (1) drinking, (2) cooking, (3) washing clothes, (4) taking bath, and (5) washing face and hands, however it was observed from field survey (questionnaire) that the actual water consumption was smaller than the water supply rate in the Project.

2) Water quality

The Project uses boreholes as water source which yield clean water and hardly go dry by drought. It was proved in the water quality test conducted during the Basic Design Study that the water quality of existing boreholes in Southern Province meets the WHO's standard. Therefore, there seems to be no major problems regarding water quality in the Project as long as the Project uses boreholes. However, to prevent human waste from pit-latrines from getting into the boreholes, the upper 20m of the boreholes shall be perfectly sealed with cement.

There are no factories around the Project sites to cause any pollution, and most of the residents at the Project sites are small farmers growing organic crops. Therefore, it is understood that neither factories nor farming would cause groundwater pollution in the Project sites in the future.

3) Design served population

The design served population for the Project is set as the population at 1997, when the Project is being implemented. It is calculated by multiplying the population of each Project site at 1996 by the population growth rate in each district announced by CSO. As shown in Table 2-1, the total design served population is estimated as approximate 59,000.

4) Number of water supply facilities to be constructed

The necessary number of water supply facilities at each requested village is estimated with the following design concept:

① Population:

With regard to the calculation of necessary number of boreholes from the population, the Basic Design Study followed the method adopted in the Prelliminary Study as to divide the population of the village by 250.

② Primary School:

There are primary schools at approximately half of the Project sites. In the case if the number of pupils amount to more than 1/3 of the population at the Project site, it is observed that many pupils are coming from outside of the Project site. In these cases, a water supply facility separated from the one for village use shall be provided to the school to avoid shortage of water caused by pupils coming from outside of the Project site.

③ Formation of village:

The formation of the Project villages characterized by scattered and sporadic houses, shall be taken into consideration for decision of the location of the boreholes and the necessary number of boreholes.

④ Hydrogeology:

Hydrogeological investigation is essential to find proper location and the number of boreholes.

(2) Policy on natural conditions

Safe and stable deep groundwater shall be the water source for the Project. There are many faults and crack zones in the Project sites along the underground passage where the water runs. Many of the boreholes drilled in the past take water from this underground water passages. The standard depth of a borehole in Southern Province is an average of 50 - 60m. According to the geoelectric prospecting survey conducted at 98 sites in the Basic Design Study, about ten percent of the Project sites are judged to require approximate 100m depth drilling.

Geographically, it is presumed that the ridge is made of hard rock formation and the area weakened by the crack and fault was weathered and became eroding. Since the valley that extends in a straight line has strong possibility of a techtonic line, boreholes shall be constructed in the ravine area.

In the pre-Mesozoic layer, there is 15 to 20 meter of weathered zone near the surface of the earth. Though this weathered zone contains shallow aquifer, it is not safe and stable, and unsuitable for the water source for the Project.

(3) Policy on social conditions

The location of water supply facilities shall be selected after having close discussions among the communities in the Project sites, DWA staff and the related parties as well as investigating residents' living standard, the circumstances for operation and maintenance and the awareness of the residents.

(4) Policy on the water supply facilities

According to the hydrogeological survey, the drilling depth is estimated from 50 to 100m. The casing pipe shall be installed up to the same depth, and the length of the screen pipe shall be 30% of the total depth. Their diameter should fit the selected handpumps. Commonly used casing pipe and screen pipe in Zambia and surrounding countries shall be examined for use after considering effectiveness and quality.

As for handpumps, India Mk-II, India Mk-III, Standard II (Patel Pump), Bush Pump,

Nissaku Pump and Mono Pump are in use in Zambia. However, due to the easiness of operation and maintenance, circulation of the spare parts and the national policy for standardization, the Indian Mark II is chosen as the suitable handpump.

Besides the handpump, the water supply facility consists of the pump foundation, apron, drainage and soakaway. The apron and drainage shall be made of concrete and its design shall be simplified by using the standard mold in Zambia. The soakaway shall be rectangle and filled with gravel. However, if the excavation is not possible due to being hard bedrock, an apron with the shape that promotes evapotranspiration shall be constructed.

(5) Policy on construction

DWA, the executing agency for the Project, is basically able to operate the geoelectric prospecting survey, drilling, logging, installation of the casing pipe and screen pipe, and pumping test. The skill of DWA's engineers are superior to that of the private drilling companies' engineers in Zambia. The DWA staff will carry out the geoelectric prospecting survey, drilling, borehole construction and pumping test under the supervision and technology transfer of the Japanese Contractor.

(6) Policy on drilling machines

For the construction work of the Project, 4 drilling machines procured for DWA under previous Japan's Grant Aid Assistance shall be utilized. Out of the 4 drilling machines, 3 were procured under the Rural Water Supply Development Project (Phase-III) in 1992 and 1993 and being allocated in Central Province. These 3 drilling machines will be moved to Southern Province by August 1997. The other drilling machine was procured by the Non-Project Grant Aid of Japan in 1989 and being allocated in Southern Province.

Japanese Contractor shall be fully responsible for the construction of boreholes. In the use of the drilling machines, Japanese engineer(s) and/or technician(s) will be dispatched to service them with the procured spare parts to avoid hindrance caused by service inferiority. In addition, after the completion of the construction work, the engineer(s) and/or technician(s) will service and maintain the machines for further use.

(7) Policy on operation and maintenance

The National Water Policy sets policy for implementation of rural water supply project as operation and maintenance of water supply facilities achieved by community participation. Especially as decentralization over the rural water supply sector has been facilitated, it is required to embody the policy under the recognition of importance to backup financial and administrative weakness of local governments as well as to reform the awareness of the importance of water and sanitation among rural residents.

This Project is based on the concept of community participation for operation and maintenance of water supply facility so as to consist with the National Water Policy. Therefore, the V-WASHE committees organized by the benefiting residents carry out daily repairs and maintenance for the water supply facilities. DWA is involved in the construction of borehole water supply facilities as it may facilitate establishment of the V-WASHE committee in each Project site before the commencement of construction work as educating the community on the basis of WASHE policy and develop human resources such as Pump Menders and Caretakers who support the WASHE activities at grass root level.

(8) Policy on the construction schedule

After investigating geological conditions at Project sites, capacity of drilling machines and approaching road, it was judged that 1 drilling machine may be capable to construct approximate 4.5 boreholes in 1 month. The construction schedule for 220 boreholes with 4 drilling machines is calculated as follows (at the success ratio of drilling as 85%):

$$220 \text{ boreholes} / \{0.85 \times (4.5 \text{ boreholes/month} \times 4 \text{ units})\} = 14.3 \text{ months}$$

In due consideration of the delivery period of the spare parts and service of the drilling machines, the Project is divided into 2 phases. The priority order among the Project sites is decided according to the request from Zambia side, the condition of the approach road during the rainy season, and the degree of facilitation of the WASHE activities in each Project site.

Though DWA agreed to transfer 3 drilling machines from Central Province to Southern Province by the end of August, 1997, some of the equipment, vehicles and spare parts to be used for construction work under the Project need 6 months for procurement and 2 months for delivery and customs clearance. Thus, this time factor is given enough attention to set up the timing and period of service for the existing drilling machines as well as construction schedule.

(9) Policy on the procurement plan

Procurement Plan for equipment and materials was examined and decided as follows reflecting intention from Zambia side:

1) For the existing drilling machines and the supporting vehicles

Spare parts are to be procured for the existing four drilling machines, their supporting vehicles and compressor which are utilized for the construction work of the Project. These spare parts shall be genuine articles from the makers.

New supporting vehicles will be procured instead of the existing old vehicles which are too old to use for the Project. Vehicles must be stout and the standard ones in Zambia, and their spare parts can also be obtained easily in Zambia.

2) Workshop equipment and materials

The workshop equipment and materials are to maintain and service drilling machines and other equipment. Due to the convenience of location, they are delivered to DWA Provincial Office in Choma District located in the center of Southern Province.

3) Equipment and materials for community participation and maintenance promotion activities

The vehicles for the transportation of workers and materials, the office equipment for data processing, report making and stock control, and tools for repair and maintenance of handpumps are necessary to secure the

sustainability of the operation and maintenance system to be achieved with community participation. Since these equipment and materials are lacking in each district office of Southern Province, they are procured under the Project. The standardized equipment and materials in the WASHE activities are taken into consideration for the procurement.

2-3-2 Basic Design

(1) Design water supply rate

According to the water supply rate per capita per day (30 litres) and the planned demand of population per borehole (250 capita), the design water supply rate per day is calculated as follows:

30 litres/capita/day × 250 capita/borehole = 7,500 litres/day/borehole

The pumping capacity of India MK II handpump, which will be used in the Project, is estimated approximately 12.5 litres/minute (maximum 23 litres/minute) according to the investigation. On the condition that the running hours of handpump per day is 10 hours, the water supply rate per day will be:

12.5 litres/minute × 60 minutes/hour × 10 hours = 7,500 litres/day

As the result, the pumping capacity of India MK-II handpump is satisfactory to the design water supply rate.

(2) Project sites and the number of boreholes

The outline of the result of the survey conducted in each Project site including population and the number of necessary borehole water supply facilities are shown in Table 2-1. As shown in the location map of the Project sites, the Project sites are spread out along 8 districts and 1 city in Southern Province. It has been confirmed that 101 sites among the requested 104 sites meet the condition of the design policy and 234 boreholes are needed in order to satisfy planned design criteria. However, since there are 14 borehole water supply facilities within 101 villages, 220 borehole

water supply facilities are to be constructed newly under the Project. The number of total beneficiaries are 58,755, and one borehole serves 267 people on an average. There are 27 primary schools whose number of pupils exceeds 1/3 of the population at the site. In these 27 sites, water supply facility for the school shall be constructed separately from the one for the residents.

(3) Water supply facility

1) Borehole structure

Standard Borehole Structure is indicated in Fig 2-1. Borehole shall be drilled by diameter of ϕ 8 ½". According to the pumping rate and the diameter of the riser pipe of handpump (ϕ 40 mm), the borehole diameter shall be ϕ 4" (100 mm) which is the standard borehole diameter for handpump. The materials of the casing pipe and screen pipe shall be polyvinyl chloride pipe (PVC) which can be obtained at a low cost in neighboring countries. Since there is a possibility of contamination of water occurring in the shallow aquifer in the upper part of the borehole, the upper part of the borehole (about 20 meter from the ground surface) shall be sealed with cement to prevent an inflow of the contaminated water. The centralizer shall be installed at an interval of approximate 6 meters as to protect the casing pipe from curving.

Table2-1 Outline of the Project Sites (1)

No.	District	Site Name	Hydrogeological potencial 1)	Accessibility 2)	Population 1997	Necessary number of boreholes 3)	Existing Boreholes	Number of to-be drilled boreholes	Existence of school 4)	Number of pupils in the primary school	Remarks
1		Shimayoba School	○	◎	686	3	1	2	○	390	
2		Sigwidi Village	○	◎	1,248	4		4			
3		Chief Kaingu	△	◎	312	1		1			
4		Chief Muwezwa	△	○	1,498	5		5	○	150	
5		Bayangwe Village	△	○	312	1		1			
6		Nkobo Village	○	△	416	1		1	○	80	
7	NAWALA	Tampe Village	○	◎	520	2		2	○	56	
8		Naumba Village	○	△	624	2		2			
9		Masompe Village	○	△	832	3		3			
10		Mobola Village	○	◎	832	3	2	1	OP	-	
11		Kabwe School	○	◎	416	2		2	○	252	
12		Ngabo Settlement	○	◎	832	3		3	○	N/A	Under construction
13		Namulumbwe Village	○	◎	312	1		1			
14		Nachumba Village	○	◎	780	3		3			
15		Bachele Village	○	○	1,040	4		4	○	280	
total	15 sites				10,661	38		35	7		
16		Mweezya School	○	◎	727	3		3	○	320	
17		Syansimuna Village	△	○	415	1		1			
18		Mazyamuna Village	○	◎	364	1		1			
19	SINAZONGWE	Fodwi Village	○	○	467	1		1			
20		Sinapumba Village	○	◎	519	2		2			
21		Syankuku Village	○	△	415	1		1			
22		Simumpande Village	◎	◎	519	2	1	1	OP	unknown	
23		Syankumba Village	○	△	415	1		1			
total	8 sites				3,843	12		11	2		
24		Simonga Village	○	◎	518	3		3			
25		Kasiya R.H.C.	◎	◎	518	2		2			
26	LIVINGSTONE	Mapenzi/Nansanzu	○	◎	776	3	1	2			
27		Katiba Village	○	△	311	1		1			
28		Makoli/Mandandi Village	△	◎	518	3		3	○	300	
total	5 sites				2,639	12		11	1		
29		Mukwelele Village	○	△	355	1		1			
30		Chigabwa Village	○	△	274	1		1			
31		Naambo Lukubi Village	○	◎	182	1		1			
32		Chikonga Village	○	○	203	1		1			
33		Mpokota Village	○	◎	279	1		1			
34	MONZE	Mwanza West Clinic	△	○	304	1		1			
35		Nangweluka Village	○	○	203	1		1			
36		Cheepahabulembe Village	△	○	203	1		1			
37		Muvwanga Village	△	○	253	1		1			
38		Simuzingine Village	△	▲	253	1		1			
39		Chinongwe Village	○	◎	152	2		2	○	315	
40		Simuumba Village	○	◎	304	2		2			
total	12 sites				2,964	14		14	1		
41		Syanjase Village	△	○	316	1		1			
42		Mpola Village	○	△	316	1		1			
43		~~Chibule Village~~	–	–		1	1	0			Excluded from the list because there is existing borehole.
44		Sinanfu Village	○	△	611	2		2			
45		Siabozu Village	○	△	526	2		2			
46		Syejumba Village	○	○	526	3		3	○	195	
47		Nkungwa School	○	○	526	2		2	○	157	
48	KALOMO	Polo Village	○	△	790	3		3			
49		~~Konayuma Village~~	–	×				0			Excluded from the list due to problems in approach road
50		Siankoge Village	○	△	790	3		3			
51		Siempondo Village	○	△	632	2		2			
52		Chikuyu Village	△	◎	632	2		2			
53		Kayuni Village	○	◎	316	2		2	○	320	
54		~~Chana Village~~	×	×	211			0			Excluded from the list due to hydrogeological difficulties
55		Siandwazi Village	○	△	632	2		2			
56		Chibalani Village	○	△	253	1		1			
total	16 sites				7,075	27		26	3		

Table2-1 Outline of the Project Sites (2)

No.	District	Site Name	Hydrogeological potencial 1)	Accessibility 2)	Population 1997	Necessary number of boreholes 3)	Existing Boreholes	Number of to-be drilled boreholes	Existence of school 4)	Number of pupils in the primary school	Remarks
57		Hinamanjolo Village	○	◎	1,023	5		5	○	450	
58		Sibanyati Settlement	○	◎	920	3		3	○	280	
59		Sepande Village	◎	○	767	4	1	3	○	500	
60		Singani Upper School	○	◎	818	3		3	○	280	
61		Munaputi Village	○	◎	256	2		2	○	280	
62		Maluma Village	○	◎	767	4	2	2	OP	450	
63	CHOMA	Nakeempa RHC	○	○	1,636	6	1	5	OP	573	
64		Siakakole Village	○	○	552	3		3	○	280	
65		Simbulo Primary School	△	△	368	2		2	○	280	
66		Muzoka Village	◎	◎	1,023	4	1	3	○	45	
67		Munyama Health Post	○	◎	818	3		3	○	280	
68		Mulongo Village	○	◎	511	3		3	○	720	
69		Simudima Primary School	○	△	767	3		3	○	250	
total	13 sites				10,226	45		40	13		
70		Halumya Village	○	◎	782	3	1	2			
71		Siancheeka Village	○	◎	522	2		2			
72		Fumbo P. School	○	◎	835	4		4	○	378	
73		Gulumunyanga School	○	▲	782	3		3	○	96	
74		Sinafala Turn Off	○	◎	730	2		2			
75	GWEMBE	Chisabuka Village	○	○	209	1		1			
76		Sinafala Village	○	◎	365	2		2	○	280	
77		Mabuta P. School	○	▲	626	2		2	○	125	
78		Siabwango	○	△	365	1		1			
79		Hazobwe Village	○	△	261	1		1			
80		Hacheelo Village	○	◎	522	2		2			
81		Hachangu Village	○	△	417	1		1			
total	12 sites				6,416	24		23	4		
82		Mukwela School	○	◎	930	3		3	○	225	
83		Malala Village	○	◎	1,550	7	1	6	OP	696	
84		Ngandu Haveenzu Village	○	◎	775	3		3			
85		Chisekwa Village	○	◎	517	2		2			
86		Mulando Village	○	◎	517	2		2			
87		Mwendankama Village	○	◎	517	2		2			
88	MAZABUKA	Bonbo Village	△	○	517	2		2			
89		Kaunga P. School	○	○	620	2		2	○	518	
90		Muvela Village	○	◎	775	3		3			
91		Mweemba Primary School	○	◎	413	2		2	○	311	
92		Mulawo Primary School	△	◎	413	2		2	○	350	
93		Nadezwe Agri. Camp	○	◎	517	2		2			
94		Makangala Village	○	◎	1,033	4		4			
95		Naluana Primary School	○	◎	258	2	1	1	○	200	
total	14 sites				9,350	38		36	6		
96		Simamba/Matero	○	○	184	2		2	○	245	
97		Manchamvwa	○	○	368	2		2	○	245	
98		Siamwiinga Village	○	○	511	2		2			
99	SIAVONGA	Dibwi	○	○	736	2		2			
100		Dambwe/Syakalinda	○	○	1,022	4		4	○	175	
101		Chinyama /Jemba	○	○	818	3		3	○	165	
102		Siamwinga P. School	△	○	102	2		2	○	100	
103		Zemba Zemba Village	○	◎	1,022	4		4			
104		Mangaba Village	○	○	818	3		3			
total	9 sites				5,581	24		24	5		
Ground	Total				58,755	234	14	220	42		

REMARKS

1) Possibility of ground water development
◎ : High potential
○ : Have potential
△ : Have potential at specified place
× : Low potential

2) Accessibility
◎ : Possible to transport drilling rig even in the rainy season
○ : Possible to transport drilling rig only in the dry season
△ : Necessary to repair road partly to transport drilling rig (not approachable in the rainy season)
▲ : Necessary to repair road to transport drilling rig (not approachable in the rainy season)
× : not approachable

3) Number of borehole is calculated as one borehole for 250 capitals. A borehole will be constructed at school in case if the number of pupils is more than one third of the village population.

4) OP : Hand pump is already existing

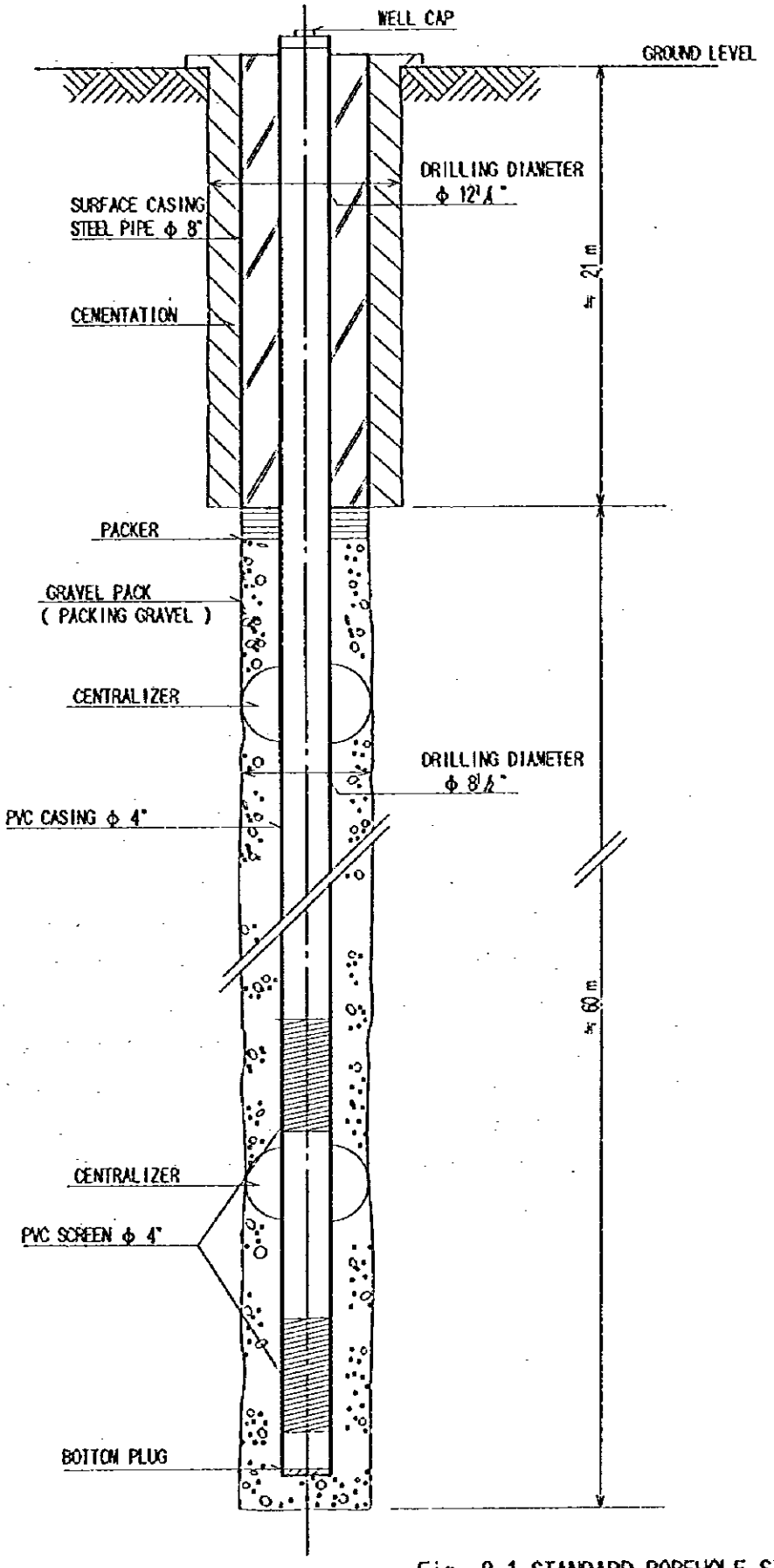


Fig. 2-1 STANDARD BOREHOLE STRUCTURE

2) Specification of the handpump

The specification of handpump to be used in the Project shall be in consistent with standardization of handpumps promoted by CMMU and DWA. Those to-be standardized handpumps are less expensive and easy to be procured in Zambia. As the result of the Basic Design Study, it was confirmed that India MK- II handpump has some advantages for the aspect of operation and maintenance and therefore selected as the Project specified handpump. An observation hole for measurement of water level in the borehole shall be set up to the pump stand. Table 2-2 and Fig 2-2 indicate the specification and the standard drawings of India MK- II.

Table 2-2 Specification of India MK- II

Average Discharge*	12.5 litres/min
Suitable Dynamic Water Level	20-51m
Diameter of Riser Pipe	40mm
Stroke Length	150mm

* It is estimated with using condition based on maximum capacity of 23 litres/min (50stroke/min).

3) Appurtenant facility

The appurtenant facility for the water supply facility in the Project consists of the apron, drainage ditch and soakaway. The design for the appurtenant facility has not been uniformed in the previous Projects, however WASHE promotes standardization of the appurtenant facility to simplify the design of the facility so that the local residents can participate in the construction work. The design of the appurtenant facility in the Project is following this WASHE concept. Fig 2-3 and 2-4 are the drawings of standard water supply facility (including appurtenant facility). As mentioned in the Design Concept, 2 types have been designed and either will be adopted depending on the condition of the soil and geology in the Project site.

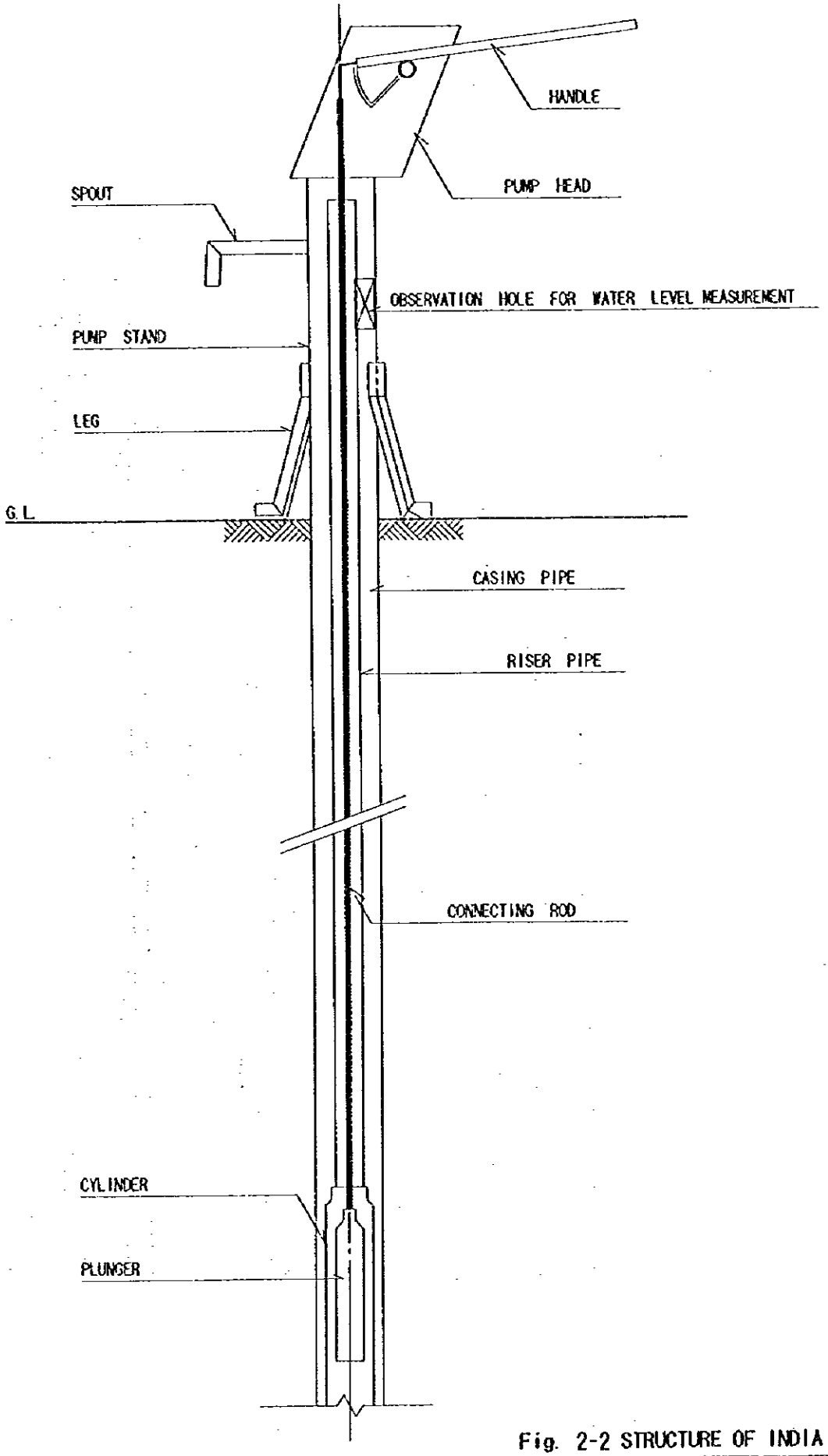
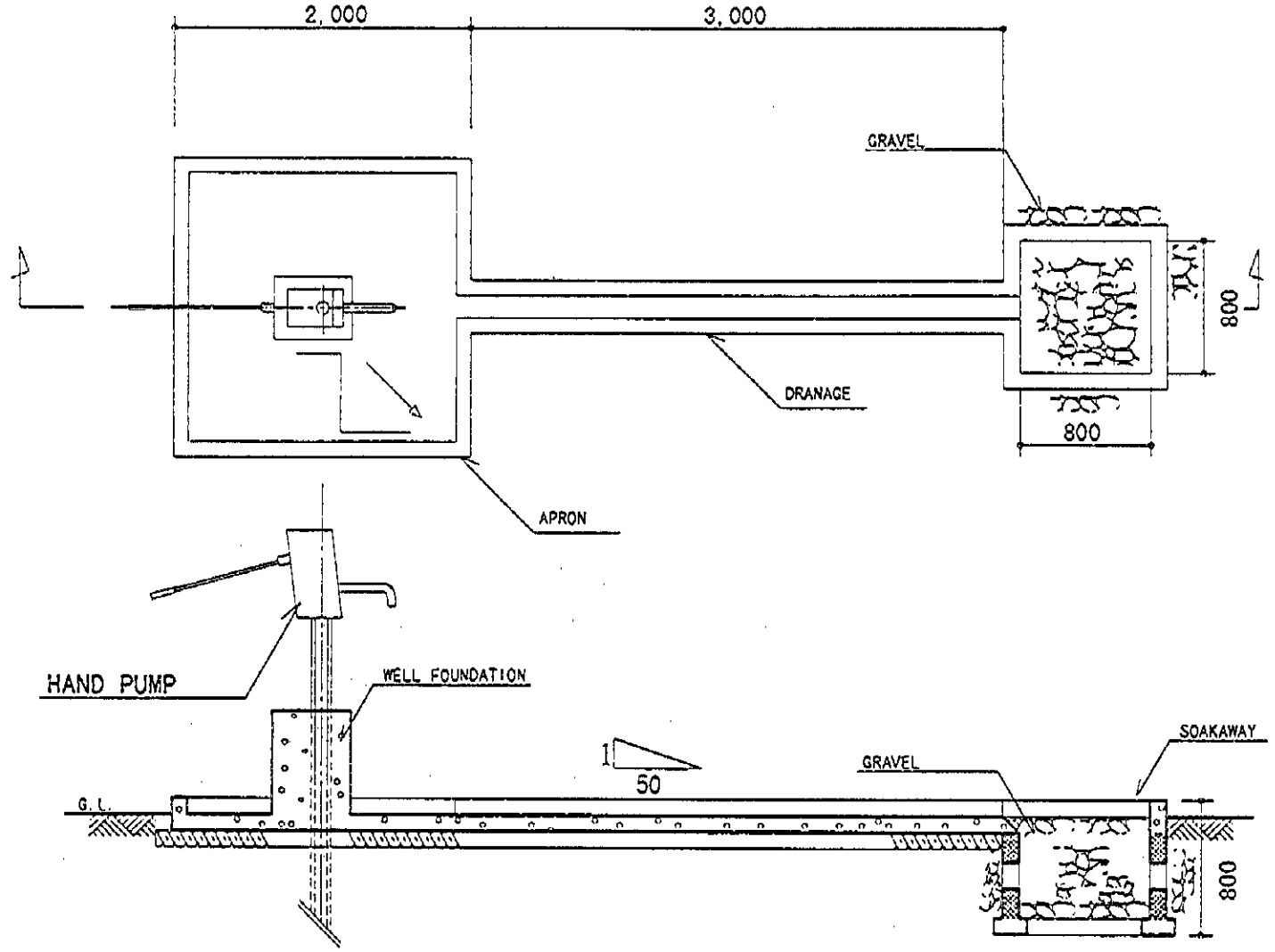


Fig. 2-2 STRUCTURE OF INDIA MK-II

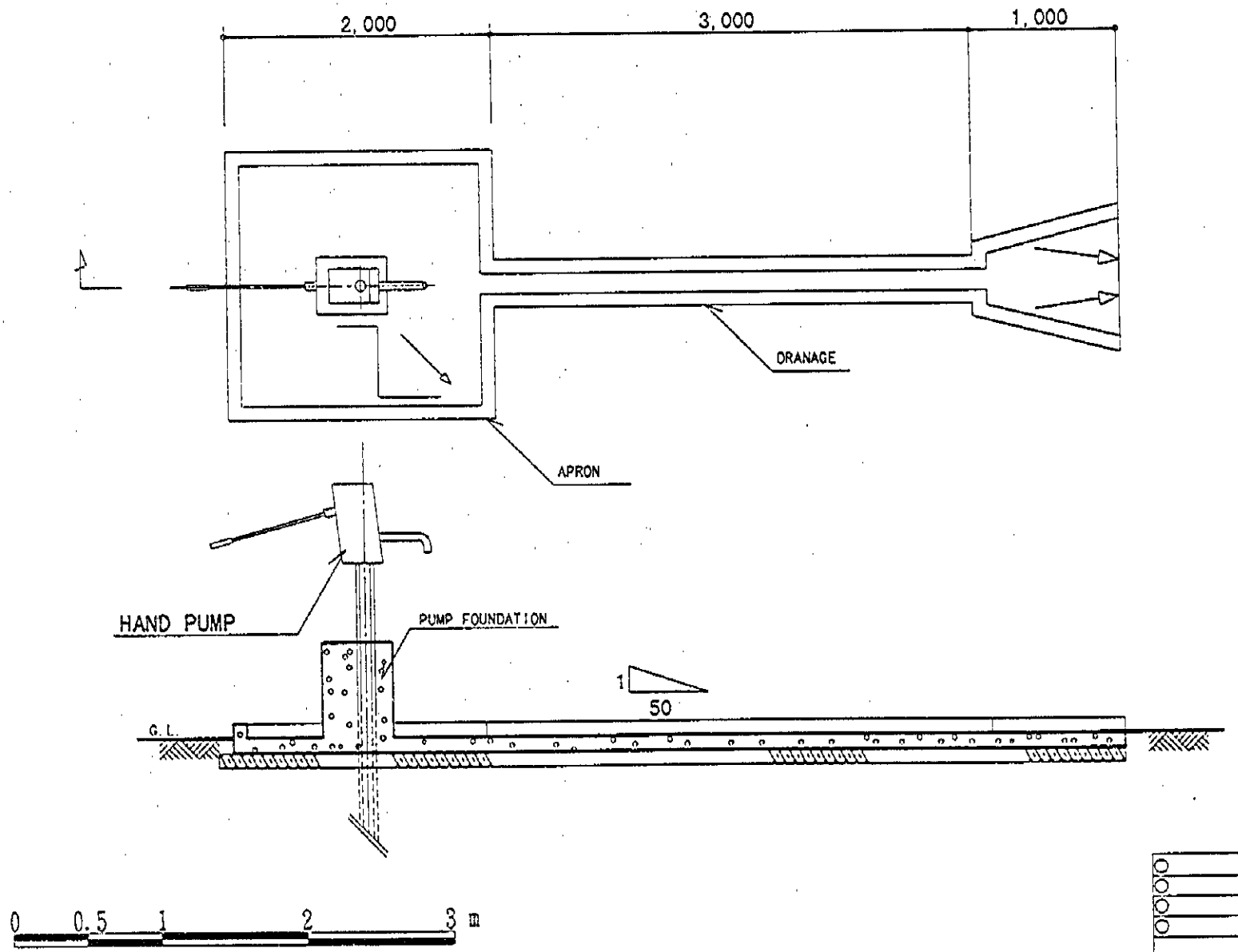


NOTES : LENGTH OF DRAINAGE IS 3.00m. SOAKAWAY IS MADE OF CONCRETE BLOCK.

Fig. 2-3 STANDARD WATER SUPPLY FACILITY(1)

STANDARD WATER SUPPLY FACILITY (TYPE I)

JAPAN TECHNO



NOTES : LENGTH OF DRAINAGE IS 3.00m

Fig. 2-4 STANDARD WATER SUPPLY FACILITY(2)

	STANDARD WATER SUPPLY FACILITY (TYPE II)
	JAPAN TECHNO

(4) Project implementing structure for the construction of water supply facility

Fig 2-5 shows process of implementation at Project site and Table 2-3 describes roles of the teams of DWA staff organized for the construction of the water supply facility. Construction work will be divided into several stages and each team will be in charge of the stage. It will be essential to keep the frequent communications between each team during the construction period.

① V-WASHE members, the Consultant and DWA select the drilling point.

② The Japanese Contractor and DWA execute drilling, logging, pumping test, installation of handpump, casing pipe and screen pipe (the community provides labour force to install handpumps).

③ D-WASHE and V-WASH members construct appurtenant facility.

1) Implementing structure for borehole drilling

Concerning the drilling, 4 drilling machines procured under previous Japanese Grant Aid Project are provided from DWA. The Japanese Contractor perform technology transfer to the DWA staff. Drilling of boreholes including geophysical prospecting survey, logging, installation of casing pipe and screen pipe, pumping test and the construction of pump foundation is to be done by the DWA staff and the Japanese Contractor under the responsibility of Japanese Contractor. Regarding the cost of borehole construction, the Japanese side takes charge of the procurement of necessary equipment and materials, the dispatch of Japanese engineer(s) and/or technician(s), and the management of construction work. The Zambia side takes charge of the provision of existing drilling machines and assignment of the DWA staff for the Project including wages and allowances for the staff.

2) Installation of handpump and the construction of the appurtenant facility

In the previous Japanese Grant Aid Projects, installation of handpump and construction of apron and soakaway were included in the responsibilities for the Japanese side. However through the WASHE activities which other donors

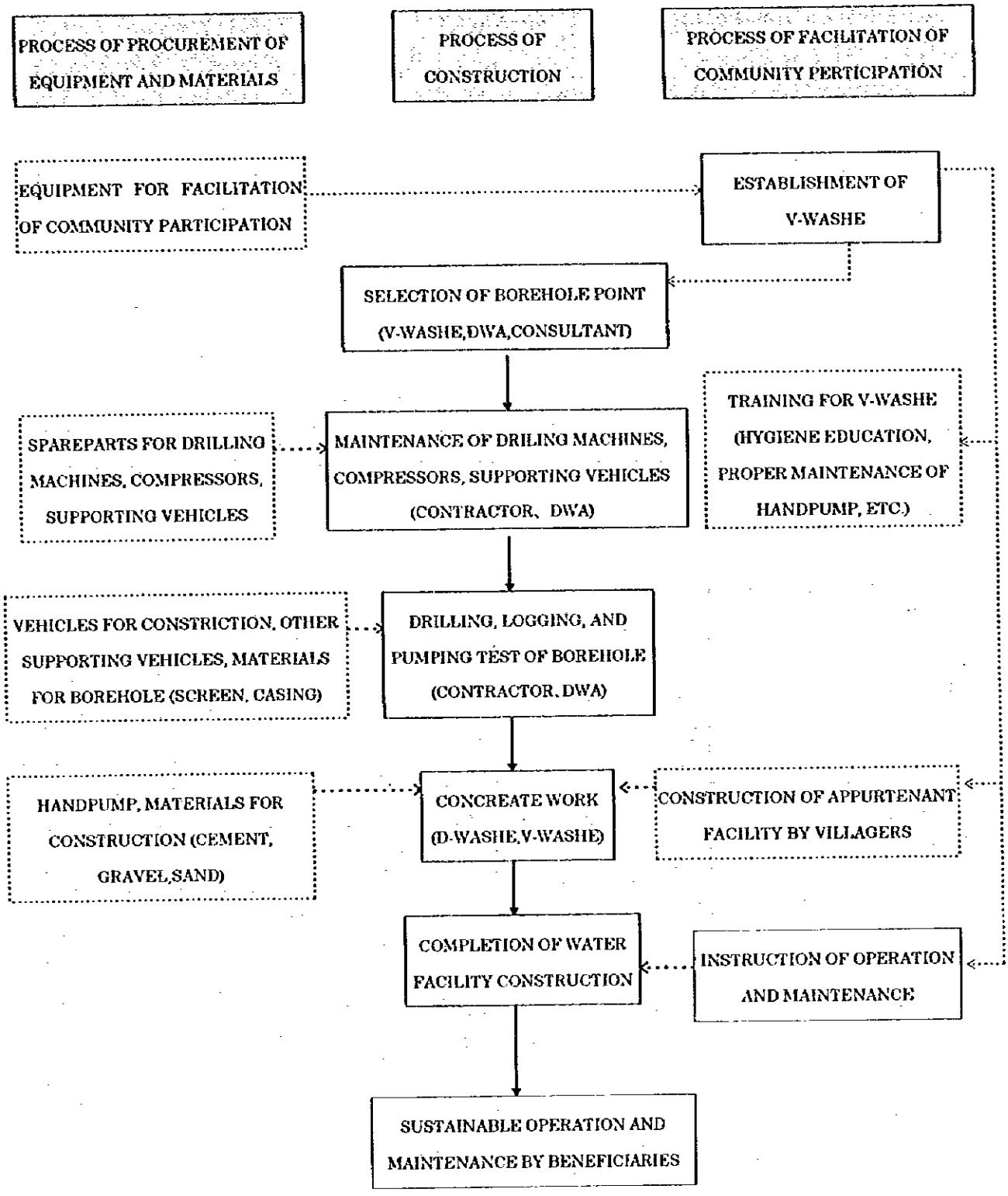


Fig. 2-5 Process of Project Implementation

Table 2-3 The Roles of the Teams of DWA Staff for Project Implementation

Team Title	Number of Teams*	Team Member	Roles and Activities
Project Management Team	1/1	Project Engineer: 1 Assistant Engineer: 1 Office Worker: 1 Driver: 1	The Project Management Team is based at Choma Main Depot and responsible for the administrative coordination such as scheduling and supervising of construction work, meeting with Contractor, Consultant and Ministry, and pre-survey of the Prijject sites.
Survey Team	2/2	Hydrogeologist: 1 Geophysicist: 1 Assistant Engineer: 1 Casual Worker: 6 Driver: 1	Though the site survey is carried out in the detailed design study, the Survey Team carries out detailed geophysical survey after the establishment of V-WASHE committee so as to take social conditions into consideration for the selection of borehole point. Final drilling point is selected after due deliberation among Consultant, Study Team and V-WASHE.
Drilling Team	3/4	Japanese Drilling Engineer: 1 Driller:1 Mechanic: 1 Casual Worker: 4 Driver: 3 Guard: 3	The Drilling Team executes drilling of borehole and installation of casing pipes under the supervision and guidance of the Japanese Drilling Engineer.
Well Logging Team	3/3	Well Logging Engineer: 1 Assistant Engineer: 1 Driver :1	After the completion of borehole drilling, the Well Logging Team executes logging of the borehole and confirms the position of the aquifer to design the casing program.
Pumping Test Team	3/4	Equipment Worker: 1 Casual Worker: 2 Driver: 1	After the Drilling Team finished drilling and installation of casing pipes, the Pumping Test Team carries out step and continuous pumping tests to understand the characteristics of the borehole.
Construction Team	3/4	Equipment Worker: 1 Concrete Placer: 1 Bar Assembler: 1 Forms Worker: 1 Casual Worker: 3 Driver: 1	The Construction Team constructs foundation and basement for the handpump after pumping test is carried out. While installation of handpump and construction of apron are done by the community, foundation and basement must be done by the DWA's skilled workers and the Contractor due to the technical complication.
Transportation Team (1)	3/4	Driver: 1 Assistant Driver: 1	Transportation Team (1) accompanies to the Drilling Team to transport materials such as casing pipes, screen pipes and handpumps from the Main and Sub depots to the drilling sites.
Transportation Team (2)	3/3	Driver: 2	Transportation Team (2) delivers fuel and water to the drilling sites using fuel and water tankers.
Service and Maintenance Team	1/1	Equipment Engineer: 1 Machinery Mechanic: 4 Vehicle Mechanic: 4 Casual Worker: 4	The Service and Maintenance Team is principally based at workshop in the Main Depot and services drilling machines and supporting vehicles used in the Project.
Stock Control Team	1/1	Warehouse Manager: 1 Office Worker: 1 Casual Worker: 1	The Stock Control Team controls materials such as screen pipes, casing pipes, handpumps and cement kept at the warehouse in Main Depot.

*:Number of 1st Phase Teams / Number of 2nd Phase Teams

have been promoting, the community are given technical guidance to the construction, operation and maintenance of the water supply facilities so as to facilitate the awareness of importance of clean and safe water and the sense of ownership for the facilities. Government of Zambia (DWA, CMMU) and other donors advised that the same stance should be introduced to this Project. In this case, installation of handpump and the construction of the appurtenant facility shall be under the responsibility of the community. However, since the cash income of the community is unstable and inadequate, the Japanese side provides equipment and materials necessary for the works done by the community to lessen the financial burden and the community provide the labor force.

(5) Phasing and priority order for the construction sites

The phasing is examined accordingly to the Design Concept and concluded as 2 phases, i.e. 35 villages with 60 water supply facilities under the first phase and 66 villages with 160 water supply facilities under the second phase. All the sites located in the same district are to be completed within the same phase. The construction schedule has been formed according to the priority order among the construction sites submitted by DWA, the degree of progress on D-WASHE activities and the condition of the approach road. The construction schedule in phase and district order is shown in Table 2-4.

Table 2-4 Construction Schedule

	District	No of Sites	No of Water Facilities
Phase I	Monze	12	14
	Sinazongwe	8	11
	Namwala	15	35
	Total	35	60
Phase II	Choma	13	40
	Siavonga	9	24
	Gwenbe	12	23
	Kalomo	13	26
	Livingstone	5	11
	Mazabuka	14	36
	Total	66	120
	Grand Total	101	220

(6) Procurement of equipment and materials

As the result of the investigation based on the design concept, procurement of equipment and materials for the construction work listed on Table 2-5 and for the community participation and maintenance promotion activities listed on Table 2-6 are decided. Detailed background of the selection of the items and quantity is described in the Appendix-11. Spare parts for 2 years' operation are procured for the vehicles and equipment.

1) The existing drilling machines and supporting vehicles

Spare parts are procured for the existing four drilling machines, the supporting vehicles and the equipment which will be used for the Project. Special maintenance and service are necessary for the drilling machine and supporting vehicles procured under the Non-Project Grant Aid and allocated in Southern Province due to their conditions of being old and exhausted. However, another drilling machine allocated in Southern Province is not used for this Project as it is heavily exhausted and its spare parts are not to be procured. Spare parts must be genuine articles from the makers.

For the construction work of the Project, four sets of pumping test equipment mounted on truck, supporting truck for transport of materials and supporting truck to mount compressor are necessary. One complete set of them is newly procured due to being in short. 18 pick-up trucks necessary for the construction work of the Project are procured newly because the existing pick-up trucks procured under Rural Water Supply Development Phase-Ⅲ are too old and decrepit to use. Vehicles to be procured newly must be the popular ones in Zambia with enough provision of spare parts. During Basic Design Study, it was confirmed that there is a great share of Japanese vehicles in Zambia and their local dealers are in healthy operation. Since the Japanese vehicles were procured under previous Japanese Grant Aid Projects, the Japanese vehicles shall be procured continuously in this Project from the view point of ability to interchange spare parts and easiness to obtain spare parts.

2) Workshop equipment and materials

Workshop equipment and materials are to service drilling machines, supporting vehicles and handpumps. The contents of them are welding machine, generator, adjustable wrench, pipe wrench, and so on and delivered to the DWA's provincial office in Choma District.

Table 2-5 List of Equipment and Materials for Construction Work

ITEMS	Q'ty	ORIGIN	SPECIFICATION
1. SPARE PARTS FOR DRILING MACHINE & RELATED EQUIPMENT			
1)For drilling equipment mounted on trucks	4 lots	Japan	• Mud pump, oil pressure equipment, batteries, tire, etc.
2)For other supporting truck			• Tire, batteries, filter for other supporting trucks, etc.
3)For air compressor	1 lot	Japan	• Solenoid valve, hose, gasket, tire, batteries, filter, etc.
4)For testing equipment	4 lots	Japan	• Pump for pumping test (new), spare parts of generator for pumping test, geoelectric survey equipment,
	1 lot	Japan	borehole logging equipment mounted on station wagon
2. MATERIALS FOR CONSTRUCTION OF BOREHOLE WITH HANDPUMP			
*Casing		3rd Country	• PVC ϕ 100mm、42-70m
*Screen	For 220	3rd Country	• PVC ϕ 100mm, 12-30m
Hand pump	borehole	3rd Country	• India MK II (including riser pipe ϕ 40mm、30m)
*Other materials		3rd Country	• Casing bottom, polymer, etc.
3. SUPPORTING VEHICLES AND EQUIPMENT			
1) Truck to carry material for construction			
Cargo truck with crane to carry material for borehole construction	1 unit	Japan	• Maximum pay load 7t, fitted with crane, 6×6
Truck to mount air compressor	1 unit	Japan	• Maximum pay load 7t, 4×4
2)Pick-up truck to carry staff & materials*	18units	Japan	• Maximum rating capacity 90PS, double cabin 4×4
3)Pump testing equipment mounted on truck*	1 set	Japan	• Cargo truck with crane, generator, pump, etc.
4)Others*	1 set	Japan	• Camping equipment, radio telephone, water/fuel tank
4. WORKSHOP EQUIPMENT AND MATERIALS*	1 unit	Japan	Generator (10KVA, 220V), engine welder (17KVA, 60-140A, 220V), gas welding equipment (acetylene type),air compressor (10kgf/cm², 1.5Kw、220V)、containers to store these workshop tools and procured spare parts, general work shop tools

Table 2-6 List of Equipment and Materials for Community Participation and Maintenance Promotion Activities

ITEMS	Q'ty	ORIGIN	SPECIFICATION
1. SUPPOTING VEHICLES			
1)Pick up truck to staff and materials*	9 units	Japan	• Maximum rating capacity 90PS, double cabin 4×4
2)Motor bike to staff and materials*	18 units	Japan	• Off load type125CC
3)Bicycle*	18 units	3rd Country	• Off load type 22 inch
2.OFFICE EQUIPMENTS			
• Personal computer*	2 sets	3rd Country	• 32bit, 600MB, color monitor, printer,
• Typewriter*	9 sets	3rd Country	• Electric type
• Photocopying machine*	9 sets	3rd Country	• Available for A3 paper
• Facsimile*	9 sets	3rd Country	• Thermal paper type
• Global positioning system*	9 sets	3rd Country	• Rechargeable batteries type
• Plastic laminate coating equipment*	9 sets	Japan	• Available for A3 paper
3. MAINTENANCE TOOLS FOR WATER FACILITY			
• Standard tools (for repair)	46 sets	3rd Country	• Pipe wrench, hammer, wire blush, etc.
• Special tools (for pump installation)	46 sets	3rd Country	• Spanner, pipe lifter, clump, etc.
• Tools for concrete work	46 sets	3rd Country	• Steel shuttering, shovel, bucket, etc.
• Spare parts kits for hand pump	220sets	3rd Country	• Gasket, bolt, spanner, etc.
4. STATIONARY FOR COMMMUNITY PARTICIPATION	32 sets	3rd Country	• Black board, maker, pin, glue, tape, paper, etc.

*: Procured with spare parts for two years' operation

3) Equipment and materials for community participation and maintenance promotion activities

Supporting vehicles for WASHE activities to be used for transportation of workers and materials are 9 trucks (1 for each district), 18 motorbikes (2 for each district) and 18 bicycles (2 for each district). Office equipment related to the operation and maintenance contains 2 computers for the head office in Choma District, typewriter, photo-copy machine, fax machine, GPS (to measure the latitude and longitude), and 9 laminate coating machines for educational materials (1 machine for each district). 46 sets of tools for operation and maintenance are procured and 2 sets are distributed to each of the 23 catchment areas. 1 set of maintenance kit (220 sets in total) is provided to each water supply facility. 1 set of stationery for educational purposes is provided to each of the 23 catchment areas and 9 districts. These items are standardized by the WASHE activities as mentioned before.

(7) Technology transfer

Following technology transfers are considered to be necessary for smooth and effective implementation of the Project:

1) Technology for groundwater development

The DWA staff have already been transferred basic technology relating to the groundwater development from Japanese engineer(s) and/or technician(s) in the previous Japanese Grant Aid Projects. However, technology transfer for the geoelectric prospecting survey, the geomagnetic survey and the skill for monitoring of groundwater are carried out by the Consultant during the implementation of the Project to intend higher quality investigation for groundwater development.

2) Technology for the borehole drilling

DWA technicians have mastered basic skills for borehole drilling. However, the management skills of drilling such as scheduling of construction work, supervising of operation, servicing machines, etc. and drilling skills under

complicated geological conditions are still in the developing stage. Therefore, the Japanese engineer(s) and/or technician(s) dispatched from the Contractor carry out technology transfer related to the skills mentioned above for the DWA staff during the construction of borehole water supply facilities.

3) Technology transfer for operation and maintenance of the procured equipment and the service of drilling machines

Some of the workshop equipment need adequate instruction and demonstration for the usage and maintenance. Training is carried out to the staff of DWA by the Japanese Contractor.

Servicing technicians of DWA receive technology transfer regarding the skills to service drilling machines while the Japanese technical staff repair and service drilling machines at the commencement and completion of the Project.

2-4 Operation and Maintenance System, and WASHE (Water, Sanitation and Health Education) Activities

2-4-1 D-WASHE Committee and V-WASHE Committee

Zambian Government has implemented water supply projects in rural areas with assistance of several donor countries and other institutions, under which hand-dug boreholes with water supply facility has been constructed in large number. However, there is increasing number of water supply facilities not in use and no significant improvement in coverage ratio. It is attributed to inefficient planning and management system not only at ministerial-level, but also at community-level. WASHE (Water, Sanitation and Health Education) activities has been introduced in Zambia as a national policy and strategy to improve the situation.

In addition to activities of DWA in implementation, operation and maintenance, as an implementing agency of the Project, introduction of WASHE activities in the Project from the implementation stage is relevant to accord the Project with national policy and strategy in water and sanitation sector, and it is rather essential to establish efficient operation and maintenance system with capacity building of institutions at ministerial- and community- level. Furthermore, WASHE activities integrate hygiene education in water supply project so as to improve awareness and change attitudes of rural population in hygiene and sanitation aspects. It maximize impact of water supply Project on hygiene and sanitation aspects at village-level.

WASHE activities are promoted at different level, such as national-, provincial-, catchment-, and village-level. WASHE activities at each level is different in nature, although concept employed in WASHE activities is identical. Thus, institutions which are responsible for WASHE activities at different level shall be established. CMMU and N-WASHE Coordination and Training Team are responsible for formation of D-WASHE Committee and training for the committee members. At catchment area, D-WASHE Committee is expected to build capacity of its extension workers who foster WASHE activities at village-level. D-WASHE Committee and those extension workers collaborate and facilitate formation of V-WASHE and VLOM (Village-Level

Operation and Maintenance) Team, which is composed by the community. D-WASHE Committee and its extension workers conduct village-level activities to develop the capacity of those V-WASHE Committee and VLOM Team in operation and maintenance of the facilities. They also conduct hygiene education at village level.

Institutional framework for WASHE activities at different level, roles and responsibilities of each institution, and necessary subjects in capacity building of members of those institutions for each institution to implement WASHE activities are described below (also refer to Fig. 2-6). It shall be noted that DWA is responsible, in implementation of the Project, for those institutional building at each level and implementation of WASHE activities itself at the Project area.

2-4-2 WASHE Activities and Establishment at District-Level

(1) Roles and responsibilities of D-WASHE Committee

D-WASHE Committee, which facilitates WASHE activities at district-level, takes a roles of implementing body for policy and strategy in water and sanitation sector decided at national-level. It is also responsible for formation of V-WASHE Committee and develop the capacity of the committee members, and for follow-up of its activities. D-WASHE Committee shall; 1) assess the present situation in water and sanitation sector at district-level, 2) make solution and action plan to solve the identified problems in the forms of "D-WASHE Development Plan", and, 3) implement the D-WASHE Development Plan and monitor their activities.

(2) Institutional framework of D-WASHE Committee

D-WASHE Committee is one of sub-committees under DDCC (District Development Coordination Committee). The committee, which is normally headed by Development Secretary of District Council, is composed of and run intersectorally by responsible members from district officials of ministries and NGOs concerned to water supply and sanitation, regional development, education.

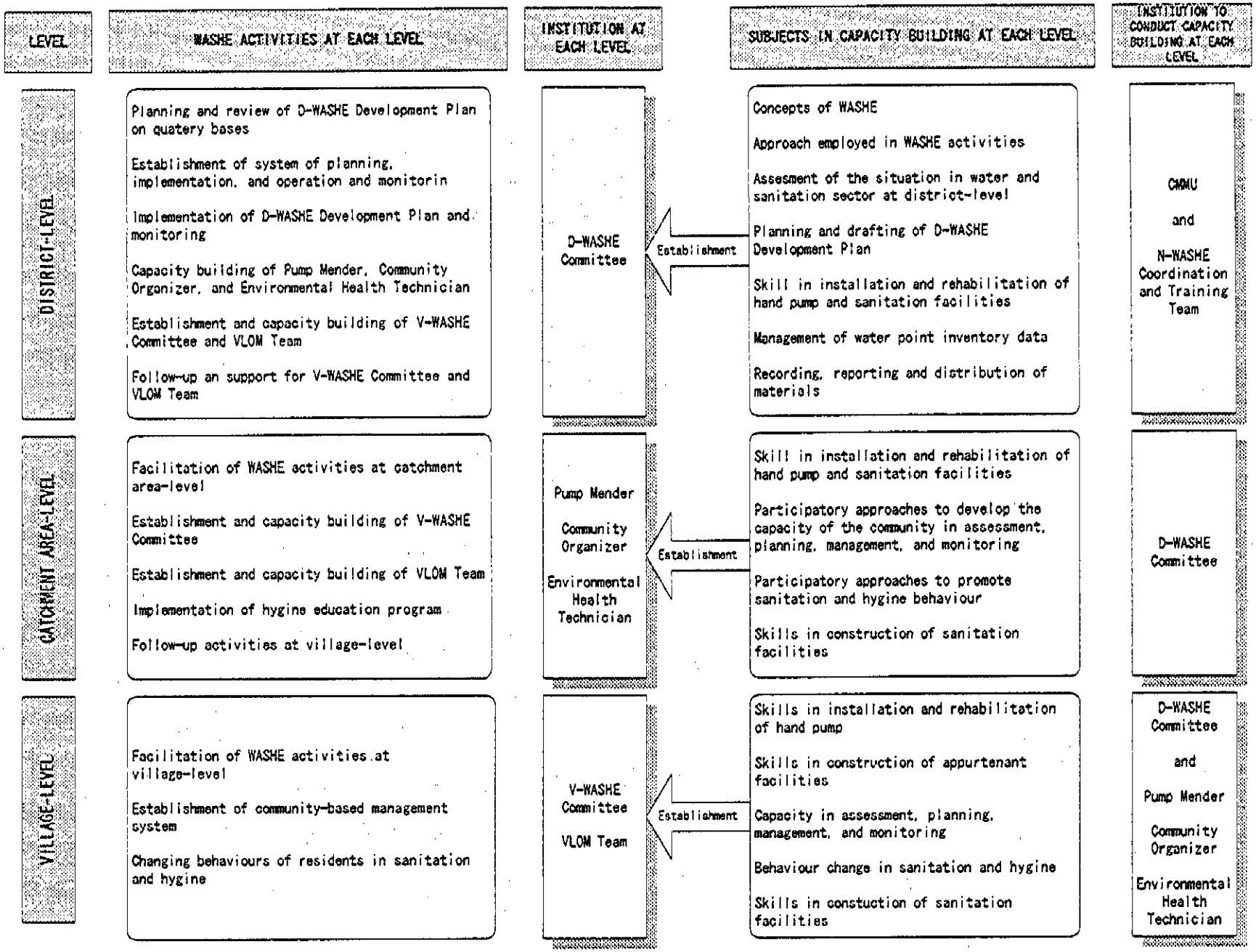


Fig. 2-6 WASHE Activities and Subjects of Capacity Building at Each Level

(3) Establishment of D-WASHE Committee and capacity building of its members

D-WASHE Committee has been established and trained at 6 districts (Kalomo, Siavonga, Sinazongwe, Choma, Monze, Mazabuka) out of 9 districts in Southern Province. At two districts (Namwala and Gwembe) and one city (Livingstone), however, D-WASHE Committee and its capacity building has been yet completed. Prior to the implementation of the Project, DWA shall coordinate with ministries and other relevant organizations concerned to facilitate establishment of D-WASHE Committee at those 2 districts and one city.

Establishment of D-WASHE Committee necessitates training to develop capacity of the committee members to understand and promote WASHE activities. Contents of those necessary training and capacity building in each fields are described below.

1) Introduction of the concept of WASHE, and capacity building in assessment, planing, and implementation of WASHE activities at district level.

The concept of WASHE, of which approach is integrated and intersectoral ranged from national-level to village-level, is to be introduced to newly formed D-WASHE Committee. Subsequently, D-WASHE Committee members shall assess the present situation in water supply and sanitation at the district-level, find possible solution and make action plan. The analysis of the present situation and action plan shall be articulated in D-WASHE Development Plan. For the implementation of WASHE activities in the Project, the action plan shall be made. The D-WASHE Development Plan has to be reviewed and revised if it is necessary on quarterly bases. Monitoring activities shall be properly conducted for the quarterly review and planning.

2) Training of D-WASHE members as trainers on the installation and rehabilitation of hand pump and sanitation facilities

The selected D-WASHE Committee members shall be trained as trainers on the installation and rehabilitation of hand pump and sanitation facilities. Those members are expected to train and support pump menders, who conducts

village-level activities. They are also responsible for storage management of spare parts of hand pump.

3) Capacity building of D-WASHE Committee members on the management of water point inventory data

Capacity building of D-WASHE Committee members on the management of water point inventory data is essential, and improve their capability in planning, implementation, and operation and maintenance of the Project. Selected D-WASHE members shall be trained on the management of water point inventory data, and computerized data bank will be established.

4) Improvement of the capacity of warehouse staff in the recording, reporting and distribution of materials

As a line to improve capacity of D-WASHE Committee in operation and maintenance of the Project, warehouse staff shall be trained in the recording, reporting and distribution of material and spare parts.

2-4-3 WASHE Activities and Establishment at Catchment Area-Level

(1) Extension worker and their role and responsibilities

D-WASHE Committee members train extension workers, who station at each catchment area (i.e. sub-district) and facilitate WASHE activities at village-level. Then, those extension workers train the communities and develop their capacity in planning and management, utilizing participatory approach. They facilitate formation of V-WASHE Committee and VLOM (Village-Level Operation and Maintenance) Team to promote village-level / community management system. They are also responsible for implementation of hygiene education at village-level.

Those extension workers at catchment area composes of Pump Menders, Community Organizers, and Environmental Health Technicians. Activities of each staff is described as follows.

1) Pump Mender

Pump Menders train the community on installation, operation and maintenance of hand pump, and construction of appurtenant facilities. They also facilitate formation of VLOM Team to promote village-level / community-based management system.

2) Community Organizer

Community Organizers facilitate formation and capacity building of V-WASHE Committee with participatory approach. They train V-WASHE Committee members to develop their capacity in assessment, planning and implementation of the water and sanitation project at village-level. In the process, V-WASHE Committee members are clearly aware of importance of community participation and their roles and responsibilities. Moreover, Community Organizers train village-level cashier in user fee management to establish finance system for maintenance of the facilities. All those training is conducted with utilization of participatory approaches.

3) Environmental Health Technician

Improvement of awareness and behavior change of the community on hygiene and sanitation, and accessibility of the sanitation facilities maximize impact of the water supply project on hygiene and sanitation aspects. Environmental Health Technicians conduct hygiene and sanitation education at village-level to improve awareness of the community in hygiene and sanitation. The hygiene education accord with training for the community on construction of sanitation facilities such as VIP (Ventilated Improved Pit) Latrine, garage pit, and pottery for water storage and hand washing.

(2) Capacity building of extension workers at Catchment Area-Level

It is necessary for promotion of WASHE activities at village-level to improve capacity of the extension workers at catchment area-level in each field of the

activities. Pump Menders require training to improve skills in installation and maintenance of the hand pump and construction of appurtenant facilities. It is essential for Community Organizer to obtain participatory approach for facilitation of community participation. Environmental Health Technicians shall obtain approach in hygiene education program and require training on construction of sanitation facilities.

2-4-4 WASHE Activities and Community-Based Organization at Village-Level

D-WASHE Committee members and extension workers at Catchment Area facilitate formation of V-WASHE Committee and capacity building of the committee members. V-WASHE Committee composes of a chairperson, secretary, cashiers, caretakers, and women's group. Cashiers are responsible for collection and management of user fee to finance maintenance work of the facilities. Caretakers are responsible for sanitary protection of water facilities, while women's group demonstrate sanitation facilities. VLOM Team shall be also formed and trained for establishment of village-level / community-based maintenance system.

In the implementation of the Project, V-WASHE Committee, with assistance of Community Organizer, decides candidate water points reflecting the view points of the community (i.e. socially acceptable water points). Afterwards, survey crew of DWA implementation team conducts detail geoelectric prospecting survey on the candidate water points. Then, final decision will be made on the water point, with supervision of consultants, through discussion with V-WASHE Committee members.

The community are expected to participate in the installation of hand pump, and construction of apron and soakaway, with supervision of and training by construction crew of DWA implementation team and pump mender. Training of the community on installation of hand pump and construction of apron and soakaway would improve the capacity of the community for village-level operation and maintenance. Furthermore, exploitation of capability of the community in operation and maintenance of the facility maximize community participation.

Institutional building for facilitation of WASHE activities and implementation of

WASHE activities itself is essential for the implementation, operation and maintenance of the Project. DWA, as an implementing agency, shall coordinate ministries and other institutions concerned to establish the system for facilitation of WASHE activities at the Project area.