No. 04

BASIC DESIGN STUDY REPORT

ON

RURAL WATER SUPPLY PROJECT

IN

THE REPUBLIC OF SIERRA LEONE

JULY, 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

BASIC DESIGN STUDY REPORT

ON

RURAL WATER SUPPLY PROJECT

IN

THE REPUBLIC OF SIERRA LEONE

JULY, 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

P R E F A C E

In response to the request of the Government of the Republic of Sierra Leone, the Government of Japan decided to conduct a basic design study on the Rural Water Supply Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Sierra Leone a study team headed by Mr. Hiroshi IGARASHI, Chief of 2nd Construction Section, Construction Division, Extension Department, Water Works Bureau, Sapporo Municipal Government from February 14 to March 15, 1986.

The team had discussions on the Project with the officials concerned of the Government of the Republic of Sierra Leone and conducted a field survey in Bombali and Kambia Districts. After the team returned to Japan, further studies were made and the present report has been prepared.

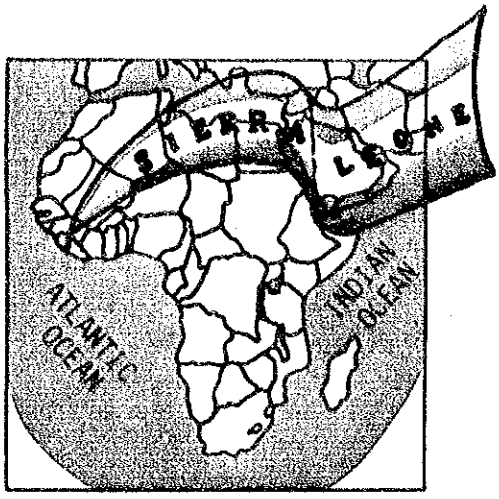
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Sierra Leone for their close cooperation extended to the team.

July, 1986.

Keisuke Arita

President
Japan International Cooperation Agency



LOCATION MAP

PROJECT AREA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

L I S T O F

B A S I C D E S I G N D R A W I N G S

LIST OF ABBREVIATIONS

Organizations

AWWA	American Water Works Assoiciation
DANIDA	Danish Aid
EEC	European Economic Community
GVWC	Guma Valley Water Company
ILO	International Labour Organization
JICA	Japan International Cooperation Agency
LWDD	Land and Water Development Division
MANR	Ministry of Agriculture and Natural Resources
MFA	Ministry of Foreign Affairs
MWEP	Ministry of Works, Energy and Power
UK	United Kingdom
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNV	United Nations Volunteers
USA	United States of America
WARDA	West African Rice Development Association
WHO	World Health Organization
WSD	Water Supply Division

Acronyms

BS	British Standards
DTH	down-the-hole
GDP	gross domestic product
GNP	gross national product
IADP	Integrated Agricultural Development Project
PVC	poly-vinyl chloride
VLOM	village level operation and maintenance

U n i t s

A	ampere	ℓ	liter
cap	capita	m	meter
cm	centimeter	m^2	square meter
°	degrees	m^3	cubic meter
°C	degrees centigrade	μ℧	micromho
$	U.S. Dollars	mg	milligram
HP	horsepower	mℓ	milliliter
hr	hour	mm	millimeter
Hz	hertz	min	minutes
in	inch	'	minutes
km	kilometer	%	percent
KVA	kilovolt ampere	P	phase
KW	kilowatt	V	volt
Le	Leone	¥	Japanese Yen

SUMMARY

S U M M A R Y

The Rural Water Supply Project is part of the National Action Plan being promoted by the Republic of Sierra Leone. This project involves reinforcement of the rural water supply facilities which require improvement for the rural population being faced with drastic water problems. As an integral part of the rural water supply program directly managed by the Water Supply Division (WSD) under the Ministry of Works, Energy and Power, this project will put emphasis on villages scattered in Bombali and Kambia Districts of the Northern Province.

The objective of this project is to construct in villages using surface water as their water source the water supply facilities for intake, treatment, storage and distribution through pipelines, and in those with availability of groundwater, to construct point-source water supply facilities using borehole type wells. Therefore, the Sierra Leonean government submitted a request for financing of this project through the Japanese grant aid program.

In response, the Japanese government formed a basic design study team through the Japan International Cooperation Agency (JICA). The team was dispatched to Sierra Leone from February 14 to March 15, 1986 to carry out a survey in which the request, background, scope and effect of the project were confirmed and the feasibility for implementation was studied. As a result of the survey, the characteristics of water resources in the project candidate sites were studied and analyzed from hydrological, hydrogeological and engineering viewpoints, and then evaluated for reliability of the water resources. Based on demographic conditions, surrounding environmental conditions and area characteristics, and upon discussions with the Sierra Leonean government, the sites were selected as listed below.

Area	Surface Water as Water Source	Groundwater as Water Source
Bombali District	0	124
Kambia District	1	18
Total	1	142

The scope of this project was based on the concepts of the Sierra Leonean government related to rural water supply projects, and upon consideration of the urgency, self-accomplishment and arrangements to be made by WSD to continue implementation by themselves. The construction facilities, and equipment and materials for this project are summarized below.

Item	Description	
Construction of Facilities Using Surface Water (Kambia District x 1 site)	Intake facilities	
	Pumping equipment and related machinery houses	
	Transmission lines	
	Storage tank	
	Treatment units	
	Distribution network	
	Distribution facilities	
Construction of Facilities Using Groundwater (Bombali District x 124) (Kambia District x 18)	Borehole type well drillings	
	Hand pump installations	
	Supply facilities construction	
Equipment and Materials for Facilities Construction	Well drilling rig and tools	2 sets
	Well drilling related equipment	
	Machineries, vehicles and materials	
	Apparatuses for flow rate measurements and water quality analysis	
	Materials for well construction (casings, screens, hand pumps, drilling mud and additives)	
	Spare parts for above	

The executing agency for this project is WSD, which was established in 1950 with responsibilities for planning, operation and maintenance of water supply works for all urban and rural areas, excluding Freetown. In particular, this organization has accumulated experience in groundwater utilization by constructing many large diameter, concrete-lined shallow wells. Although hydrogeological analyses are essential for the construction of wells, fortunately, the Land and Water Development Division (LWDD) of the Ministry of Agriculture and Natural Resources (MANR) has this capability and has always been available to assist WSD, while WSD is involved in the integrated rural development projects being accelerated by MANR. Moreover, the special task force to be organized by both divisions will also be available to assist in this project. A training program will be provided to this task force for technology transfer on well construction during the project.

WSD will be responsible for operation and maintenance. Unlike the fee system established for urban water supplies, WSD distributes water free of charge to the rural people. However, in line with the campaign for VLOM (village level operation and maintenance), the villagers are strongly asked to contribute in the form of self-efforts by participating in works not requiring any skills from the supply facilities construction stage up to the operation and maintenance stage.

For total project implementation, after the exchange of notes, with consideration of the rainy season, 36 months is required until completion.

This project will relieve the rural inhabitants from problems of being unable to receive safe and clean supplies of water. Moreover, this project will not only ensure the basic human needs, but will also have a strong influence on the agricultural policy being promoted by the government to improve the functional ability of the rural area. This project will also contribute greatly to the development of technology and personnel training required for water resources research, which will form the basis of future water supply works.

In the predicament of declining international economy in recent years, the operation of existing facilities is becoming difficult and the Sierra Leonean government has launched a new development program on its own. Therefore, in addition to receiving international aid, the government is anticipating for the villagers to implement projects and improve operation and maintenance systems as much as possible by themselves. Furthermore, in comparison to other areas, the sites selected for this project are situated in areas favorable for water resources development, which is important for this kind of projects. As a result, the immediate implementation of this project is highly desired.

CHAPTER 1 INTRODUCTION

CHAPTER 1

INTRODUCTION

Waterworks management in the Republic of Sierra Leone started in 1950 under the Ministry of Works. In 1974, the Water Supply Division (WSD) was reorganized and transferred to the Ministry of Energy and Power and had responsibilities for both urban and rural water supplies. Recently, reinforcement of this organization is receiving special support from the government. In January 1986, the newly inaugurated President, General Joseph Saidu Momoh, initiated new policies for administrative simplicity and efficiency. Therefore, the Ministry of Works and the Ministry of Energy and Power were unified to form the new Ministry of Works, Energy and Power (MWEP). Under this new ministry, WSD continues to promote the policies which have advanced water supplies around the country.

The water supply of Freetown is managed by an enterprise called Guma Valley Water Company (GVWC), and all other towns and villages are directly handled by WSD. However due to topographic and geologic conditions, water is difficult to acquire during the dry season even in areas with high annual precipitation rates, and in some areas, difficulties arise even in the rainy season. Consequently, supplying safe and stable water seasonally and locally to small villages scattered around the country is no easy task. Particularly, health problems resulting from poor quality water are eminent as can be witnessed from the outbreak of cholera, which started at the end of 1985 and is still affecting the population. A joint survey of Sierra Leone's Ministry of Health and WHO reported that this epidemic has strong correlation with water supplies. Under these circumstances, the nation's 75% rural population are in the situation of not being able to receive a supply of clean potable water.

As a result, in 1981, utilizing the opportunity afforded by the "International Drinking Water Supply and Sanitation Decade", the Sierra Leonean government established the "National Action Plan for Water Supply and Sanitation" with support from UNDP, WHO and others. Furthermore, water

supply projects are being promoted as part of the Integrated Agricultural Development Projects (IADPs) which center upon the rural population. Also, the water supply policy is given priority in the Second National Development Plan (1982 - 1986).

Therefore, the Sierra Leonean government submitted a request for Japanese grant aid to construct supply facilities using both surface water and groundwater. Two districts (Bombali and Kambia) in the Northern Province were selected based on the fact that, though this area is significant for agricultural development, water supply is extremely deficient, but that water resources development is favorable and accessibility is good.

In response to the request, a basic design study team headed by Mr. Hiroshi Igarashi, Chief of 2nd Construction Section, Construction Division, Extension Department, Water Works Bureau, Sapporo Municipal Government, was formed through the Japan International Cooperation Agency (JICA) and was dispatched to Sierra Leone from February 14 to March 15, 1986. The team carried out a survey to confirm the request, background, scope and effect of the project, and to determine its feasibility for implementation under the Japanese grant aid program. During the process of the survey, other rural water supply projects being promoted by the Sierra Leonean government were analyzed and the project in relation to others was evaluated. The results of the site survey were analyzed in Japan and organized into this Basic Design Study Report. The report contains sections on the optimum facilities design, selection of required equipment and materials, project cost estimation, plan for operation and maintenance, as well as project feasibility, and recommendations on future rural water supply projects. The minutes of meeting, field survey itinerary, list of study team members and visited persons list are included in Appendices.

CHAPTER 2 PROJECT BACKGROUND

CHAPTER 2

PROJECT BACKGROUND

2-1 Outline of Sierra Leone

Sierra Leone is located along the Atlantic Ocean Coast between 6°55' and 10° north latitude and between 10°15' and 13°20' west longitude, with a land area of 71,740 km^2. To the north, a boundary of 639 km is shared with Guinea, and a border of 254 km with Liberia is formed in the south. The country is composed of flatlands below 100 m - 1,950 m above sea level in the eastern side, with the highest point of 1950 m located at Bintumani Mountains. Nine main river systems originating from the mountains in the eastern and north-eastern parts flow throughout the whole country and drain out into the Atlantic Ocean to create the characteristic geography of Sierra Leone.

The population of the country in 1985 was about 3.7 million persons. The male-female ratio was about 50-50 and the density was about 52 persons per km^2.

The gross national product (GNP) of Sierra Leone in 1983 was $1.23 billion, with an annual average growth rate of 1.8% in the past 10 years. However, the per capita GNP was $380 which indicated a 0.3% annual decrease. The trade balance in 1982 was $111 million in exports and $298 million in imports with a deficit of $187 million. The trade balance with Japan in 1984 was $2,000 in exports as opposed to $7.47 million in imports.

Since its independence from Britain in 1961, Sierra Leone's economy has been depending on the trade of mineral resources and agricultural products such as coffee and cocoa. The former's share in the contribution to the country's revenues has been quite large, but the government is beginning to put more stress on the latter, particularly boosting rice crops, in order to prevent possible decrease in

mineral resources in the long-term forecast. This policy of increasing agricultural production is now a strategy with top priority in the National Development Plan of the country, firstly to achieve a self-sustaining supply condition and eventually to earn hard currency by exporting the excess.

Such a policy necessarily needs encouraging rural inhabitants, which account for 75% of the country's population, who are responsible for that task by funneling a variety of incentive programs, among which the water supply project has particularly been underscored by the government. This year, the newly inaugurated President Momoh has also announced new policies on such topics as highly efficient administration, private sector utilization and tax system reform, and those on water supply administration are continuously being promoted.

2-2 National Development Plan

The First National Development Plan (1975-1979), which started in 1975, was extended to 1980. The Second National Development Plan (1982-1986) ended in June, 1986. In succession, the Third Plan is now under consideration.

Since the First Plan and continuing on through the Second Plan, the Sierra Leonean government has proposed the following long-term aims.

- Political and economic stabilization
- Improvement of welfare of the population
- Expansion of income and wealth
- Acceleration of economic growth
- Intensification of economic relations as member of the Organization for African Unity (OAU)

In accordance with these goals, the Second National Development Plan has accelerated the objectives listed below.

- Recovery and stabilization of finance and economy
- Reduction of reliance on non-renewable resources
- Elevation of living standards in the rural sector and implementation of integrated rural development
- Advancement of agricultural development
- Promotion of local enterprise and fostering of technical skills
- Diversification of mining products

Within the above objectives, agricultural development as an important policy to counter the decrease in mining production, and policies to raise the living standards of rural inhabitants, who form the nucleus of agricultural activities, are being aggressively accelerated. Since the role of rural water supply projects is highly appraised, international cooperation gives high priority to these projects.

In the commencement year of the Second National Development Plan, 1981, with support from UNDP and WHO, a National Action Plan on water supply and sanitation was drawn up in accordance with the UN's Water Supply and Sanitation Decade from 1981 to 1990. Targetted for 1990, this Action Plan has objectives of supplying clean and safe water and improving sanitation facilities for the rural inhabitants, which account for 75% of the total population of about 3.7 million, who are living in about 17,000 villages.

2-3 Water Supply Situation

2-3-1 Present Situation of Domestic Water Supply

Presently in Sierra Leone, the heavily populated, urban and semi-urban type villages use surface water sources. This water is treated and transmitted through pipelines to public water stands.

On the other hand, the rural villages having small populations use groundwater from shallow wells and surface water from springs and swampholes. These waters are used directly without any treatment.

Sierra Leone has a high rate of rainfall. However, this is concentrated in the rainy season and during the dry season, the water level of rivers and groundwater lower drastically, The water level lowering in traditional hand-dug wells and also in the concrete-lined shallow wells constructed fairly deep by WSD produce conditions in which intake becomes difficult or impossible.

For rivers having possibility of intaking a required amount of water regularly throughout the year even if water level lowering occurs, contamination from external sources is pronounced. Therefore, supplying safe water without treatment is difficult. Furthermore, the water quality of swampholes, which are most susceptible to contamination, is very poor. Under these conditions, upon consideration of the scale merits for operation and maintenance of constructed facilities (served populations from a few thousand to over ten thousand), large villages are striving for supplies of clean water through piped systems which include treatment facilities.

For small villages, since many of them are using traditional shallow wells and swampholes with concurrent intake difficulties during the dry season, the inhabitants are subject to health hazards from contamination. Therefore, WSD is planning and constructing sanitary, concrete-lined shallow wells which are

drilled to depths where water level lowering during the dry season will not affect intake. However, these depths are limited due to the construction method, a long implementation period is needed, and budget and equipment are insufficient, and therefore, the well construction works are being executed by assistance from international organizations.

WSD uses the standards of WHO for water supply planning. As for daily per capita water supply rates, the goals are 45-135 ℓ for the urban sector having piped supplies, and 20-30 ℓ for those using groundwater. However, the actual situation is a low 27 ℓ for the urban population and under 10 ℓ for rural inhabitants without water supply facilities. While goals for water quanitity are set, more importance is placed on water quality. As a consequence, even if quantity is insufficient, WSD is planning and accelerating the stable supply of clean and safe water.

In particular, water supply facilities are being improved in line with the proposal of the Ministry of Health which advocates the need for safe water supplies as a countermeasure against water borne epidemics which show signs of becoming chronic. According to a report by the Ministry of Health, the number of diarrhoeal patients succeed those for helminthiasis and malaria, and the number of patients suffering from the cholera epidemic which started at the end of 1985 has surpassed 1,000 persons. This indicates that improvement of water supply facilities has strong relationships with sustained good health as can be witnessed from the decrease in child death rates and increase in life expectancies.

Table 2-1 Child Death Rate and Life Expectancy

Year	Child Death Rate	Life Expectancy at Birth
1960	41 %	37 Years
1980	30 %	49 Years

2-3-2 Organization of Water Supply Administrition

The water supply administration in Sierra Leone has been controlled exclusively by the office of the Water Supply Division (WSD) since its establishment under the Ministry of Works in 1950. This ministry was reformed into the Ministry of Works, Energy and Power (MWEP) in 1986 under the new President. The water service to five hundred thousand citizens in the national capital of Freetown is independently managed by a public corporation named Guma Valley Water Company (GVWC) on the basis of a special undertaking account. The company runs a sophisticated water supply system consisting of a series of reservoirs and treatment plants. With the exception of this case for Freetown, the public service to all other urban and rural areas across the country are undertaken by WSD in every resepct of planning, construction and management of the supply systems. As part of the integrated agricultural and rural development programs of the Ministry of Agriculture and Natural Resources (MANR), operation and maintenance of water supply facilities are handled by this ministry. With respect to personnel, including the 132 employees at the MWEP headquarters, a total of 1,053 persons are working at all offices including the seven regional branch offices. Under WSD management, 40 urban towns and 35 rural communities are benefiting from the services.

2-3-3 Water Supply Development Plan

Water supply development plans are being advanced by the Sierra Leonean government based on the "National Action Plan for Water Supply and Sanitation", which was established in 1981. This plan aims to supply clean and safe water by 1990 and sets goals for served populations as follows.

Table 2-2

Served Population Ratios

Population	1981	1986	1990
Whole Country	14.2%	33 %	75 %
Rural	2	20	70
Urban	50	65	100

However, for the rural population, the actual situation is that only 5% will be able to receive drinking water even after completion of the on-going projects through foreign aid. In this predicament, projects to reinforce rural water supplies in accordance with self-effort movements are being executed through bilateral and international cooperations.

Since water resources development is important for water supply planning, focusing on the development potential of groundwater in Sierra Leone and its economics, the significance of hydrogeological studies is evident. However, as a result of deficiencies in equipment, materials and budget, the execution of these studies on a full scale basis is long overdue.

The priority ratings of project implementations, concentrating on inhabitants of rural villages, intermediate towns and urban fringe dwellings, are based on the following criteria.

(1) Maintenance of existing water supply facilities

(2) Support of economic activities in agriculture and industries

(3) Higher priorities to areas stricken with drought

(4) Higher priorities to largely populated areas

The criteria for facilities selection are listed below.

Table 2-3

Facilities Selection according to Site Scale

Site Scale	Facilities Plan
Rural villages and intermediate towns with over 1,000 persons	Piped water supply system with public water stands, using well water or treated river water
Rural villages with below 1,000 persons	Point-source water supply facilities with hand pumps, using well water
Urban towns with over 2,000 persons	Piped water supply system with public water stands, using treated river water
Urban towns with 2,000 to 10,000 persons	Piped water supply system with public water stands, using treated river water

Note: House connections are also planned for large urban communities.

Based on the above policies, at each of the national, regional and village levels, reinforcement of water supply facilities is strived for, but as can be seen in Table 2-4 (though this is from a survey carried out in 1981), attainment of these goals is not easy.

Table 2-4

Number of Communities without Potable Water

(1981)

Population	Southern Province	Eastern Province	Northern Province	Western Area	Whole Country
T o t a l	5,061	4,076	7,982	252	17,371
Below 200	4,458	3,401	6,800	215	14,874
200 - 499	487	440	976	27	1,930
500 - 999	92	150	162	7	411
1,000 - 1,499	13	43	27	2	85
1,500 - 1,999	6	19	8	0	33
2,000 - 2,999	4	8	5	0	17
3,000 - 4,999	1	12	4	1	18
5,000 - 9,999	0	3	0	0	3
Above 10,000	0	0	0	0	0

2-4 Overseas Cooperation

In order to promote water supply projects in Sierra Leone, technical and economic cooperations are being carried out by the United Nations, World Bank, EEC, West Germany, France, Great Britain and other international organizations. The on-going rural water supply projects being implemented with overseas financing are listed in Table 2-5. These projects are continuously being implemented on a long-term basis.

The Rural Water Supply Project to construct facilities using surface water and groundwater in areas having significance for development was requested to the Japanese government. Area-wise as well as planning-wise, this project will not compete or interfere with other projects.

2-5 Outline of Request

The project requested to the Japanese government was drawn up by the Sierra Leonean government in 1981. This project is being promoted as a component of the National Action Plan for Water Supply and Sanitation. The objectives of the project are to improve the rural water supply situation and, for this purpose, to reinforce and construct water supply facilities.

Many of the rural inhabitants are confronted with shallow wells prone to constant contamination from the periphery, and water level lowering and drying up during the dry season, making the wells difficult to use. On the other hand, directly used surface waters such as streams and swampholes are highly polluted and therefore, the villagers using these untreated waters are jeopardizing themselves.

Table 2-5

On-going Rural Water Supply Projects through Overseas Cooperation

Country or Organization	Project Name	No. of Wells	Project Area	Project Period
UNDP	Rural Water Supply Programme	225	Koinadugu District	1980 ~ 1986
UK	Rural Water Supply Project	*	Western Area and Eastern Province	1984 ~ 1987
UNCDF	Eastern Area Rural Water Supply	150	Kenema, Kailahun and Kono Districts	1985 ~ 1987
ILO/ DANIDA	ILO/DANIDA Wells Programme	64	Kambia and Bonthe Districts	1982 ~ 1988
EEC	Rural Water Project	140	Port Loko and Kambia Districts	1984 ~ 1988
UNDP/UNV	Strengthening Rural Water Supply Unit	**	Freetown and others	1986 ~ 1989

* Spring utilization project

** Organiztion reinforcement project

In this respect, Bombali and Kambia Districts, which are also the implementing areas of the Integrated Agricultural Development Projects, are the project areas for the requested Rural Water Supply Project. To provide a stable supply of clean and safe water, the construction of surface water supply facilities including treatment and groundwater supply facilities using borehole type wells was proposed. Furthermore, a supply of equipment and materials such as well drilling rigs is especially included in order that Sierra Leone can construct, operate and maintain groundwater supply facilities on its own after the project. With a benefiting population estimated at 50,000 persons, the requested project is outlined below.

(1) Construction of surface water supply facilities : 2 sites
(Treatment systems, pumps, pipes, vehicles, etc. and their spare parts)

(2) Construction of groundwater supply facilities : 200 sites
(Borehole type wells, hand pumping facilities)

(3) Supply of equipment and materials for construction of groundwater supply facilities and well constructions to be performed by the Sierra Leonean side themselves after completion of the project
(2 sets of well drilling rigs, related ancillaries, casing pipes, well screens, hand pumps, vehicles and their spare parts)

CHAPTER 3 PROJECT AREA OUTLINE

CHAPTER 3

PROJECT AREA OUTLINE

3-1 Project Area

The government of Sierra Leone proposed that villages in the Bombali and Kambia Districts of the Northern Province be selected as the sites for project implementation. WSD prepared a long list of 294 villages from the two districts for this project. From this long list, representative sites were preevaluated through discussions with WSD, and were surveyed.

The only site selected for surface water utilization was Rokupr in the Kambia District. However, villages for groundwater development were not specified, and therefore, within both Bombali and Kambia Districts, upon consideration of hydrogeology, population, existence and kinds of water supply facilities, and operation and maintenance during project implementation, a total of 142 sites, of which 124 sites in Bombali District and 18 sites in Kambia District, were finally selected as project implementation sites. The number of project sites in each District is summarized in Table 3-1.

Table 3-1
Project Sites according to Water Source

Area	Surface Water as Water Source	Groundwater as Water Source
Bombali District	0	124
Kambia District	1	18
Total	1	142

Though the roads from Freetown, where WSD is located, to the project sites have some portions in bad condition, limiting factors such as permissible loads for bridges and road widths will not present any problems for passage of vehicles including well drilling rigs during the implementation of the project. Both district capitals will function as base camps where support can be obtained from branch offices of WSD. Furthermore, importance will be placed on water supply to educational and medical facilities which will also be included in the planning.

3-2 Natural Conditions

3-2-1 Geography and Topography

Of the project area, Bombali District is situated between 8°40' and 9°55' north latitude and between 11°45' and 12°35' west longitude, with a land area of about 7,700 km^2. In the northern part of the district, mountains standing above 100 m in altitude are found and in other parts of the district are flatlands between 50 and 100 m above sea level. With the Kamakwie-Pendembu-Makeni-Magburaka road as the dividing line, on the north side of this line are rocky mountains and on the south side are flat and low river terraces and swamps. In Bombali District, three rivers, the Great Scarcies, Little Scarcies and Rokel, all flow out into the Atlantic Ocean.

Kambia District is located between 8°50' and 9°35' north latitude and between 12°20' and 13°20' west longitude, and covers an area of about 3,000 km^2. This district is mostly flatlands below 50 m above sea level with villages scattered atop hills and lowlands of river terraces and swamps. The main rivers are the Great Scarcies in the north-west forming the boundary with Guinea, and the Little Scarcies in the east, both flowing out into the Atlantic Ocean.

3-2-2 Meteorology

Sierra Leone has a tropical climate divided into the rainy season caused by the monsoons and the dry season with the advent of the harmattan winds. The rainy season generally occurs from May to October, and the dry season prevails from November to April. The average annual precipitation rate is high from 2,000 mm in the north to 5,000 mm along the coastline. The monthly rainfall fluctuations are depicted in Fig. 3-1. The annual average temperature is about 26.5°C with little monthly average temperature fluctuations.

The climate in the project area is summarized in Table 3-2. The monthly average precipitation rates, temperatures and humidities of Makeni, representing Bombali District, and Rokupr, representing Kambia District are indicated in Tables 3-3 and 3-4, respectively.

Table 3-2

Climate of Project Area

Average Annual Precipitation	Duration of Rainy Season	Annual Average Temperature	Average Humidity
2,000-3,500 mm	5 months	26-31°C	Feb. 40-50% Aug. 80-90%

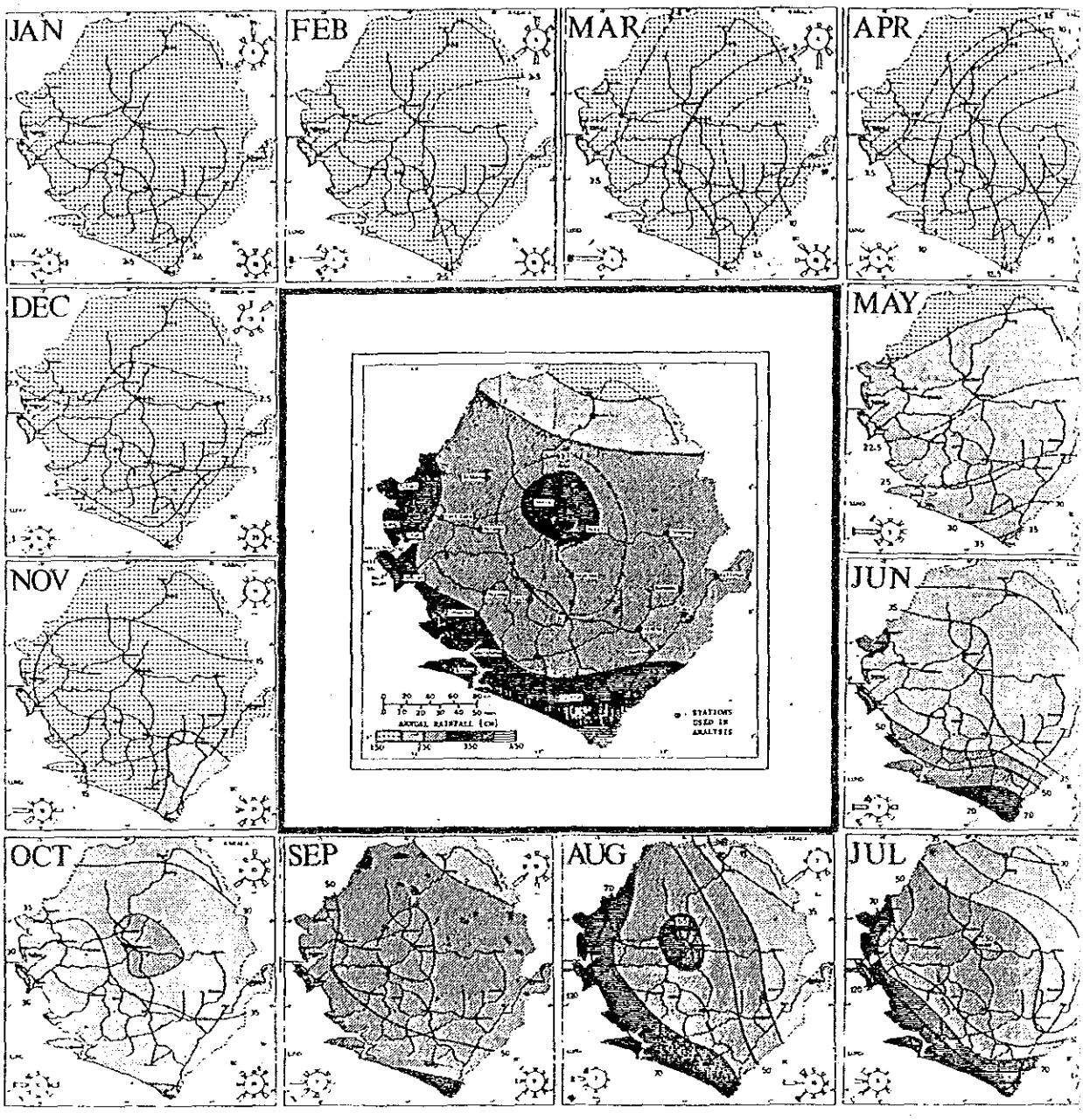


Fig. 3-1

Monthly Precipitation Fluctuations

Table 3-3

Meteorological Conditions of Makeni, Bombali District

I t e m	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	No. of Years	Final Year
Avearge Rainfall (mm)	7	9	31	89	228	388	488	658	531	419	195	31	2,282	45	1981
Average Temperature (℃)	30	32	34	33	32	30	29	28	29	30	31	31	31	—	—
Average Humidity (%) 9:00	90	87	84	85	91	91	93	94	92	91	90	88	90	25	1969
15:00	47	43	44	51	63	69	75	81	74	70	67	57	61		

Table 3-4

Meteorological Conditions of Rokupr, Kambia District

I t e m	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	No. of Years	Final Year
Avearge Rainfall (mm)	5	2	13	61	185	356	587	729	501	368	144	19	2,970	47	1982
Average Temperature (℃)	26	27	28	28	28	27	26	25	26	27	27	26	27	25	1964
Average Humidity (%) 9:00	88	88	84	82	84	89	92	92	91	88	88	86	88	15	1964
15:00	53	49	53	56	66	73	80	83	79	71	68	56	66		

3-2-3 Geology and Hydrogeology

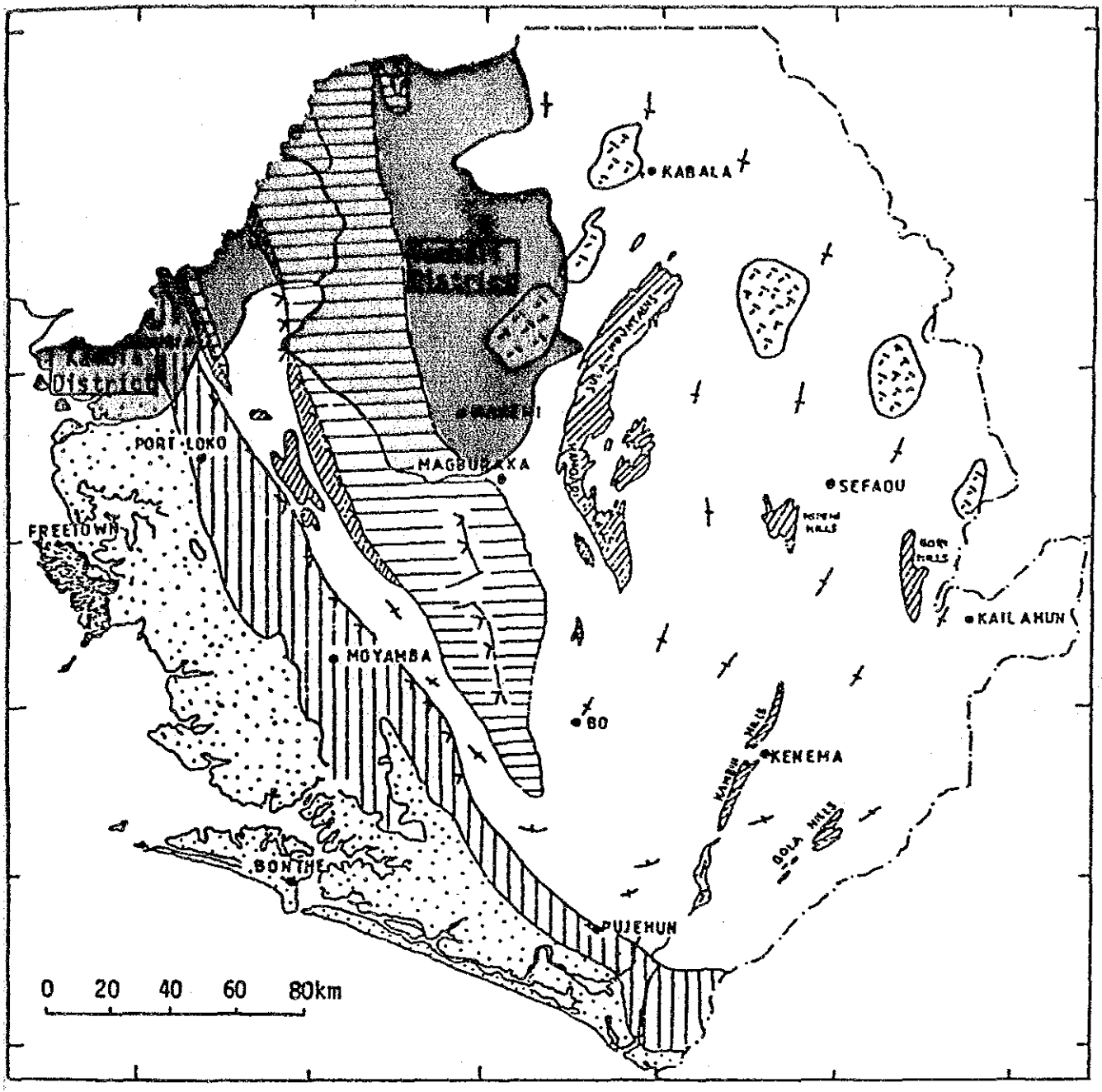
1) Stratigraphic Characteristics of Sierra Leone

The geology of Sierra Leone can be divided broadly into two categories. The first one, which covers 3/4 of the country, is the hard, metamorphic rocks of the Precambrian period forming the basement of Africa's continental block and distributed in the interior mountain areas. The second one covering the remaining 1/4 is the sedimentary layer of Tertiary to Quaternary Pleistocene formation distributed along the coastal lowlands. Both formations are distributed as wide belted layers mostly parallel to the coastline. The geological distribution of Sierra Leone is shown in Fig. 3-2 and the stratigraphy is indicated in Table 3-5.

The basement rocks of the Precambrian period can be classified into six groups by facies and age as, (1) granites, (2) Kasila Series, (3) Marampa Group, (4) Kambui schists, (5) granite-migmatite complex and (6) Rokel River Group. Furthermore, a layer of the Saionia Scarp Series formed by Ordovician sediments is distributed in the northern part of Bombali District, and a Bullom Series sediment layer of the Tertiary to Quaternary Pleistocene epoch having a width of 30-40 km is found along the coast. Then, basic intrusive rocks of the Triassic-Jurassic period are distributed in the Western Area.

2) Stratigraphic Characteristics of Bombali District

The geology of Bombali District is composed of the Rokel River Group in the western half and the granite-migmatite complex in the eastern half, with a small distribution of granites and the Saionia Scarp Series. The characteristics and groundwater development potentials of the Rokel River Group and granite-migmatite complex are the same as those for Kambia District and will be discussed later. The geological features of the Saionia Scarp Series are described below.



Bullom Series
(Tertiary-Quaternary Pleistocene)

Basic Intrusive Rocks
Freetown Complex
(Triassic-Jurassic Period)

Saionia Scarp Series
(Ordovician Period)

Rokel River Group
(Precambrian Period)

Precambrian Period

Granites

Kambui-Sula Schists

Kasila Group

Granite-Migmatite Complex

Thrust

Fig. 3-2 Geologic Map of Sierra Leone

Table 3-5 Stratigraphy of Sierra Leone

Age	Formation	Description
Holocene	River terraces, Laterite, Swamp sediments	Sands, Gravels, Clays
Pleistocene ⟆ Eocene	Bullom Series	Marine and river sediments, Sands, Gravels, Clays
Jurassic ⟆ Triassic	Basic intrusive rocks Peninsular Complex	Gabbro, Norites
Silurian ⟆ Late Ordovician	Saionia Scarp Series	Horizontal conglomerates
Late Precambrian	Rokel River Group with Kasawe Hill Formation	Conglomerates, Mudstones, Orthoquartzite, Tuff
	Unconformity	
Precambrian	Granites Kasila Series Marampa Group Kambui Schists Granite-Migmatite Complex	Schists, Gneiss, Metamorphic rocks

Saionia Scarp Series

This layer is distributed only in a small portion to the north of Bombali District, and is composed of sediments of conglomerates, arkoses, etc. and quartzites. The horizontal layer has about a 180 mm thickness. Many springs are found along the boundary between crystal rocks and siltstones, and groundwater development potential is high.

3) Stratigraphic Characteristics of Kambia District

Since the administrative division of Kambia District extends from the western coastline inwards towards the east, most of the geologic layers distributed parallel to the coast traverse this district. The geological characteristics of the formations in this district are explained hereafter.

Bullom Series

This layer is distributed to about 30 km inland from the coast, and consists of marine and fluviatile clays and sand sediments. The thickness becomes 150 m near the coast. Near the surface, a laterite layer of 10-15 m thickness is found. The water storage ability of this laterite layer is low, but judging from the thickness, the total storage amount may be large, and this layer along with the sand layer make good aquifers for groundwater development. However, during the dry season, rainfall decreases which reduces river flow, and salt water intrudes to about 50 km inland causing seawater penetration into the groundwater (see Fig. 3-3 for the limit of seawater intrusion). The results of geoelectric prospecting analysis at point No. 33 is given below and the measurement points are plotted in Fig. 3-4 (source: S.C. Jayakaran, 1985).

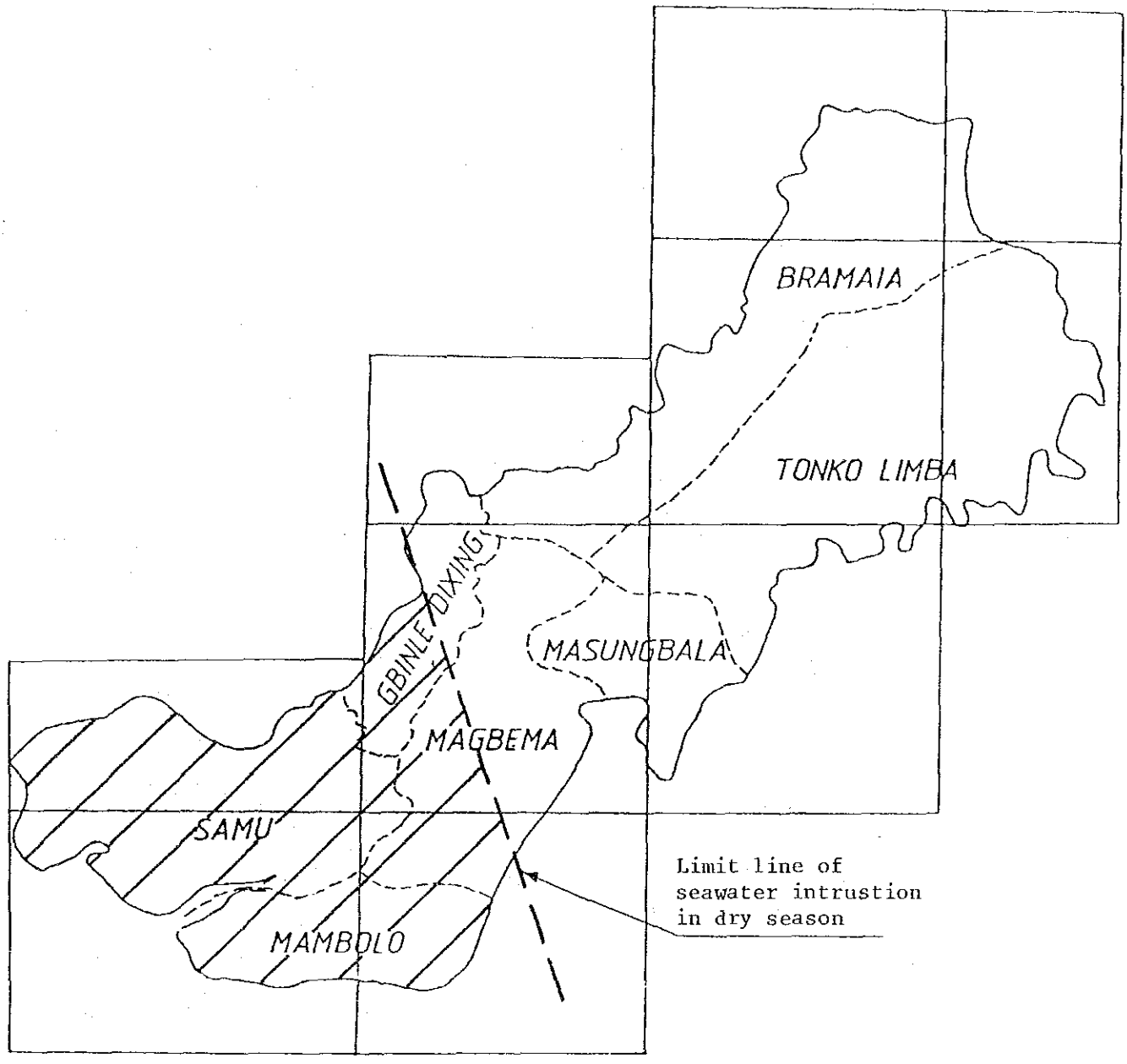


Fig. 3-3

Limit of Seawater Intrusion in Kambia District

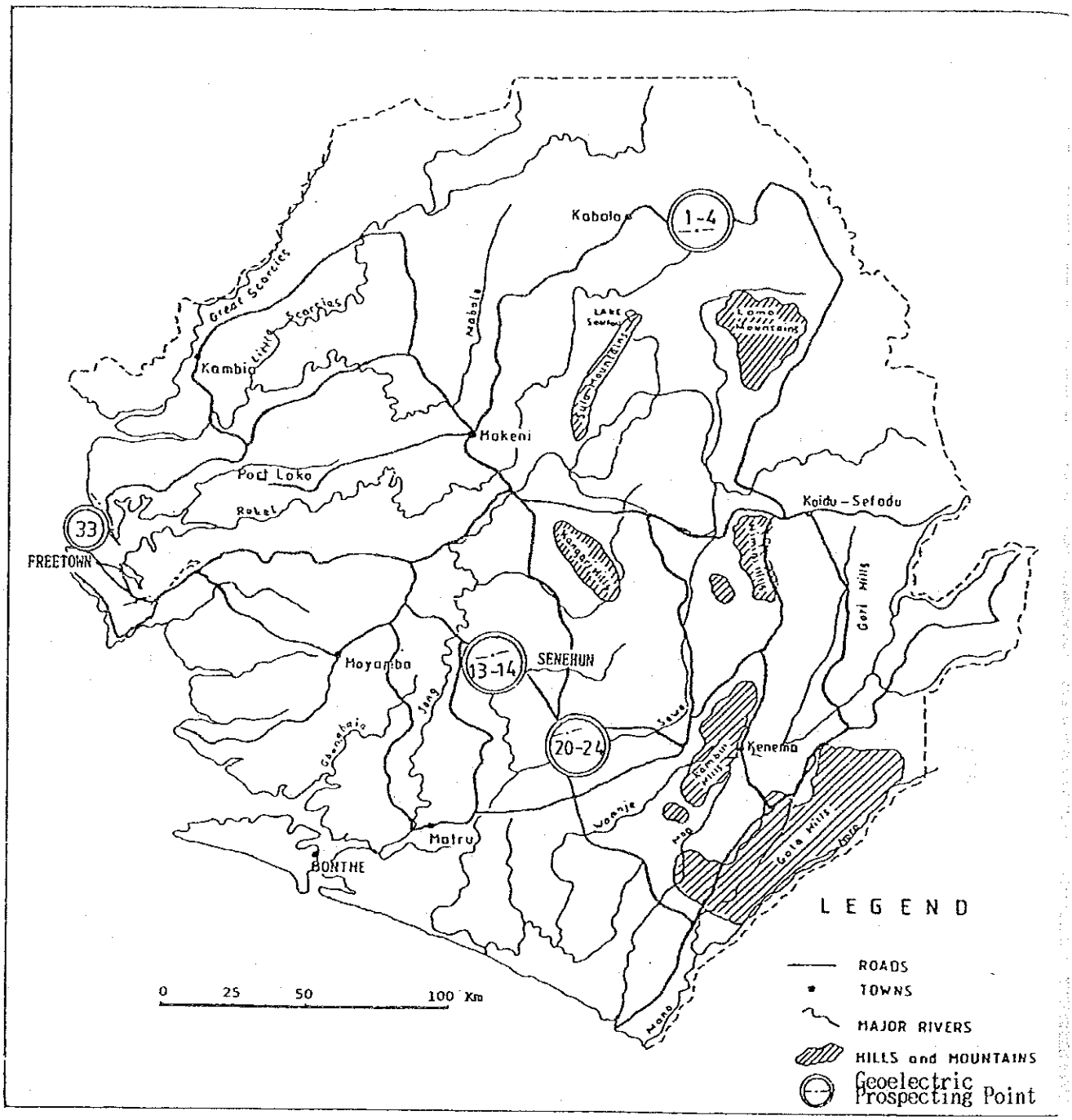


Fig. 3-4
Geoelectric Prospecting Points
(Source: S.C. Jayakaran, 1985)

Layer	Depth (m)
Top laterite (dry)	0.0 - 1.1
Laterite (aquifer)	1.1 - 6.5
Sand (aquifer)	6.5 - 13.2
Clay	13.2 - 19.8
Block crystalline rock	Below 19.8

Kasila Group

This group is distributed about 10 km further inland than the Bullom Series, and is made up of schists, gneisses, migmatites and granulites. These rocks are hard and dense that only the weathered sections near the surface become fissures where groundwater can exist. Therefore, this aquifer is poor for groundwater development.

Granite-Migmatite Complex

This formation is distributed near the center of Kambia District, and laterite covers the surface underlain by a highly weathered granite layer. The rocks are cracked due to aggresive tectonic movements. As an aquifer, groundwater development potential is very low. The results of simple flow rate testings on existing wells at geoelectric prospecting points No. 1-4 and No. 20-24 revealed pumping rates of 3 m^3/hr and 9.8 m^3/hr, respectively.

Kambui-Sula Schists

This layer is distributed with a narrow belt formation in the central part of Kambia District. Schists are the main rocks, and groundwater exists in the surface laterite layer and fracture zones. The schists of the Kambui Group, especially the Marampa Group which possesses abundant spring water, are excellent aquifers with high potential for groundwater development.

Rokel River Group

This group is mainly distributed around the north-eastern part of Kambia District. The layer is composed of shale sediments containing metamorphic folded clays, silts and sandstones; igneous rock sediments of arkose, etc.; and volcanic rocks such as tuffs and andesite lava. In general, the layer is inclined. Groundwater in a confined or semi-confined state mainly exists in the sandstone layer, due to the existence of shale and clay layers. As a result, groundwater development potential is highest in comparison to other formations of Sierra Leone. The results of analysis on geoelectric prospecting carried out at Senehun (No. 13-14) are indicated below.

Layer	Depth (m)
Sand-gravel	0.0 - 0.6
Shale (dry)	0.6 - 9.0
Shale (existence of narrow aquifer)	9.0 - 56.0
Crystalline rock	Below 56.0

4) Groundwater Development Potentials of Bombali and Kambia Districts

The characteristics and groundwater development potentials of the layers in Bombali and Kambia Districts are summarized in Table 3-6. Of these, the Rokel River Group, Kambui-Sula Schists and Saionia Scarp Series have high potential for groundwater development. Therefore, these three layers are the most appropriate aquifers for this project.

Table 3-6

Geologic Layers and Groundwater Development Potentials of Bombali and Kambia Districts

District	Layer	Groundwater Development Potential
Bombali	1. Rokel River Group	Very high
	2. Granite-migmatite complex	Low
	3. Granites	Low
	4. Saionia Scarp Series	High
Kambia	1. Bullom Series	High (however, saltwater intrusion in dry season)
	2. Kasila Group	Low (saltwater intrusion in dry season in some areas)
	3. Granite-migmatite complex	Low
	4. Kambui-Sula Schists	High
	5. Rokel River Group	Very high

3-3 Socio-Economic Situation

3-3-1 Ethnic Groups and Population

Sierra Leone is inhabited by 18 main ethnic groups. The largest of these, Temne and Mende, each occupy about 30% of the total population. In the project area of Bombali and Kambia Districts, with Temne leading the list, Limba, Susu and Lokko groups are settled here.

In the 1985 population census, the total population of Sierra Leone was about 3.52 million persons, but due to possible under enumeration, the government adjusted this figure upwards by 5% for a total of 3.7 million people. The male-female ratio for the whole country is about 50-50. The population density is about 52 persons/km^2.

The population of Bombali District is about 330,000 persons and for Kambia District, about 200,000 persons. The annual growth rates since the previous census are 3.2% for Bombali District and 2.2% for Kambia District. The male-female ratios are about 48% male to 52% female for both districts. The population densities are 43 persons/km^2 for Bombali District and 65 persons/km^2 for Kambia District. The populations for both districts as well as the whole country from the last three censuses are listed in Table 3-7.

Table 3-7
Populations

	1963	1974	1985
Bombali District	199,000	234,000	332,000
Kambia District	138,000	155,000	196,000
Sierra Leone	2,180,000	2,735,000	3,700,000

3-3-2 Administrative Divisions

The local administration of this country is executed in accordance with administrative divisions as follows. The Western Area is a special division in which the capital city of Freetown is situated and the remaining part of the country is divided into three Provinces of Northern, Southern and Eastern, which are subdivided into twelve Districts. As shown in Table 3-8, the smallest administrative units are called Chiefdoms, which number at 147. The Chiefdoms in Bombali and Kambia Districts are listed in Table 3-9.

Table 3-8
Administrative Divisions of Sierra Leone

Province	District	No. of Chiefdoms
Northern	Bombali	13
	Kambia	7
	Koinadugu	11
	Port Loko	10
	Tonkolili	11
Southern	Bo	15
	Bonthe	11
	Moyamba	14
	Pujehun	12
Eastern	Kono	14
	Kailahun	13
	Kenema	16
W e s t e r n A r e a		

Table 3-9

Chiefdom Names in Project Area

District	Chiefdom
B o m b a l i	1 Biriwa 2 Bombali Sebora 3 Gbanti Kamaranka 4 Libeisaygahun 5 Magbaiamba 6 Makari Gbanti 7 Paki Masabong 8 Gbendembu Gowahun 9 Safroko Limba 10 Sanda Tenraran 11 Sanda Loko 12 Sela Limba 13 Tambakha
K a m b i a	1 Gbinle Dixing 2 Bramaia 3 Magbema 4 Mambolo 5 Masungbala 6 Samu 7 Tonko Limba

3-3-3 Rural Economics

Since Sierra Leone is blessed with mineral resources, economic activities are centered around mining, generating almost half of the export revenues. In 1982, 290,000 carats of diamonds were produced, which ranked 9th in the world. Iron ore (42,000 tons), bauxite (610,000 tons) and other minerals are also produced.

On the other hand, since about 75% of the population rely upon agriculture for their livelihood, agriculture is also significant for the economy of Sierra Leone. However, agriculture occupies only about 30% of the GDP (gross domestic product) and yields low profits. In as much as rice is the staple diet and has high dependence on imports, self-sustaining food production is being strived for, which implies that agricultural productivity will become a big topic in the near future.

The economies of Bombali and Kambia Districts also rely on agriculture. Oil palm and rice are mainly produced in both districts. In Kambia District, the Rokupr Rice Research Station, supported by WARDA, makes research on developing improved methods for swamp and upland rice production.

As part of the National Development Plan, the government is promoting various Integrated Agricultural Development Projects (IADPs) around the country. Of these, the Northern Area IADP includes Bombali District with main aims to develop swamp and upland rice, increase production of groundnuts, construct feeder roads and erect health centers. Kambia District is included in the Northwestern Area IADP which has objectives of coastal and swamp rice development, and production increase of cashew nuts and onions. Domestic water supplied to the rural inhabitants through the present Rural Water Supply Project will complement the IADPs being promoted in both districts.

3-4 Present Situation of Water Resources

3-4-1 Areas Using Surface Water Sources

Semi-urban type villages use surface water from relatively large streams which is treated before use. Most villages having small populations use other surface waters such as streams and swamps without treatment. These waters are easily susceptible to contamination with resultant turbidity due to unsanitary environmental conditions such as breeding livestock inside the village perimeter.

The only site to use surface water in this project is Rokupr. With consideration of existing water sources and future plans, groundwater needs to be developed with attention paid to seawater intrusion.

Generally, villages using surface water from large rivers have small populations and intake points are far away. If the distance to the water source is short, such as the cases for streams and swamps, many sources have problems with water quality which require treatment facilities, but the village scale is usually too small to organize a system of operation and maintenance for the facilities. Past projects implemented with overseas cooperations have established the recipient population as a few thousand to over ten thousand, but problems such as reduced operating hours, leakage and break-downs still occur. However in Rokupr, the needs for the daily market is high; the villagers' active participation with understanding of water supply works is anticipated; and the existence of the Rokupr Rice Research Station with many engineers will contribute to the management of the water supply system to be constructed by this project, by offering personnel, bearing part of the expenses and other assistances.

3-4-2 Areas Using Groundwater Sources

Groundwater of Sierra Leone exists in various patterns according to the hydrogeology. Since Sierra Leonean concerns are familiar with unconfined groundwater owing to their past experiences, this will be primarily used for this project and confined aquifers can be considered in the future.

The existing wells are of the traditional shallow type or the concrete-lined shallow wells constructed under government projects. Some villages differentiate their wells into drinking and miscellaneous uses. However, the construction methods and equipment employed have resulted in many wells not being drilled to required depths, and therefore, water level lowering during the dry season makes pumping difficult or impossible. As a consequence, many villagers must travel 5-6 km to obtain a supply of clean water. To avoid this situation, borehole type wells drilled to depths deep enough to prevent contamination and conceive year round pumping will be constructed in this project.

3-4-3 Water Quality

Samples of surface water and groundwater were collected from various locations to be analyzed for water quality determinations. The drinking water standards of WHO, Japan and U.S.A. are shown in Table 3-10. The results of analyses are listed in Table 3-11, which reveal that the sampled waters are generally of good quality.

Table 3-10 Drinking Water Quality Standards

Item		WHO	Japan	USA
pH	(—)	7.0 ~ 8.5	5.8 ~ 8.6	—
Chloride	(mg/ℓ)	200	200	250
Total Iron	(mg/ℓ)	0.3	0.3	0.3
Manganese	(mg/ℓ)	0.1	0.3	0.05
Fluoride	(mg/ℓ)	1.0	0.8	2.0
Total Hardness	(mg/ℓ)	500	300	—
NH_3-N	(mg/ℓ)	0.5	Not detected at same time	—
NO_2-N	(mg/ℓ)	—		—
NO_3-N	(mg/ℓ)	40	10	45
Coliform Count		MPN < 10	0/50 mℓ	Positive<10%

Table 3-11a Water Quality in Project Area

Item	Rokupr	Rokupr	Rokupr	Binkolo	Binkolo	Kambia	Mabole
Sampling Location	Intake Point	Near Intake	Faucet	#1 IADP Well	#2 IADP Well	Shallow Well	IADP Well
pH (—)	6.0	6.0	6.0	5.8	6.4	6.2	6.6
Chloride (mg/ℓ)	15	20	15	20	25	20	25
Total Iron (mg/ℓ)	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Manganese (mg/ℓ)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluoride (mg/ℓ)	0.5	0	0.5	0.6	0	0	0
Total Hardness (mg/ℓ)	15	10	25	35	70	25	100
Alkalinity (mg/ℓ)	15	20	20	15	25	10	50
NH_3 −N (mg/ℓ)	< 0.4	0.5	< 0.4	< 0.4	0.8	0.5	0.5
NO_2 −N (mg/ℓ)	< 0.006	0.02	< 0.006	0.01	0.01	0.02	0.02
NO_3 −N (mg/ℓ)	< 0.23	—	< 0.23	0.03	45	5.0	30
Coliform Count (N/mℓ)	0	2	0	0	19	0	40
Conductivity (μ℧/cm)	93	18	161	192	155	50	180
Water Temperature (℃)	19.0	28.8	18.5	19.0	23.8	25.5	25.0

Table 3-11b Water Quality in Project Area

Item	Kalangba	Kalangba	Kalangba	Lunsar	Lunsar	Makari	Kamabai
Sampling Location	Village Chief's Well	IADP Well	Well near Stream	Secondary School Well	Primary School Well	Shallow Well	Spring
pH (—)	5.8	6.6	6.0	6.0	5.8	5.8	6.0
Chloride (mg/ℓ)	15	25	10	10	15	20	15
Total Iron (mg/ℓ)	< 0.2	10	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Manganese (mg/ℓ)	< 0.5	0.3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluoride (mg/ℓ)	0.6	0.8	0	0	0.5	0.6	0.6
Total Hardness (mg/ℓ)	15	200	5	15	10	35	5
Alkalinity (mg/ℓ)	10	210	5	10	0	15	10
NH_3 −N (mg/ℓ)	< 0.4	5.0	0.5	0.5	< 0.4	< 0.4	< 0.4
NO_2 −N (mg/ℓ)	0.01	0.02	0.02	0.02	< 0.006	0.01	< 0.006
NO_3 −N (mg/ℓ)	0.3	1.0	1.0	7	< 0.23	0.03	< 0.23
Coliform Count (N/mℓ)	0	34	2	2	0	0	1
Conductivity (μ℧/cm)	118	—	21	39	204	192	80
Water Temperature (℃)	19.0	26.0	25.5	25.0	19.5	19.0	19.5

Table 3-11c Water Quality in Project Area

Item		Makari	Makari	Tambiama	Mapaki	Mapaki	Makump Bana
Sampling Location		Shallow Well	IADP Well	Well w/ Handpump	Rokel River	Faucet	IADP Well
pH	(—)	5.8	6.0	6.2	6.0	5.8	6.0
Chloride	(mg/ℓ)	20	20	25	10	15	25
Total Iron	(mg/ℓ)	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2
Manganese	(mg/ℓ)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluoride	(mg/ℓ)	0.6	0.5	0	0.8	0.3	0
Total Hardness	(mg/ℓ)	35	35	90	20	10	25
Alkalinity	(mg/ℓ)	15	10	40	30	15	10
NH_3 −N	(mg/ℓ)	< 0.4	0.4	0.4	< 0.4	< 0.4	0.5
NO_2 −N	(mg/ℓ)	0.01	0.02	0.02	< 0.006	< 0.006	0.02
NO_3 −N	(mg/ℓ)	0.03	30	30	< 0.23	< 0.23	15
Coliform Count	(N/mℓ)	0	0	2	0	0	2
Conductivity	(μ℧/cm)	192	101	131	122	56	83
Water Temperature	(℃)	19.0	23.5	24.0	19.0	19.0	25.0

CHAPTER 4 PROJECT DESCRIPTION

CHAPTER 4

PROJECT DESCRIPTION

4-1 Objective

The objective of this project is to establish the water supply systems which enable stable water supply both in quantity and quality for rural areas in Sierra Leone. This can be carried out by installing water supply facilities which include pumping facilities, treatment plants, storage tanks and distribution facilities for the communities using surface water sources(one site, Rokupr in Kambia District) and drilled wells of borehole type with pumping facilities to those tapping groundwater sources (124 sites in Bombali District; 18 sites in Kambia District), in the Northern Province, as part of the rural water supply program directly undertaken by the government of Sierra Leone. In addition, basic equipment and materials will be supplied for continuation of well drillings by WSD themselves under their organization.

Moreover, an on-the-job training program will be provided to WSD during the project implementation. This program will involve technology transfer on geoelectric prospecting, well siting, well drilling rig operation, well completion and other aspects of well construction.

4-2 Confirmation of Requested Project

4-2-1 Project Sites

To ensure reliable water resources, the project sites were selected by first analyzing the sources from hydrological and hydrogeological viewpoints; then, considerations were made on the populations, existence and kinds of water supply facilities, and operation and maintenance problems during project implementation. The number of sites selected in each Chiefdom are listed in Table 4-1. These are indicated for Bombali District in Fig. 4-1 and for Kambia District in Fig. 4-2.

Table 4-1
Number of Project Sites by Chiefdom

Water Source	District	Chiefdom	No. of Sites
Surface Water	Kambia	Magbema	1
	Total		1
Groundwater	Bombali	Bombali Sebora	11
		Gbanti Kamaranka	6
		Libeisaygahun	31
		Makari Gbanti	25
		Gbendembu Gowahun	11
		Sanda Tenraran	24
		Sanda Loko	2
		Sela Limba	3
		Tambakha	11
		Subtotal	124
	Kambia	Bramaia	4
		Masungbala	3
		Tonko Limba	11
		Subtotal	18
	Total		142

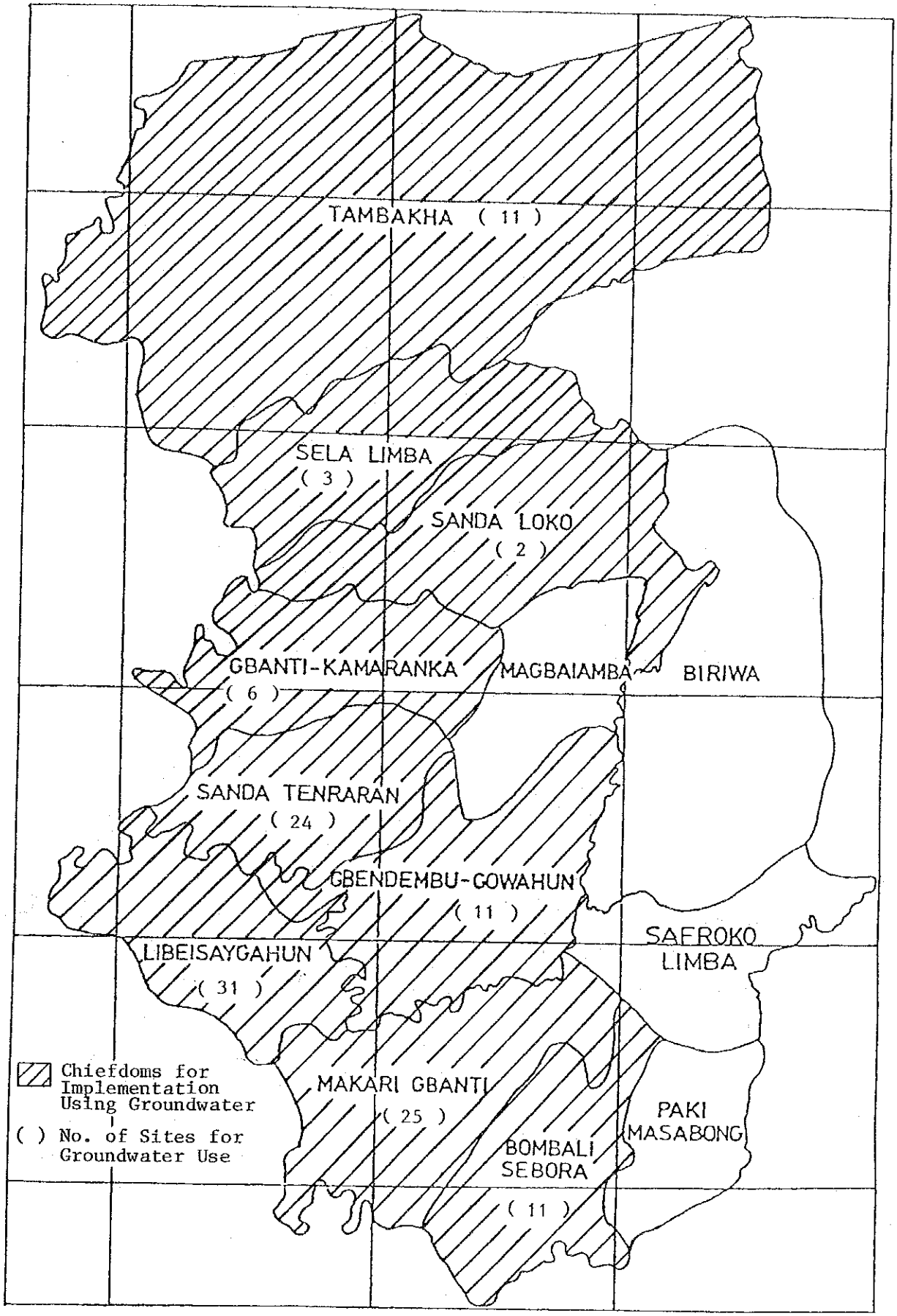


Fig. 4-1 Feasible Sites in Bombali District

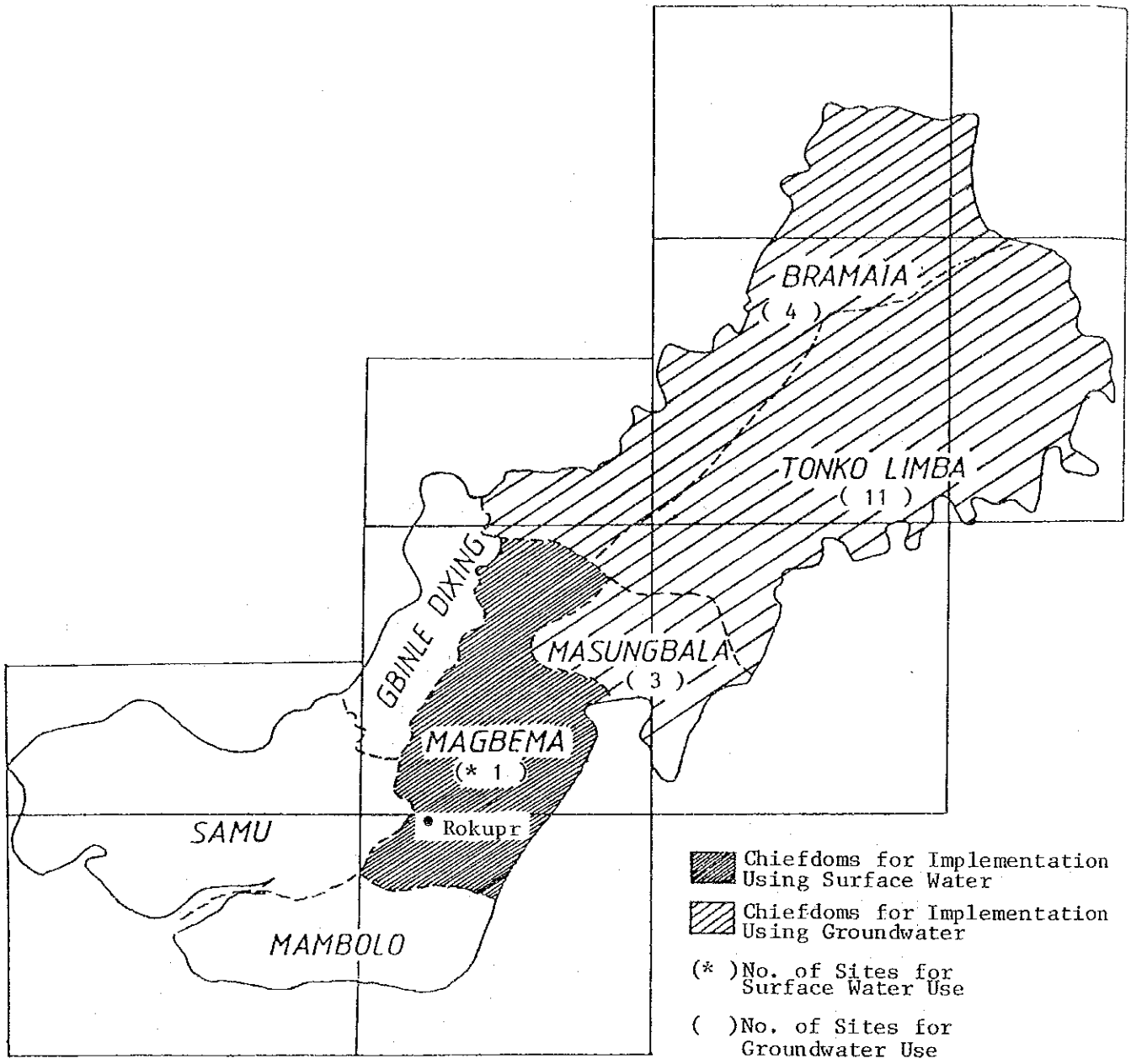


Fig. 4-2

Feasible Sites in Kambia District

For many villages using surface water, the populations are so small that operation and maintenance would be difficult. Furthermore, even for sites having completed facilities with consideration of scale merits, their operating situations are crucially hampered by financial aspects.

4-2-2 Using Surface Water as Water Source

The only site planned for using surface water is Rokupr in Kambia District. Water of this site is satisfactory in quality and sufficient in quantity. Accessibility during the construction stage will not present any problems. Since the existing facilities constructed in the 1940's are old and worn out, rehabilitation of these facilities will be combined with construction of new facilities, and the project needs to be implemented without stopping the operation of the existing facilities.

The project sets a goal of 50 ℓ/person/day in accordance with WSD's standard for surface water use. Therefore, the design water supply rate is 580 m^3/day. The served population is 11,600 persons.

Other than the 2 sites originally requested, an alternative of 3 sites was also suggested during the field survey. However, with the exception of Rokupr, sites were rejected due to reasons such as not having scale merits, abnormally long distances to water sources and difficulties with management. Moreover, Rokupr conforms to the priority rating set in the guidelines of the National Action Plan.

The possiblities for self-effort by the villagers during the project and satisfactory operation and maintenance are high as was explained in a previous section of this report. Therefore, this site is evaluated to be feasible for project implementation.

The existing facilities at Rokupr consist of an intake dam, pumping facilities, pipelines and storage tank. As a surface water supply system, treatment facilities are not available, and as a result, since the end of 1985 with the outbreak of the cholera epidemic, the inhabitants in this area are placed in an exceedingly dangerous situation.

Therefore, a treatment system which includes a simple disinfection unit is necessary. Even when the raw water in highly turbid, treatment is possible with a conventional system consisting of coagulation, sedimentation and filtration. Furthermore, to cope with the seasonal fluctuations in water quality and to minimize the expenses, a treatment system without chemical dosing is also possible.

The existing two reciprocating pumps were installed in the 1940's. One of them is completely broken and the other one is barely functioning, since procurement of spare parts is extremely difficult due to the model being too old. In consequence, new pumps are urgently needed. Moreover, the existing pipelines, mainly of asbestos, are badly deteriorated and also need to be renewed when extensions are made to new distribution areas. However, fortunately, the intake dam and storage tank can still be used . The water supply plan for surface water utilizing the above facilities is outlined below.

Total System Flow : Intake-Pumping-Transmission-Treatment-Storage-Distribution

Intake Facility : Renovated

Pumping Facility : Renovated

Transmission Pipe : Renovated

Treatment System : Newly installed

Storage Tank : Existing

Distribution Pipe : Renovated, newly installed

Distribution Facilities : Renovated, newly installed

4-2-3 Using Groundwater as Water Source

Finding groundwater sources for domestic water use in both Bombali and Kambia Districts is not difficult. With the exception of a portion of Kambia District where seawater intrusion must be considered, water quality is generally good and can be used for this project. The WSD's request for villages having populations between 100 and 2,000 persons is used as the standard for site selection. Therefore, since there is a limit on the population that can be served by one well, some villages may require more than one well to meet their demands.

The number of sites for project implementation was selected after careful analysis of the hydrogeological conditions in the two districts. As was discussed in a previous section, the layers having the highest potential for groundwater development in the project area are the Rokel River Group, Kambui-Sula schists and Saionia Scarp Series, which are consequently, the most suitable layers for this project. The Bullom Group and Kasila Group in Kambia District are difficult for groundwater development, due to saltwater intrusion during the dry season when river flow decreases.

From the long list of villages prepared by WSD for this project, those located in areas of high groundwater development potential, were relisted. As a result, 124 sites in Bombali District and 18 sites in Kambia District for a total of 142 sites were selected for implementation of well construction.

However, considering the present conditions of hydrogeological data, determining the number of well drillings from the relationship between the well production rate and the per capita water demand of villagers is not realistic. Therefore, based on Sierra Leone's rural water supply policy of constructing as many safe water points as possible and that existing facilities may be available, the general rule of one well per village will be adopted for this project. Furthermore, since the well drilling efficiency due to the country's hydrogeological conditions is about 80%, the equipment and materials to be supplied must be planned with consideration of these factors.

For this project, confined groundwater from borehole type wells will not be used at this moment. In comparison to easily polluted hand-dug shallow wells which dry up in the dry season, WSD has been constructing large diameter shallow wells with sanitary concrete-lining, aiming towards a stable supply of water. However, even these wells have pumping difficulties in the dry season due to insufficient depths resulting from inadequate drilling methods. Consequently, in order to reach depths sufficient for year round stable pumping (at an average depth of 35 m), borehole type wells which can be constructed within a short period are suitable, and these are constructed to prevent contamination from the periphery. For pumping from these wells, hand pumps are appropriate for handling within the policy of VLOM.

At a total of 142 sites, water supply facilities which include borehole type wells and hand pumps will be constructed. That is, 142 wells will be drilled. However, since an allowance of about 20% for unsuccessful wells, which originate from hydrogeological reasons, will need to be taken, the actual number of wells to be drilled will be 177. Upon consideration of geologic conditions, about 4 days is required to drill each well.

Taking into account the allowed project period within the grant aid program and the rainy season, the period for the construction stage in each phase will be 6 months, which will total 18 months when all 3 phases are combined. Assuming the acutal working days as 25 days, the number of drilling rigs and teams required during the 18 month period to drill 177 wells is calculated below.

$$\frac{4 \text{ (Required drilling days/well)}}{25 \text{ (Actual working days/month)}} \times 177 \text{ wells} = 28.3 \text{ months}$$

$$\frac{28.3 \text{ months}}{18 \text{ months}} = 1.57 \text{ months} \longrightarrow 2 \text{ teams (or 2 rigs)}$$

This implies that 2 teams using 2 rigs are needed to complete the well drillings of this project. However, in consideration of the inefficient work conditions during the early stage of works, unusual work pace required while transferring technology through on-the-job training and project phasing, the well drilling program shown below will be feasible.

Table 4-2
Well Drilling Team Program

	Phase 1	Phase 2	Phase 3	Total
Newly Introduced Team	1 rig 1 team	1 rig 1 team	None	
Total Team in Operation	1 rig 1 team	2 rigs 2 teams	2 rigs 2 teams	
Number of Wells to be Drilled	31	70	76	177

4-2-4 Selection of Equipment and Materials for Well Construction

Borehole type wells suitable for the formations having high groundwater development potential are specified as, average drilling depth of 35 m (maximum depth is 50 m) and well diameter of ϕ150. Rigs, tools and ancillaries, as well as other equipment, vehicles and materials needed to construct these wells are planned by considering Sierra Leone's Present conditions and future development possibilities of confined groundwater.

1) Drilling Rigs

Analysis of the hydrogeological conditions in the project area is very important for selection of drilling rigs and related ancillaries, since these are the main equipment and materials for borehole type well construction.

According to the hydrogeological analysis, the layers of high gorundwater potential in both Bombali and Kambia Districts are as follows.

a. Rokel River Group : A consolidated sedimentary layer (The sandstone layer is considered as the aquifer between impermeable shale layers. Depths down to about 50 m.)

b. Kambui-Sula Schists : A consolidated rock layer (Fissure water is found betwee cracks and fractures. The range of layer depth is uncertain, but groundwater flowing in relatively upper layer is considered.)

The formation (a.) above occurs widely in both districts, and this layer can be drilled with either percussion or rotary type rigs. However, for the rock formation (b.), a percussion rig cannot be used, and a rotary rig, especially of top-head drive type using an air hammer with compressor is most appropriate. Therefore,

the latter equipment is suitable for both layers, and further, this can be used even when a hard consolidated, granite layer, which is widely distributed in both districts, is to be developed. Furthermore, providing a sufficient amount of tools and standard ancillaries such as swivel, kelly, mud pump, measuring devices, valves, pipes, wire rope and hose is essential.

2) Materials for Well Construction

The materials such as casing pipes, well screens and hand pumps are required for construction of groundwater supply facilities. Casing pipes and well screens are the main items for well construction and hand pumps are important for intake and supply of water.

The diamer of the casing pipe must be appropriate for installation of the hand pump, while at the same time, the spacing between the outside diameter of the pump and the inside diameter of the casing pipe must be considered to minimize the hydraulic head loss. Considering that the pump outside diameter is 90-147 mm, the casing pipe must have an inside diameter of 150 mm. The pipe material will be steel.

To intake groundwater effectively, the larger the opening ratio of the well screen, the better. Steel wire-wound screens of 15% efficiency with the same diameter as the casing pipe will be used.

Assuming an average pumping rate per well of 5 m^3/day, the pumping water levels of each well are different. Therefore, the pumps will be specified with a range of 10 to 40 ℓ/min at 10 - 30 m head. These are selected with simple operation and maintenance for VLOM in mind.

The above figures were considered with phasing of works in mind.

3) Machinery, Vehicles and Materials for Construction

In this project, after commencement of construction works by the Japanese side and with sufficient technology transfer, the works will be handed over to the special task force of WSD. Therefore, as a result of evaluation of WSD's present situation, the machinery, vehicles and materials required for each of the two well drilling teams of this project are determined. Geoelectric prospecting and logging are indispensable for determination of aquifers from hydrogeological and well engineering viewpoints.

The objective of the pumping test apparatus is to collect quantitative data on the pumping situation of the completed well. This set is supplied with a submersible pump for continuous pumping possibilities, in consideration that the accumulated data will be useful for Sierra Leone's groundwater development in the future.

The workshop truck, workshop machinery, servicing machine and other related equipment are essential not only during well construction, but also for operation and management of completed facilities. These are not all-purpose type equipment and machineries, but are appropriate for this project.

Since the telecommunication situation of Sierra Leone is very poor, wireless radio sets are vital for transmitting instructions to the sites, ordering required materials, informing unexpected accidents and other pertinent communications. Both stationary and mobile type sets are considered.

The supplied equipment and materials will be used by WSD for the completed facilities as well as the well constructions to be implemented after the project. The success of operation and maintenance of these facilities will largely depend on the supply of spare parts, and therefore, selection will be made so that the parts are in compliance with each equipment and machinery within each phase.

4-2-5 Depot Candidate Sites

A candidate site in Kissy, a suburb of Freetown, was surveyed for possibility of using it as a depot for maintenance and storage of the equipment and materials needed to carry out the construction works for water supply facilities using both surface and groundwaters. The plot is a government owned property with an area of about 4,500 m^2, and accessibility for transporting in and out of equipment and materials is good. Moreover, a regional depot candidate site common for both Bombali and Kambia Districts is also available.

4-3 Project Outline

4-3-1 Executing Agency and Implementing Structure

The executing agency for this project is WSD. This office has responsibilities for every aspect of public water supply including planning, construction and management to all urban and rural areas except Freetown. In particular, this organization has accumulated experince in groundwater utilization by constructing many concrete-lined shallow wells. Although hydrogeological analyses are essential for construction of wells, fortunately, the Land and Water Development Division (LWDD) of the Minsitry of Agriculture and Natural Resources (MANR) has this capability and is available to assist in this project on these matters, and a special task force is formed for this purpose. The organziation for execution and implementation of this project is shown in Fig. 4-3.

The Sierra Leone government is organizing personnel for the technology transfer to be provided during the project implementation. Judging from the circumstances encountered during this training period, the government will recruit, increase and reinforce their staff for the well constructions to be carried out by themselves using the equipment and materials to be supplied by this project.

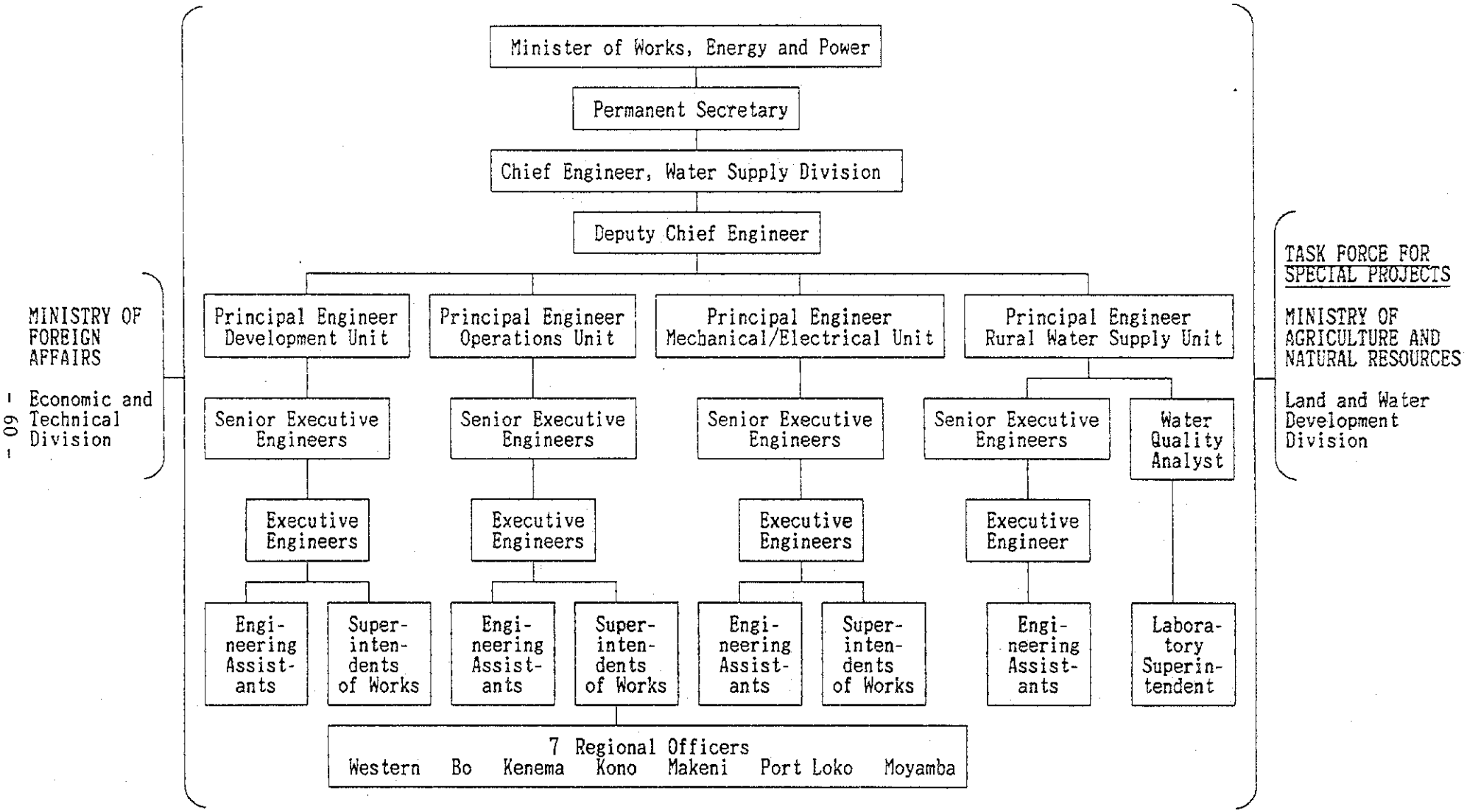


Fig. 4-3 Organization of Rural Water Supply Project

Personnel Required during Construction Stage (Special Task Force)

Function	No.	Responsibility	Position
Project Manager	1	Both surface and groundwater portions	Current WSD water supply engineer (Senior engineer)
Project Engineer	1	Surface water portion	Current WSD water supply engineer (Senior engineer)
Hydrogeologist	1	Groundwater portion	Current MANR hydrogeologist (actively working in cooperation with WSD) (Senior hydrogeologist)
Assistant Hydrogeologist	1	Groundwater portion	WSD water supply engineer (Junior engineer)
Plumber Apprentice	2	Hand pump installation; Groundwater supply facilities construction	Current WSD shallow well drilling team and from regional office
Driller Apprentice	4	Well drilling apprentice	Current WSD shallow well drilling team and from regional office

Personnel Required during Operation and Management Stage

- For operation and management of the surface water portion, personnel will be incorporated into the regular organization of WSD. Personnel presently working on Rokupr's water supply undertakings can be continuously employed. Though a drastic scale increase in this project will not occur, staff increase is necessary, and WSD is planning the recruitment of personnel. As for technical level, since WSD and its regional offices have a staff experienced in management of surface water works, finding qualified personnel in not a problem, without the necessity for new recruitment.

- Operation and maintenance of the groundwater portion is divided into 2 categories: one for the water supply facilities constructed in this project, and the other for the borehole type wells to be constructed with the supplied equipment and materials. The operation and management of the completed water supply facilities using borehole type wells will be conducted by regular staffs of WSD. However, though special guidance and assistance on handling of parts for hand pumps and other materials will be provided by WSD, the routine operation and maintenance will be carried out by the villagers themselves in striving for VLOM. The well constructions with the supplied equipment and materials after the project will be continuously managed by the special task force organized during the project.

4-3-2 Outline of Facilities and Equipment

1) Facilities for Surface Water Use

For communities using surface water sources, piped water supply systems with treatment facilities will be constructed. Only Rokupr of Kambia District is scheduled for these facilities. In this village, water supply facilities constructed in the 1940's are existent. For this project, in addition to rehabilitation of these existing facilities, a comprehensive system consisting of facilities for intake, treatment, storage and distribution will be constructed. Since the existing facilities are antiquated, careful attention must be paid to the rehabilitation and specialized technology in water supply systems is essential for total planning.

(1) Intake Facilities ϕ350 (580 m^3/day) × 1

For intake of water, existing facilities will be used as much as possible. The intake unit will be able to prevent intrusion of minute foreign objects when pumped up and reduce the load on the treatment facilities as much as possible.

(2) Pumping Units

ϕ100 multi-stage centrifugal pump	× 3
ϕ100 centrifugal pump	× 2
60 KVA diesel generator	× 2
35 KVA diesel generator	× 2

Pumps will be of the above-ground installed type. If the project site does not have sufficient power supply, self-powered diesel generators will be used. A system of minimum unit operation during break-down will be planned. The pumps and generators will be installed inside the machinery house.

(3) Pipings

With the exception of pipings around facilities, pipelines will be installed underground with a total length of 5.5 km. Selection of the transmission line will be made to minimize the high pumping head loss resulting from long horizontal distances and large ground level difference between the intake point and distribution areas. The transmission pipeline diameter will be 100 - 200 mm and the distribution diameter will be 65 - 200 mm.

(4) Treatment System

With consideration of the construction period and local conditions, a compact unit system of coagulation, sedimentation and filtration is planned as the treatment plant. This system will also conform to the phasing plan considered for this project. Moreover, filter media and coagulants will also be supplied.

(5) Storage Tank

The existing elevated water tank (135 m^3) will be used for storing water before distribution.

(6) Distribution Network

Since the existing distribution network, except for a portion, cannot be utilized, a new network must be installed. Distribution of water will be possible through public water stands having 3 to 6 taps and considering future pipe extensions by self-effort on the part of the inhabitants, branching points will be constructed at necessary locations.

2) Facilities for Groundwater Use

For villages using groundwater sources, borehole type wells and supply facilities will be constructed. Wells having average depths of 35 m at 142 sites are planned for this project. Equipment, machinery and materials necessary for WSD to continue the construction works even after completion of the project will be supplied with consideration of well drilling efficiency. Moreover, a training program will be prepared during the project implementation for technology transfer on siting and construction of wells to the special task force to be organized by WSD.

CHAPTER 5 BASIC DESIGN

CHAPTER 5

BASIC DESIGN

5-1 Basic Concepts

The water supply facilities for this project are designed on the basis of the policies of the Sierra Leonean government which are compiled into the "National Action Plan for Water Supply and Sanitation". In order to suit the local conditions and to avoid over specifications, planning is carried out upon consideration of factors such as the hydrogeological conditions and water use situations of the project area, as well as management of completed facilities. For planning of facilities and equipment, realizing that phasing is necessary, self-accomplishment is possible with effects for each phase. This project will not only construct facilities, but also includes technology transfer during the project period and thereafter the Sierra Leonean side will continue to implement the works on their own using the equipment and materials supplied in the project. Therefore, since the project will also contribute to water resources development being accelerated by Sierra Leone, considerations are made on the organization of staff, and equipment and materials.

5-2 Design Conditions

Standards of BS, WHO, AWWA, etc. were formerly used as standards for facilities of water supply projects by WSD, but presently, WHO standards are mainly adopted, and therefore, this project will also be based on these standards. The design population of Rokupr, the only site for surface water planning, is obtained by using the growth rate of 3.4% with a design period of 15 years. The 142 sites for groundwater planning have present populations of 100 to 2,000 persons, but growth rates and design periods are not considered. The design water supply rate is set at 50 ℓ/cap/day for communities using

surface water sources. For groundwater planning, taking into account that the average well production rate is about 5 m^3/day, the supply rate is determined by placing importance on a stable supply of clean water. The project is planned for completion within the schedule allowance of the grant aid system and consideration of the rainy season.

5-3 Facilities Plan

5-3-1 Plan for Surface Water Use

Facilities using surface water will be constructed only a Rokupr in Kambia District. Facilities planning is based on WSD standards with careful consideration of local conditions and existing facilities. Rokupr possesses a piped water supply system with public water stands. A market is held daily and the Rokupr Rice Research Station, schools and other institutions are also existent. The program for facilities construction with the relation to phasing is depicted below.

Intake Facility	Pumping Facility	Transmission Pipeline	Treatment System	Storage Tank	Distribution Facilities
(Renew)	(Renew)	(Renew)	(New)	(Exist)	(Renew & New)
Phase 1			Phase 3	Phase 2	

Phase 1 : The existing pumps are in such a catastrophic condition that early installation of new pumps is especially needed. Therefore, the pumps along with the intake facility and transmission lines will be installed during this phase. With these facilities, the village located 3 km away with a ground level difference of 22 m from the intake point can benefit from improved transmission of water. Also, disinfection, which is also included in this phase, will permit local supply

of clean water.

Phase 2 : From the existing elevated storage tank, pipelines to distribute water to the villagers will be installed. As a result, areas having old facilities will be revitalized and new areas will be opened up to receive the benefits.

Phase 3 : The treatment units will be installed which will allow a supply of safe and stable water even if the raw intake water is highly turbid.

The water supply system consists of facilities for intake, transmission, treatment and distribution with related pipings as was described above. The basic flow of this system is illustrated in Fig. 5-1.

5-3-2 Plan for Groundwater Use

Water supply facilities consisting of borehole type wells and hand pumps will be constructed at 142 sites. Consequently, siting of well drilling points must be carried out at villages selected as result of careful hydrogeological analysis. The process for construction of water supply facilities using groundwater is presented in Fig. 5-2.

Sierra Leone is promoting groundwater development by geoelectric prospecting and large diameter shallow well drillings with cooperation from international organizations. Promotion of groundwater development is also anticipated in this project in which geoelectric prospecting techniques will be used to make sufficient analyses of groundwater potential, aquifer depths and other basic hydrogeological conditions.

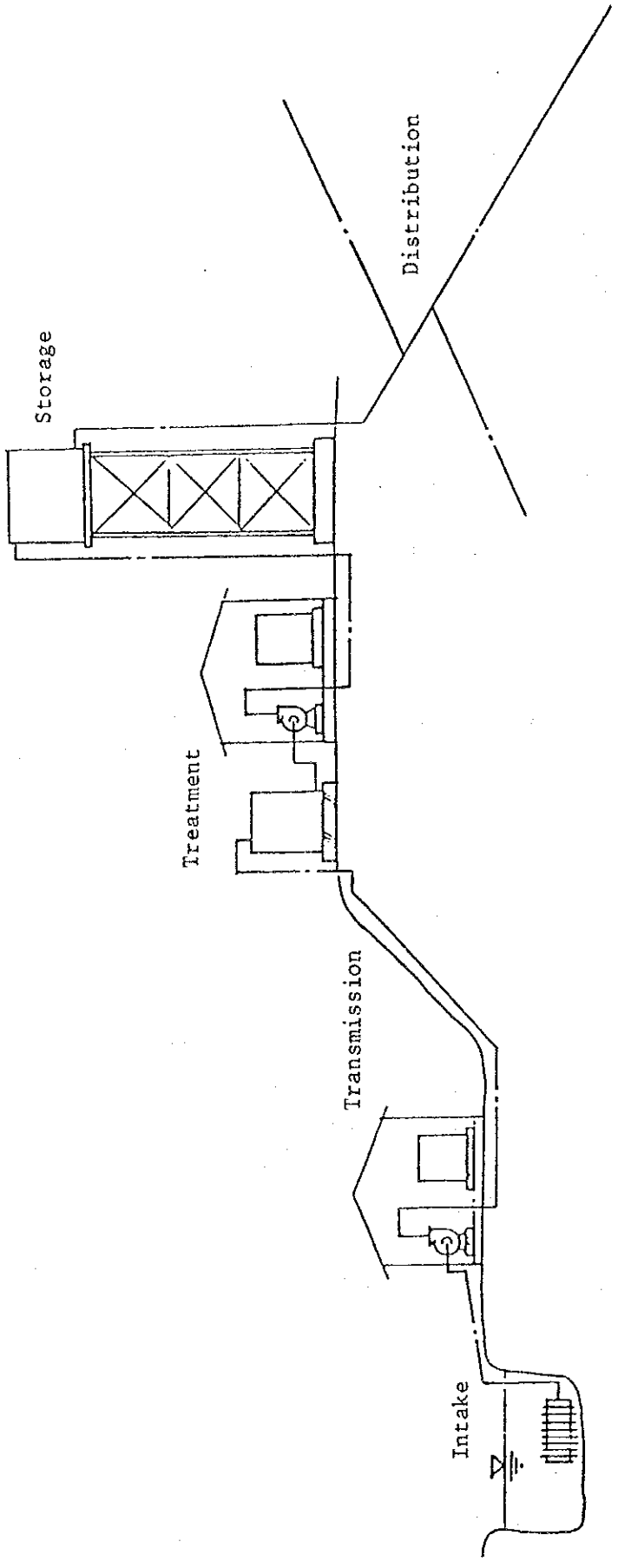


Fig. 5-1
Flow of Facilities for Surface Water Use

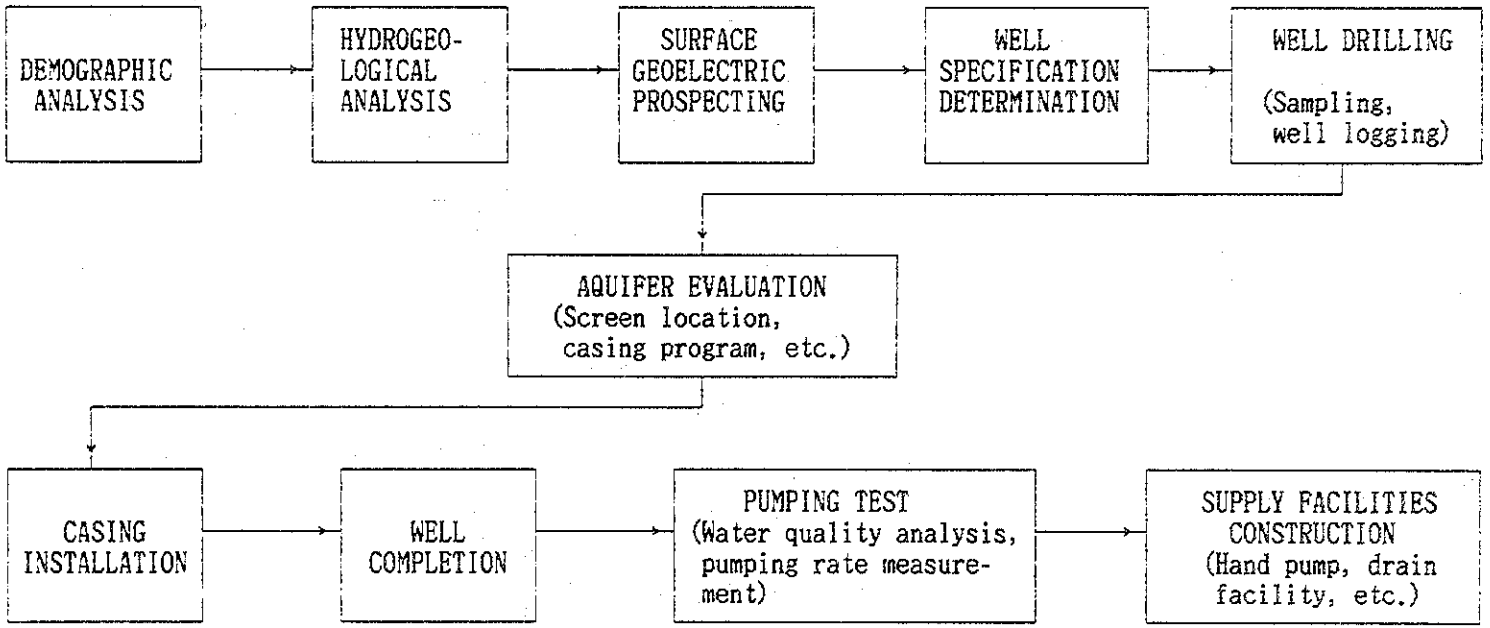


Fig. 5-2

Process Flow for Water Supply Facilities Construction Using Groundwater

The construction works is divided into the portion to be completely constructed by the Japanese side, and the portion to be performed by WSD after completion of the Japanese portion. The water supply facilities of point-source type will consist of borehole type wells with hand pumps, concrete slabs and drain pits constructed with equipment and materials supplied by the Japanese grant. A simplified arrangement of the facilities is depicted in Fig. 5-3.

The equipment and materials to be supplied for the construction works include drilling rigs, vehicles and materials for temporary works. Furthermore, materials for the Japanese construction portion, those for WSD's construction portion as well as consumables which will be needed during the construction stage will also be supplied.

Since facilities will be constructed at 142 sites, the number of well drillings will also be 142. However, as was explained previously, assuming that 20% will be unsuccessful, the required drillings will be 177 wells. Depending on hydrogeological conditions, since judgment on success or failure can be made on about half of the number before installing casing pipes, well screens and other materials, the relationship between the number of well drillings and required materials is indicated below.

Table 5-1
Number of Well Drillings

		Phase 1			Phase 2			Phase 3			T o t a l		
		W	J	T	W	J	T	W	J	T	W	J	T
Successful Wells (80%)		25	–	25	25	31	56	30	31	61	80	62	142
Unsuccessful Wells (20%)	Decide before Setting (10%)	3	–	3	3	4	7	4	4	8	10	8	18
	Decide after Setting (10%)	3	–	3	3	4	7	3	4	7	9	8	17
T o t a l		31	–	31	31	39	70	37	39	76	99	78	177

N.B.: W = With training team, J = Japanese team only, T = Total

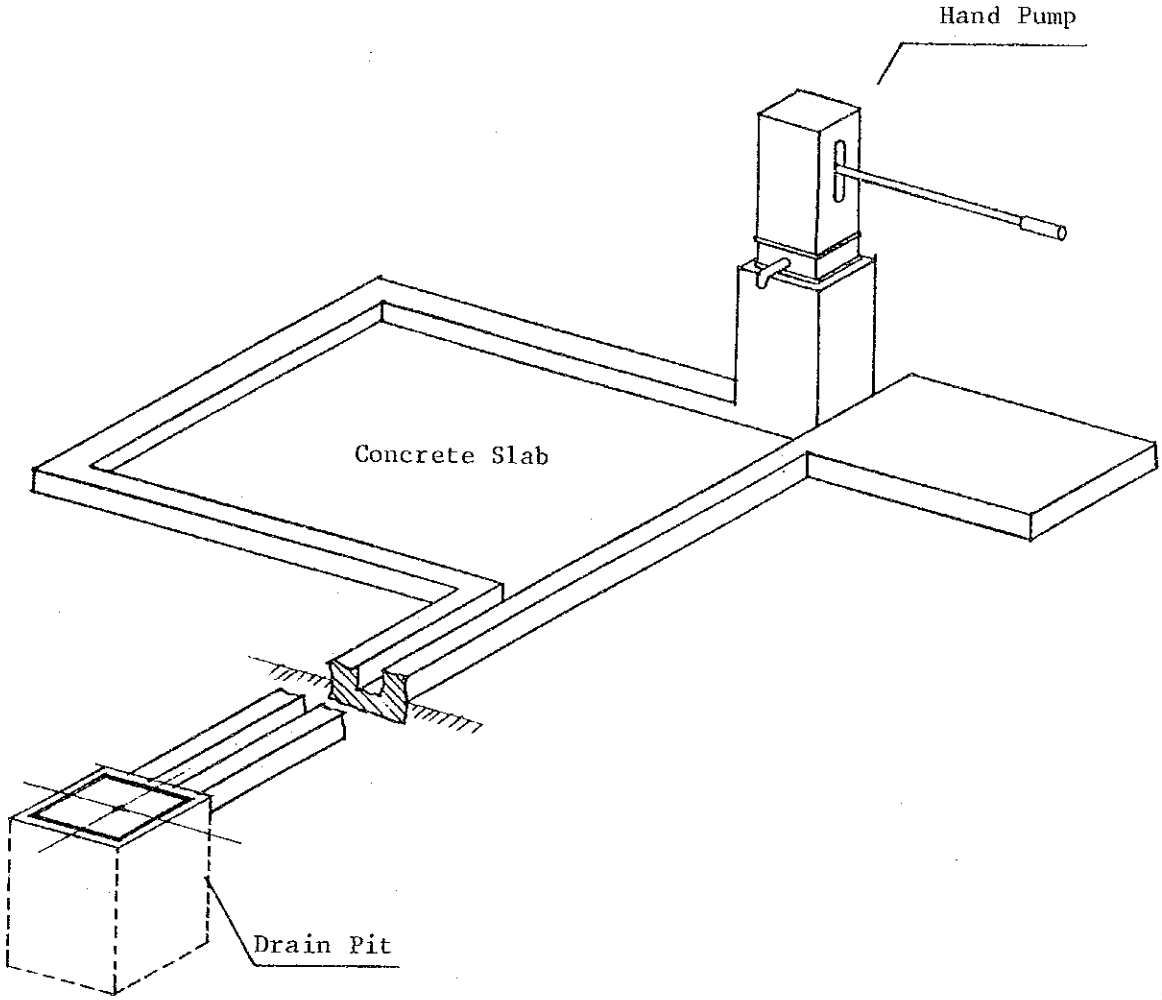


Fig. 5-3
Facilities Arrangement for Groundwater Use

5-4 Equipment and Materials Plan

5-4-1 Plan for Surface Water Use

The main equipment and materials required for surface water supply facilities are described hereafter.

1) Intake Facilities

ϕ 350 mm all welded, wire-wound, stainless steel screen × 1 set

2) Pumping Units

a.	ϕ100 mm	multi-stage, centrifugal pump ($58\ m^3/hr \times 58\ m \times 18.5\ kw$)	× 3 sets
b.	ϕ100 mm	centrifugal pump ($58\ m^3/hr \times 58\ m \times 11.0\ kw$)	× 2 sets
c.	60 KVA	diesel generator (380 V × 50 Hz × 3 P)	× 2 units
d.	35 KVA	diesel generator (380 V × 50 Hz × 3 P)	× 2 units

3) Pipes

a.	PVC	ϕ200	× 3,000 m
b.	PVC	ϕ150	× 1,034 m
c.	PVC	ϕ125	× 565 m
d.	PVC	ϕ100	× 485 m
e.	PVC	ϕ 75	× 81 m
f.	PVC	ϕ 65	× 234 m

5-4-2 Plan for Groundwater Use

The equipment and materials required for the groundwater portion consist of those for operation of the well drilling teams and those for construction of water supply facilities. The equipment and materials listed below include those for construction of 36 facilities by WSD themselves after completion of the Japanese construction portion. The following items will be distributed for each phase.

1) Drilling Rigs and Ancillaries

a. Drilling rigs 2 units

-Rotary type, 6 × 6 truck-mounted type

-Capacity: ϕ150 mm x 50 mm

-Method: : mud and air (using DTH)

b. Tools 2 sets

-For above rigs

c. Air hammer 2 sets

-For above rigs

d. Compressor for air drilling 2 units

-Diesel engine driven, portable type

-Screw type

e. Spare parts for above 1 set

2) Machinery, Vehicles and Materials for Construction

a. Geoelectric prospecting instrument 2 sets

b. Geoelectric logging instrument 2 sets

c. Water quality analysis kit 2 sets

d. Welding equipment (gas) 2 sets

e. Welding equipment (electric) 2 sets

-Diesel engine driven

-Current range: 60 - 270 A

f. Pumping test apparatus 2 sets

-Submersible motor pump: 50 m head, 200 ℓ/min

-Diesel generator : 10 KVA

g. Cargo truck with crane 2 units

-Payload : 6,000 kg (minimum)

-Engine : water-cooled, diesel, 160 HP (minimum)

-Crane capacity: 3,000 kg/2.5 m (minimum)

h. Workshop tools 2 sets

-Electrical tools

-General tools

i. Workshop truck 2 units

-Equipped with generator, electrical tools, welding equipment, etc.

j. Water tanker 2 units

-Tank capacity: 6,000 ℓ (minimum)

k. Servicing machine 2 units

-Hoist capacity: 3,000 kg (minimum)

-Sand reel : 50 m (minimum)

l. Unit house 2 units

-Prefabricated, for on-site office

-Floor area : approx. 5 m^2

m. 4-wheel drive hard top vehicle 4 units

-Engine: water-cooled, diesel, 70 HP (minimum)

n. 4-wheel drive pickup truck 4 units

-Engine: water-cooled, diesel, 70 HP (minimum)

o. 4-wheel drive station wagon 2 units

-Engine: water-cooled, diesel, 70 HP (minimum)

p. Wireless radio (stationary type) 3 sets

q. Wireless radio (mobile type) 2 sets

r. Spare parts for above 1 set

3) Materials for Well Construction

a. Casing pipe (150 mm) 4,900 m

b. Well screen (150 mm) 1,960 m

c. Well bottom (150 mm) 196 units

d. Well cap (150 mm) 178 units

e. Centering guides 845 sets

f. Hand pump 178 sets

-Head : 10 - 30 m

-Capacity: 10 - 40 ℓ

g. Spare parts for hand pump 1 set

h. Drilling mud and additives 1 lot

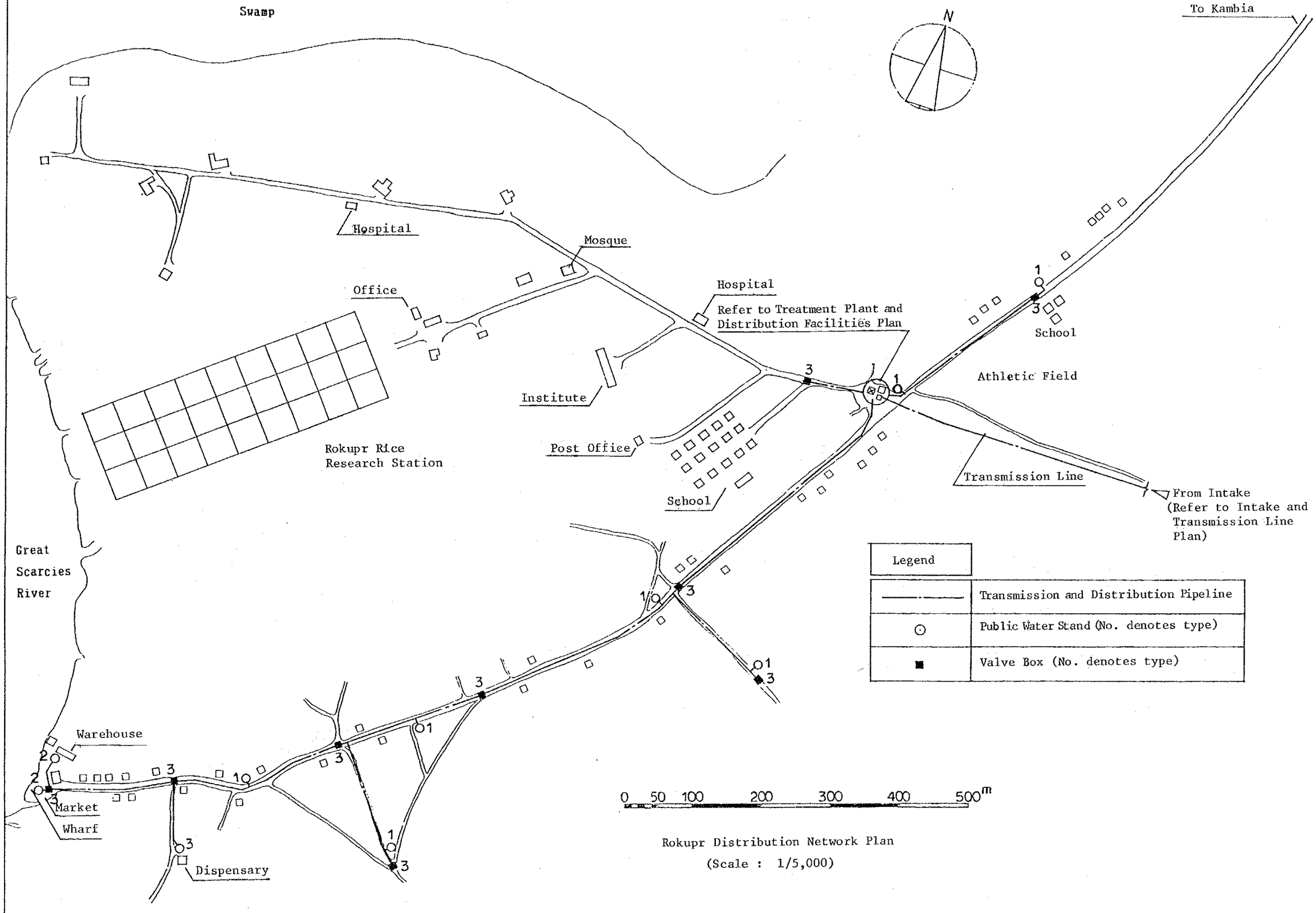
5-5 Basic Design Drawings

5-5-1 Drawings for Facilities Using Surface Water

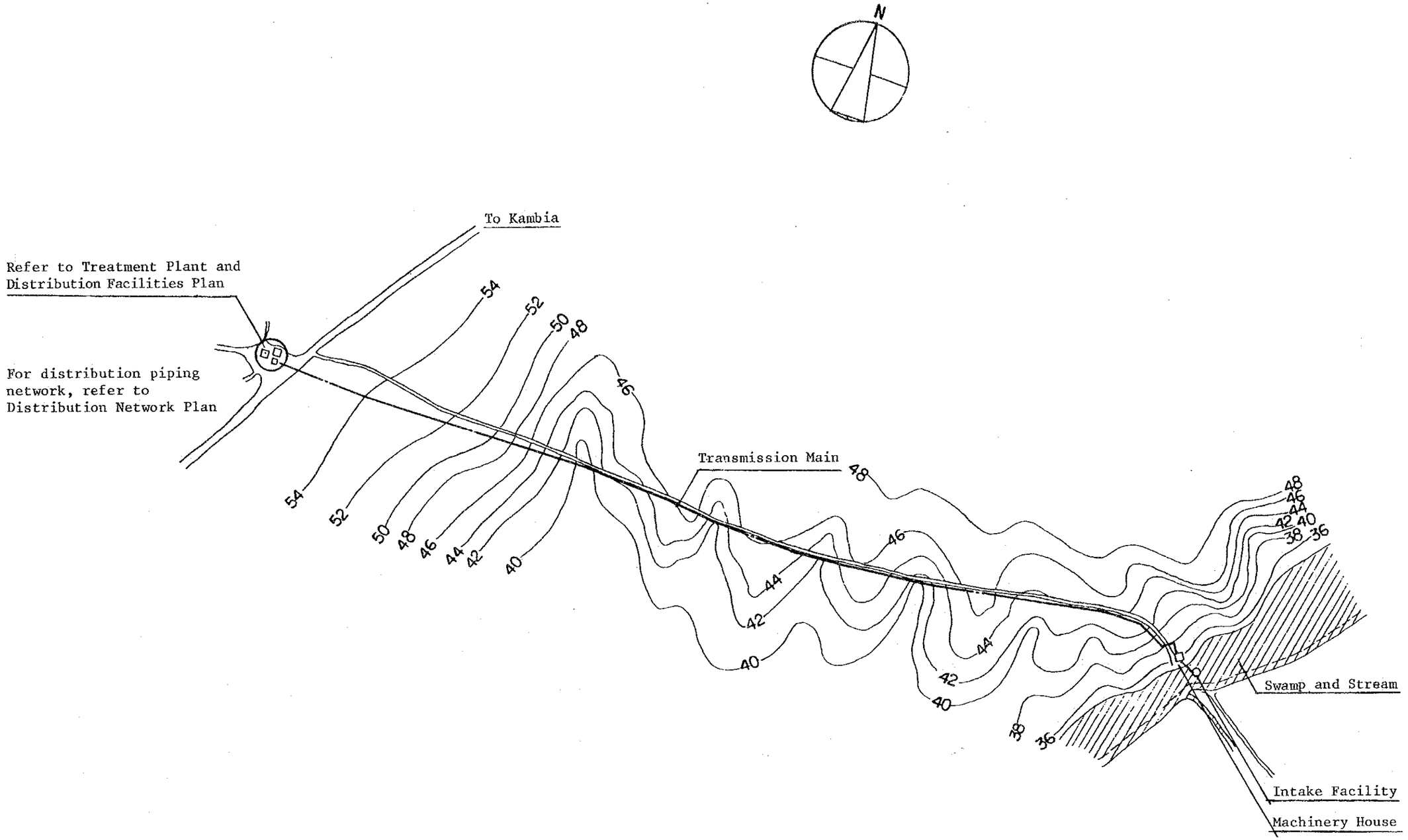
5-5-2 Drawings for Facilities Using Groundwater

5-5-1 Drawings for Facilities Using Surface Water

- Rokupr Intake and Transmission Line Plan
- Rokupr Distribution Network Plan
- Treatment Plant and Distribution Facilities Plan
- Intake Facility
- Machinery House
- Treatment System
- Public Water Stand - 1
- Public Water Stand - 2
- Public Water Stand - 3
- Valve Box - 1
- Valve Box - 2
- Valve Box - 3
- Underground Pipe Installation

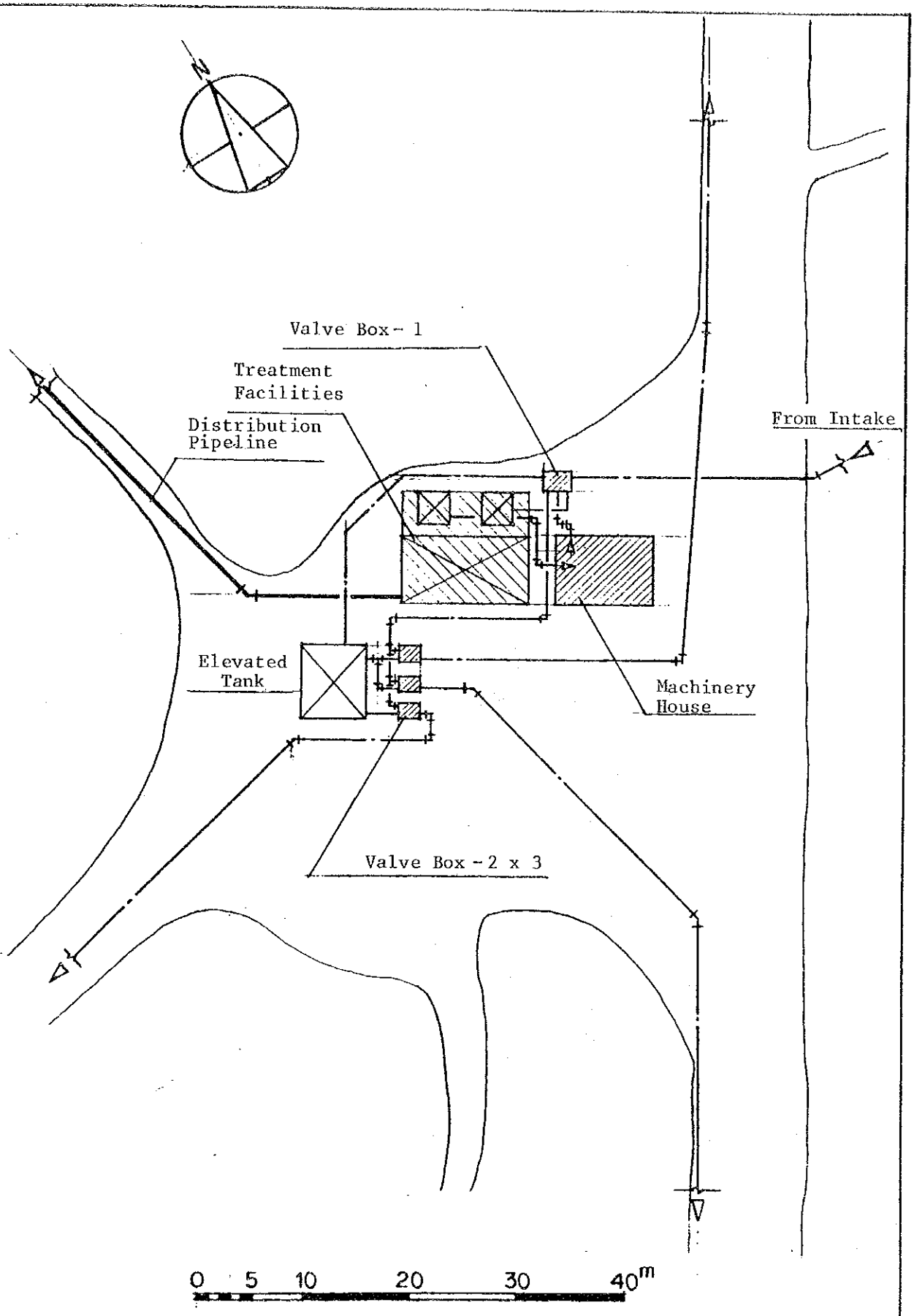


Rokupr Distribution Network Plan
(Scale : 1/5,000)



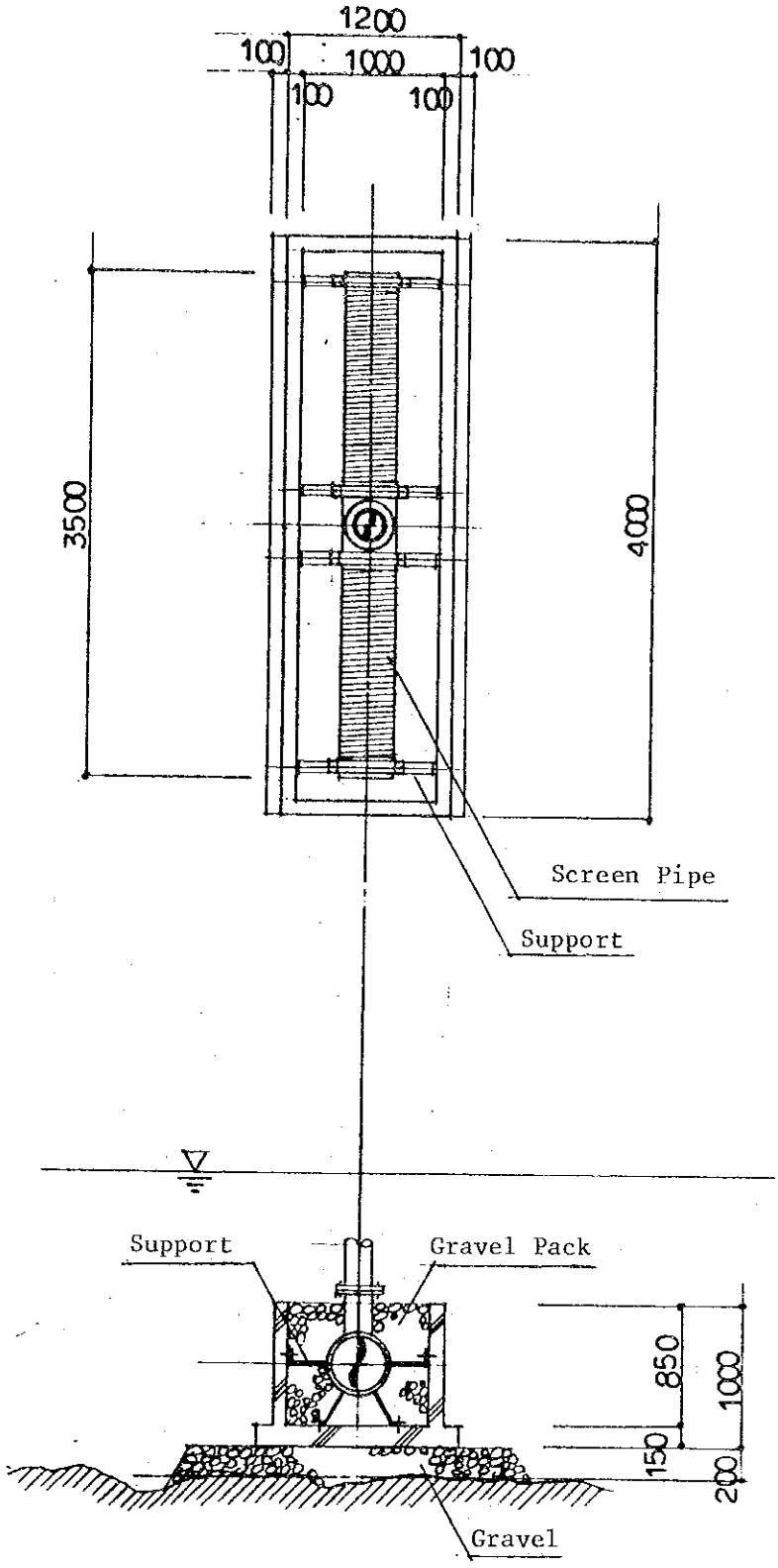
Rokupr Intake and Transmission Line Plan

(Scale : 1/5,000)



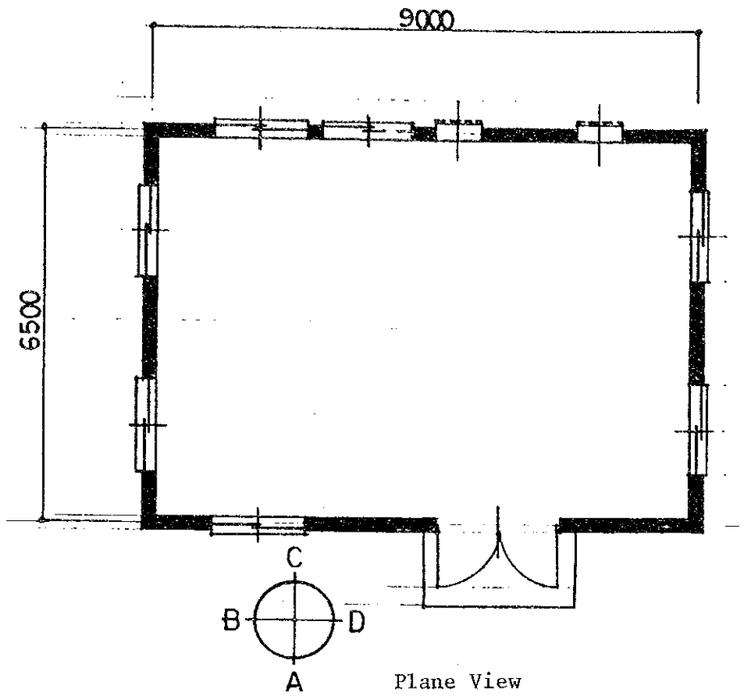
Treatment Plant and Distribution Facilities Plan

(Scale : 1/500)

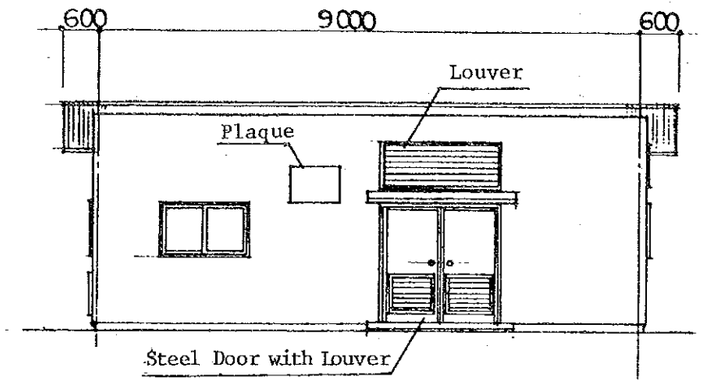


Intake Facility

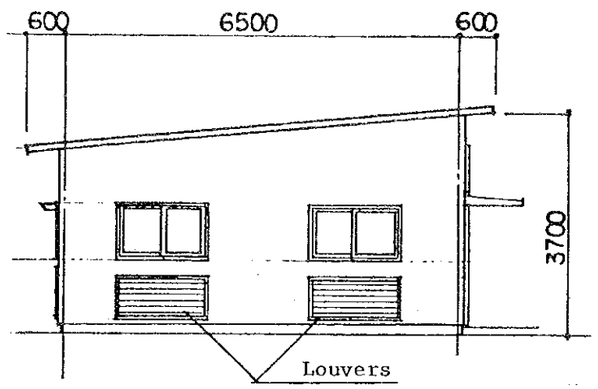
(Scale 1/50)



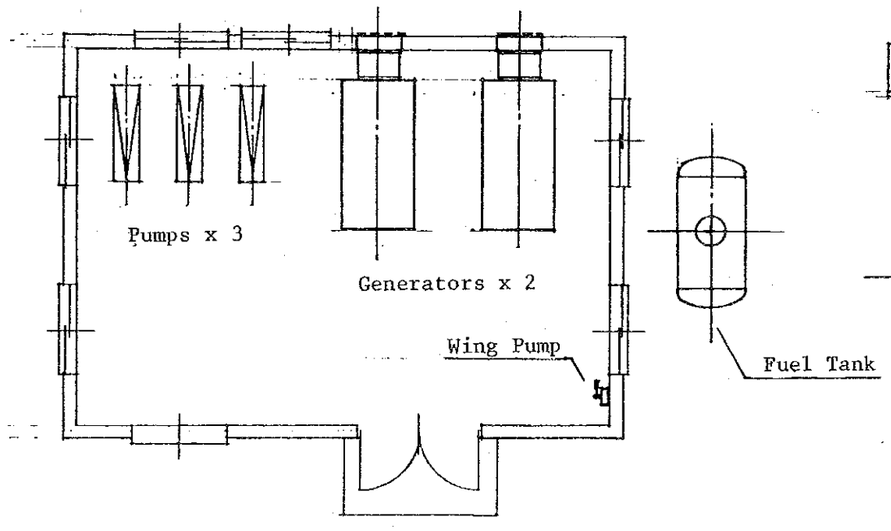
Plane View



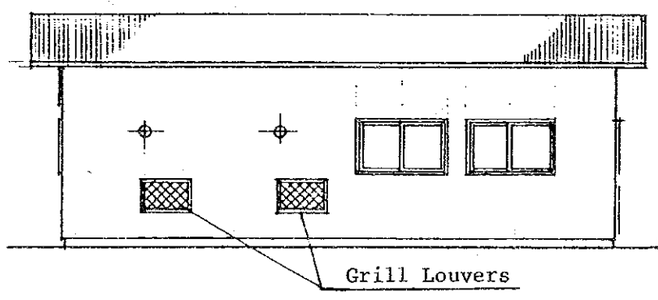
Front A View



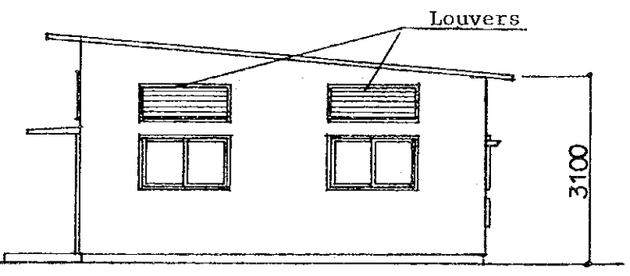
Side B View



Machinery Layout Plan



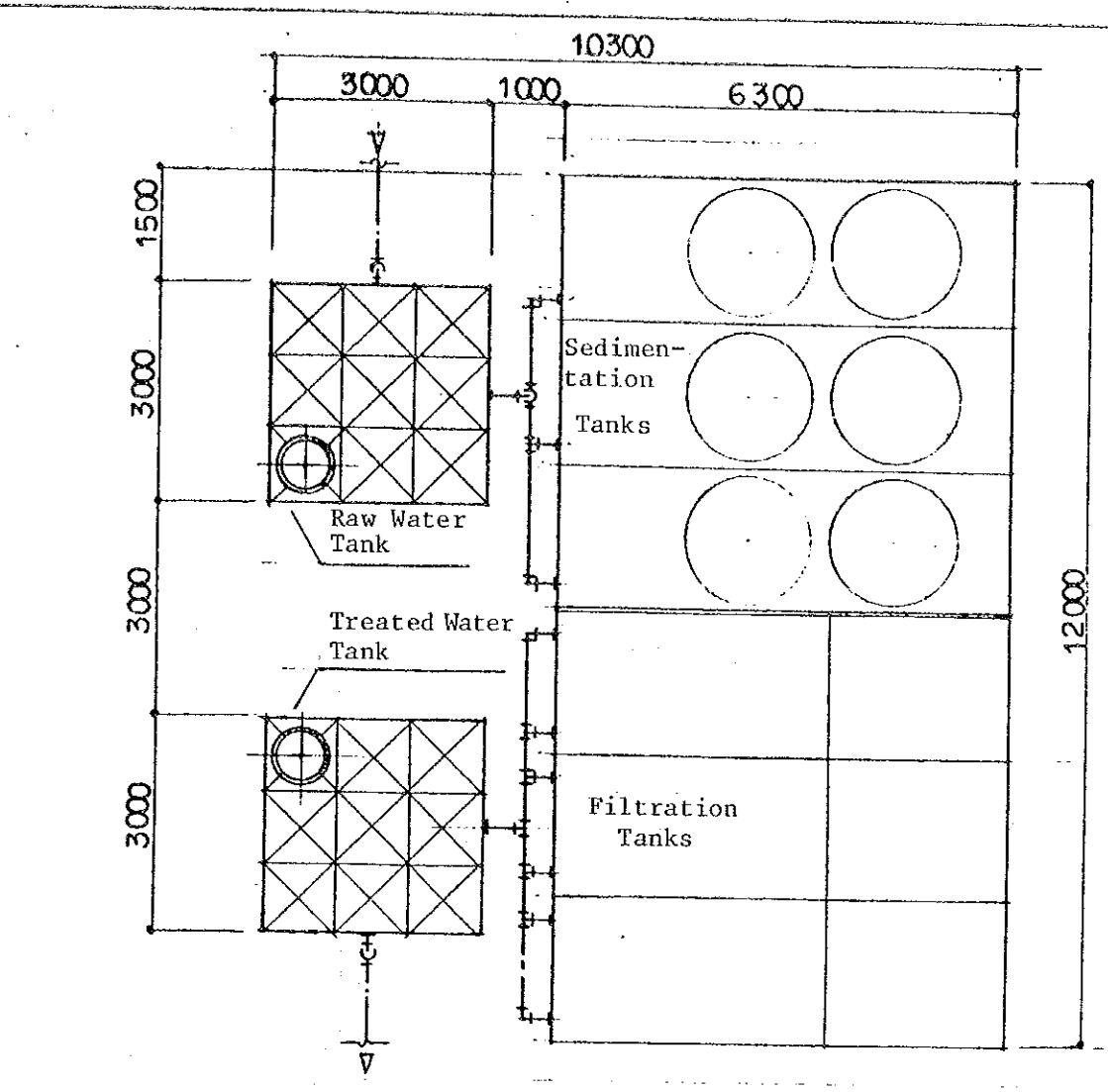
Back C View

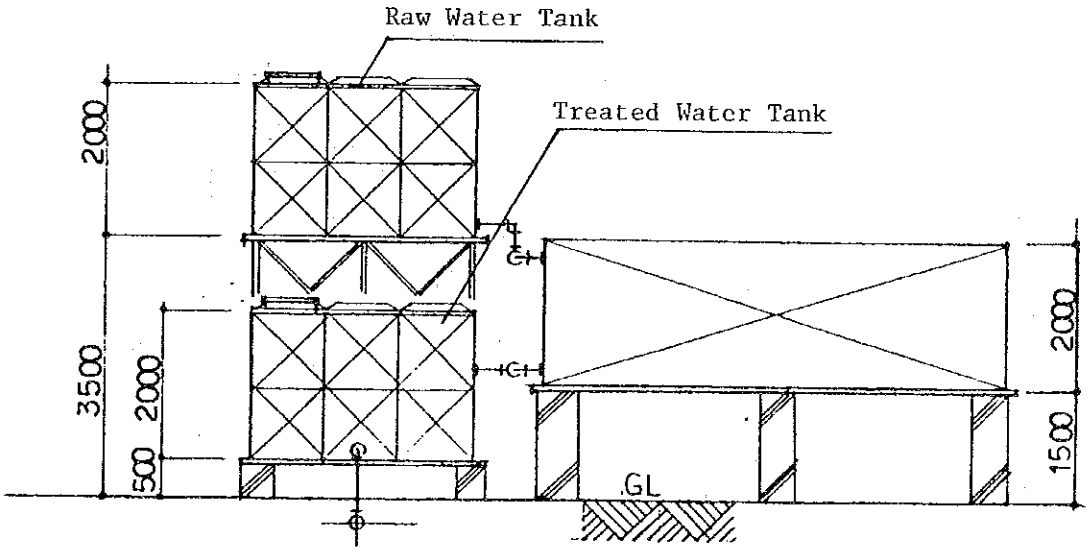


Side D View

Machinery House

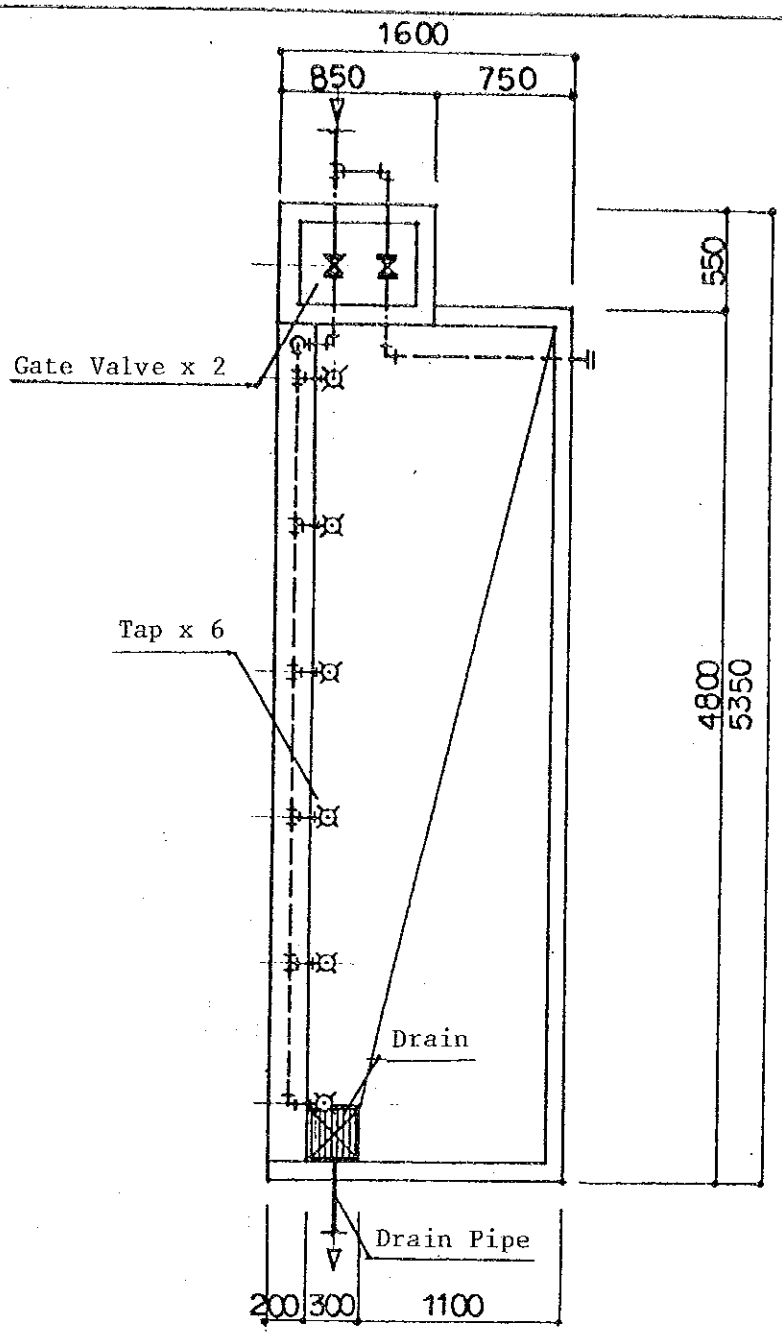
(Scale : 1/100)

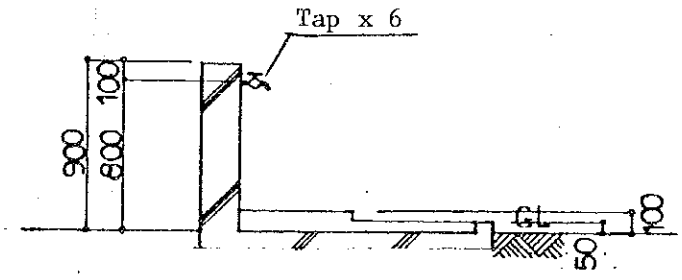




Treatment System

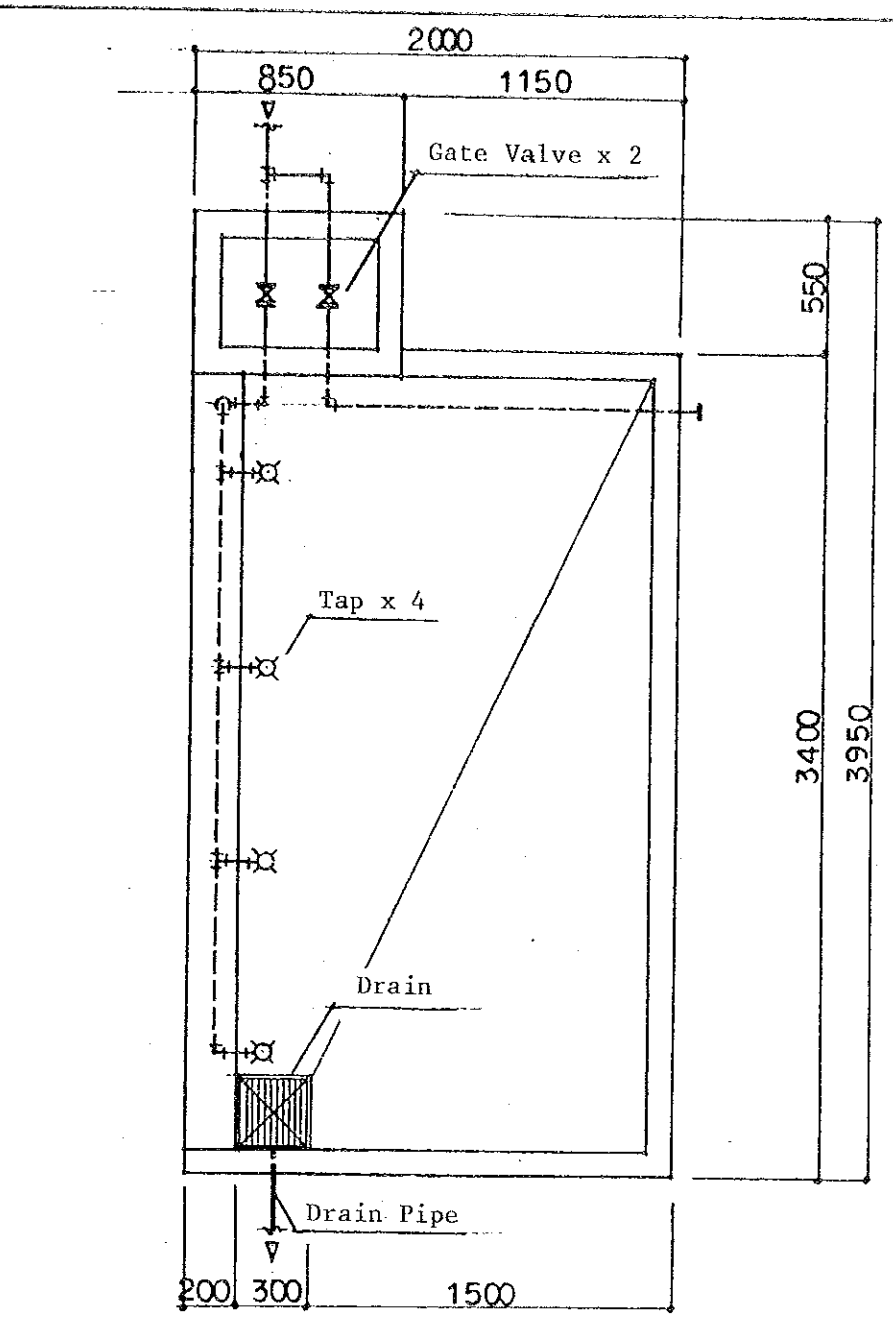
(Scale : 1/100)

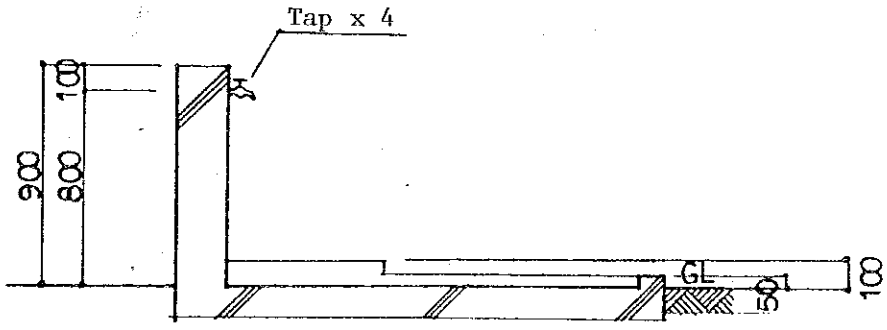




Public Water Stand - 1

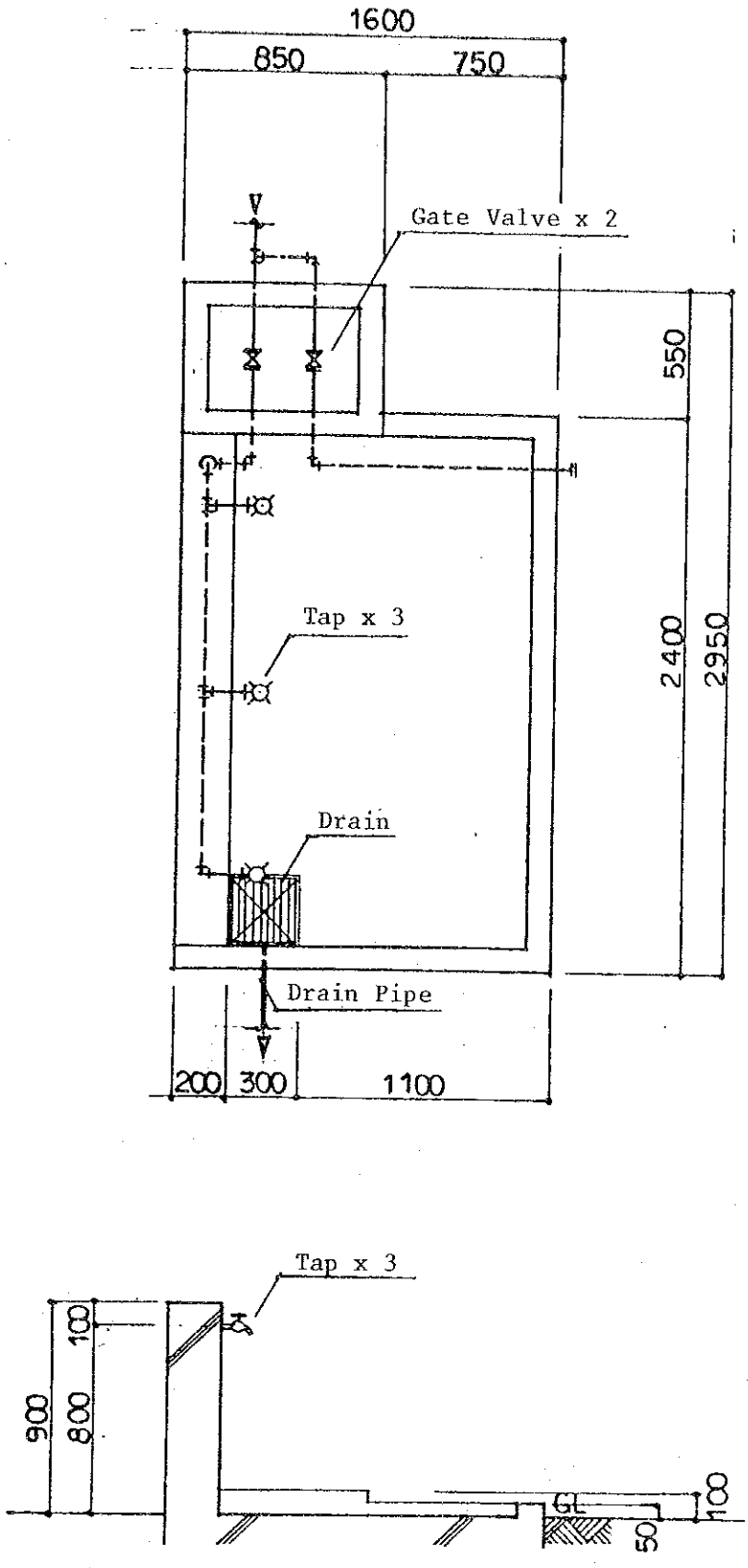
(Scale : 1/40)





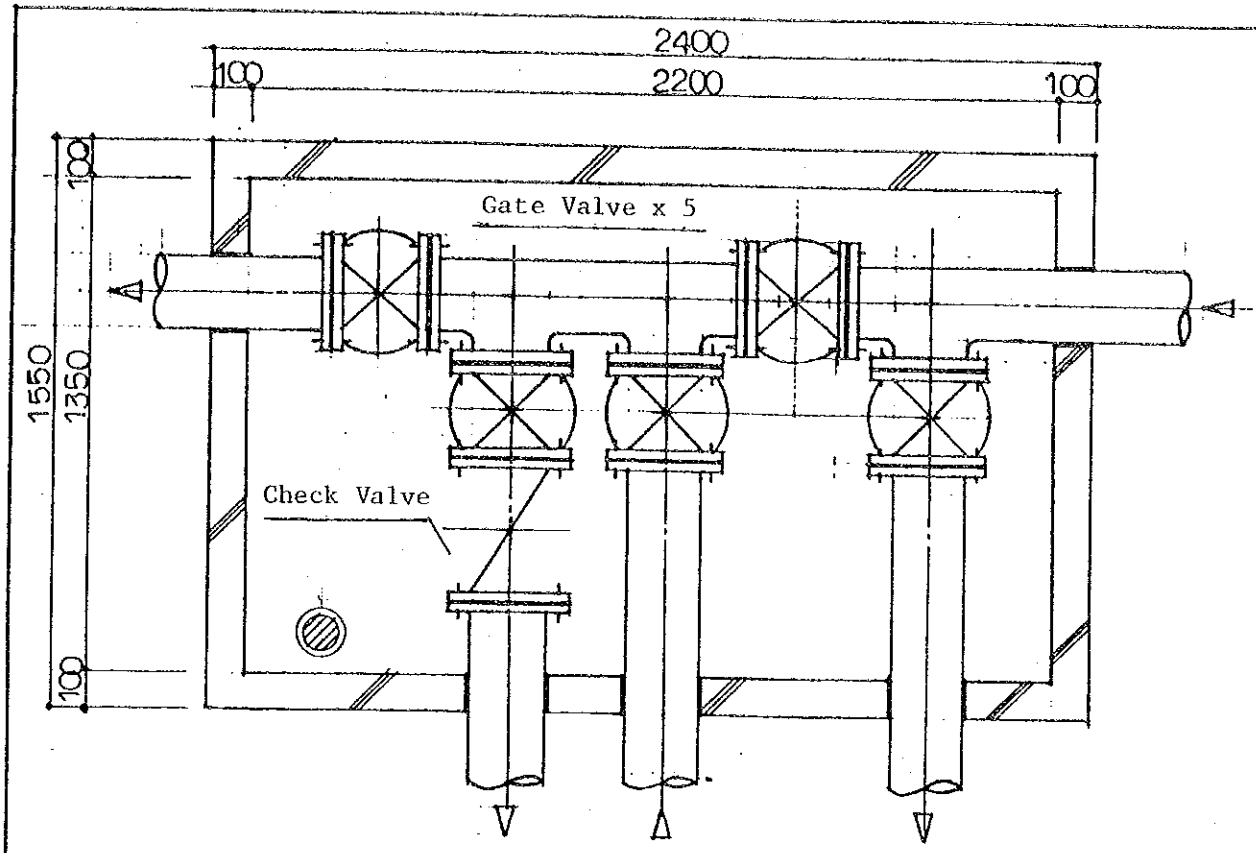
Public Water Stand - 2

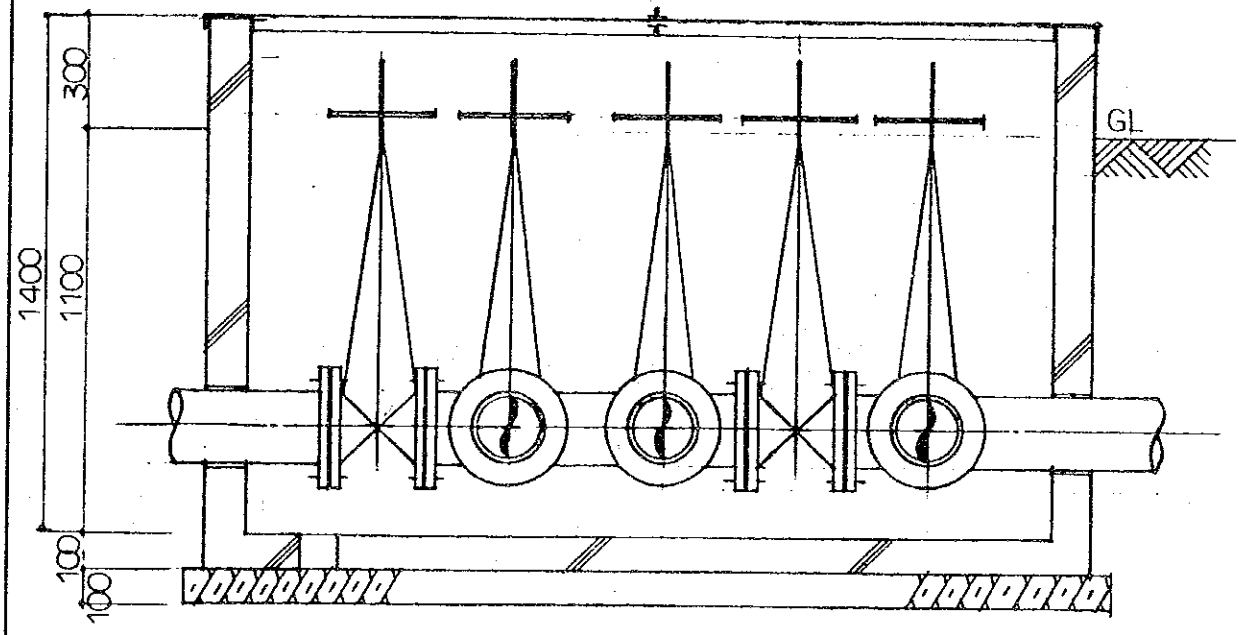
(Scale : 1/30)



Public Water Stand - 3

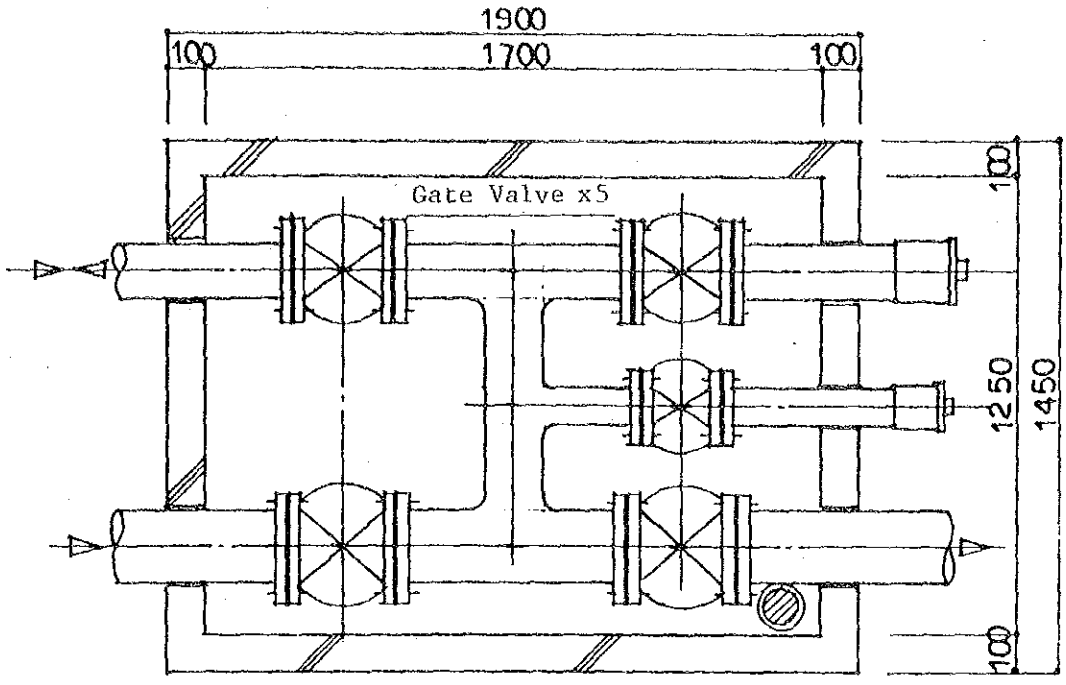
(Scale : 1/30)

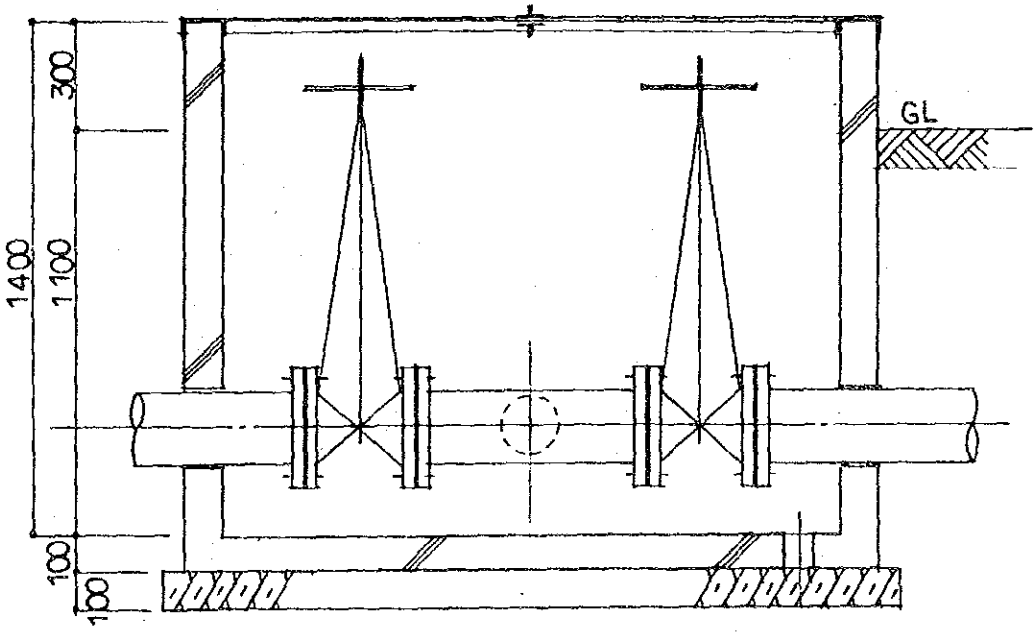




Valve Box - 1

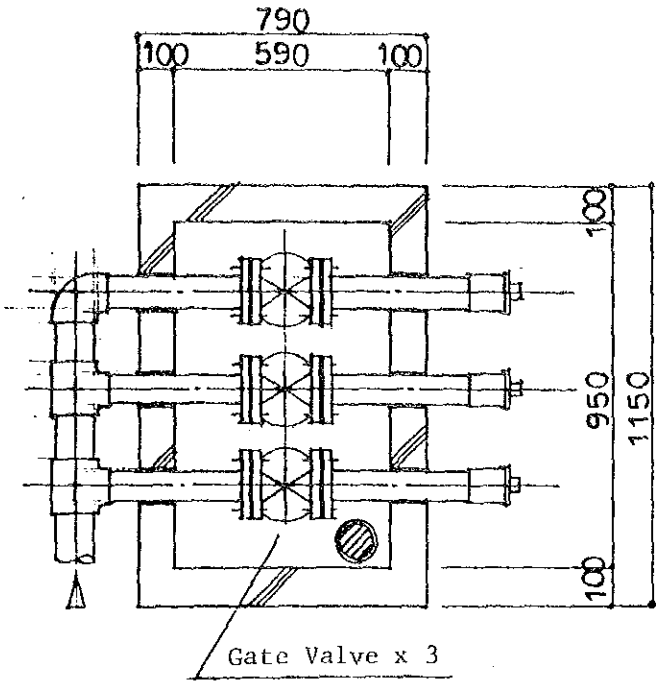
(Scale : 1/20)

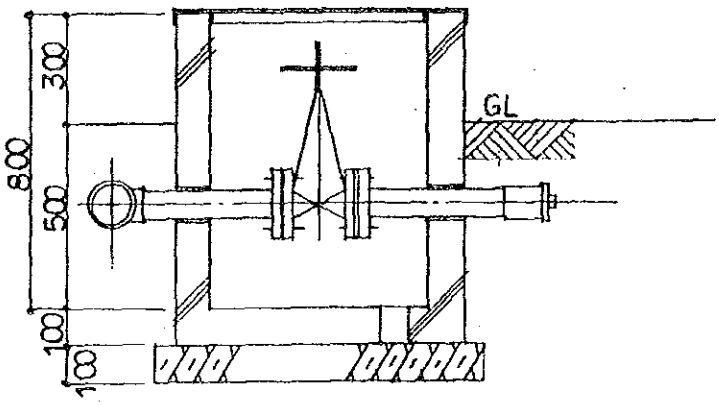




Valve Box - 2

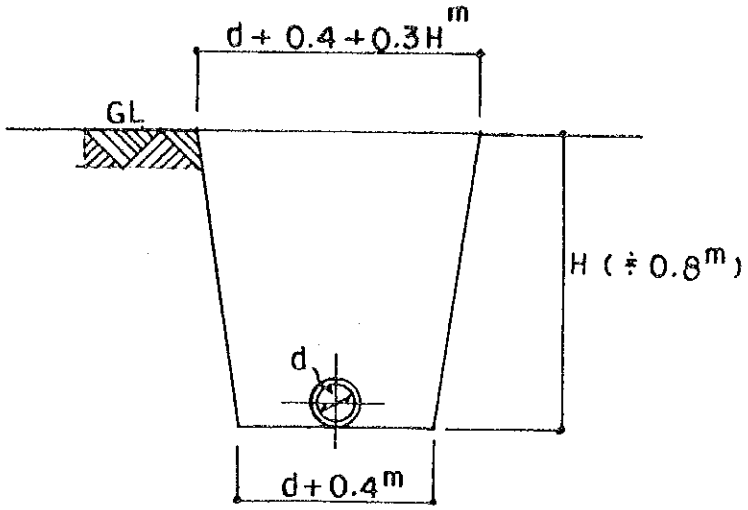
(Scale : 1/20)





Valve Box - 3

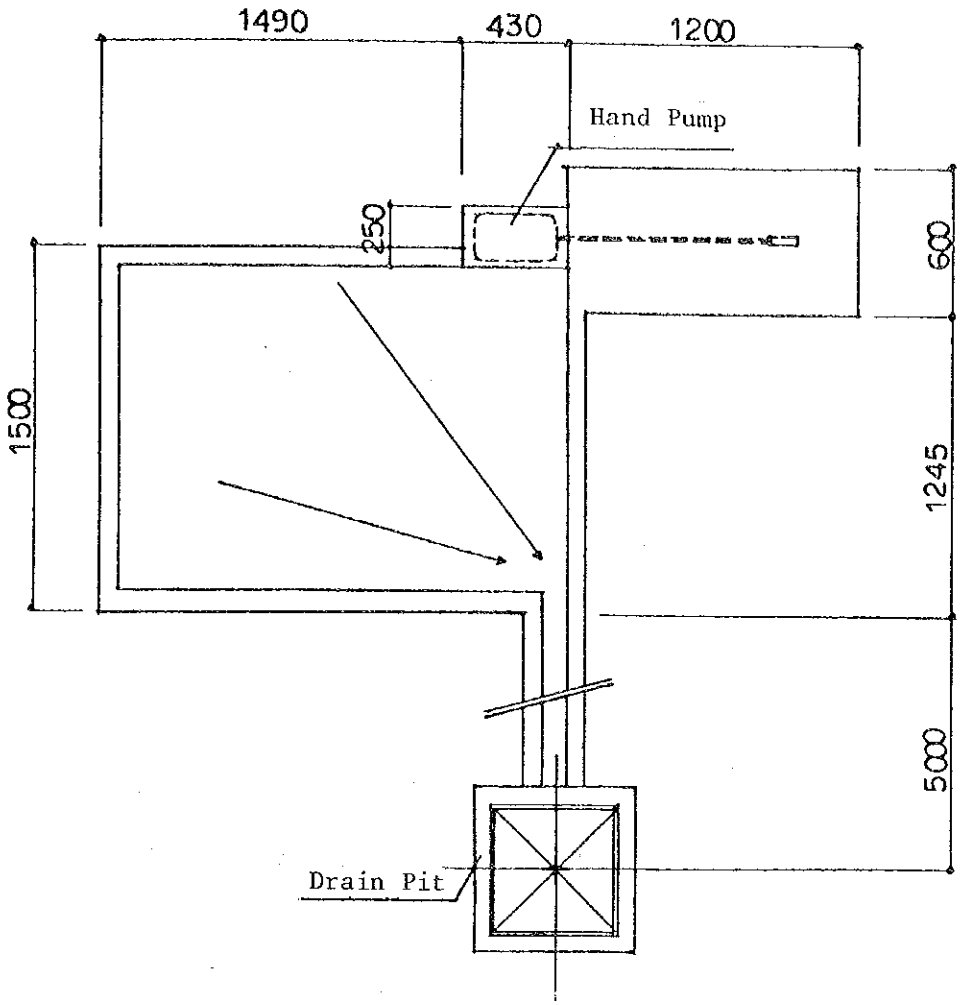
(Scale : 1/20)

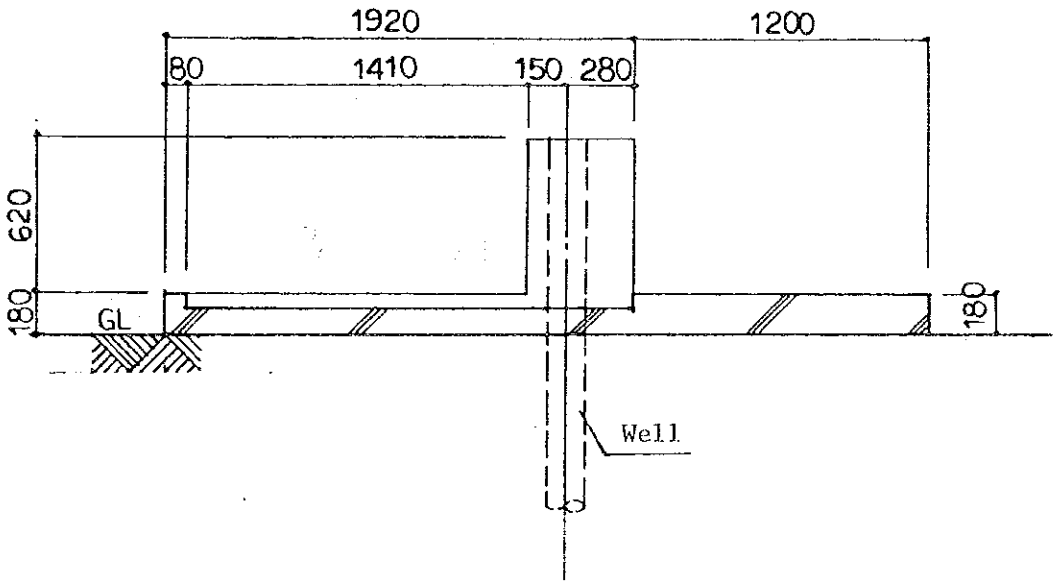


Underground Pipe Installation
(Not to Scale)

5-5-2 Drawings for Facilities Using Groundwater

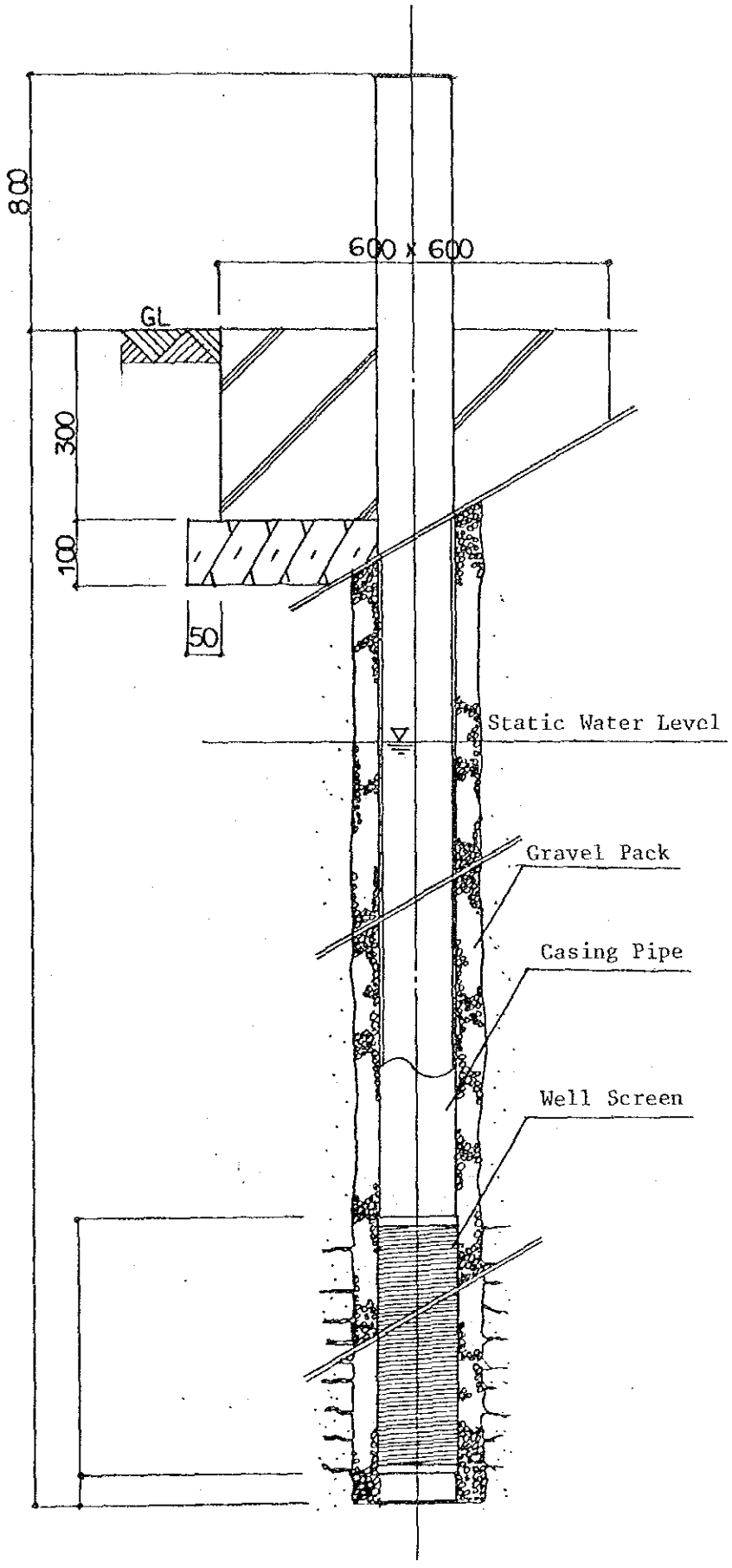
- Water Supply Facilities Plan
- Well Structure
- Hand Pump Installation
- Drain Pit



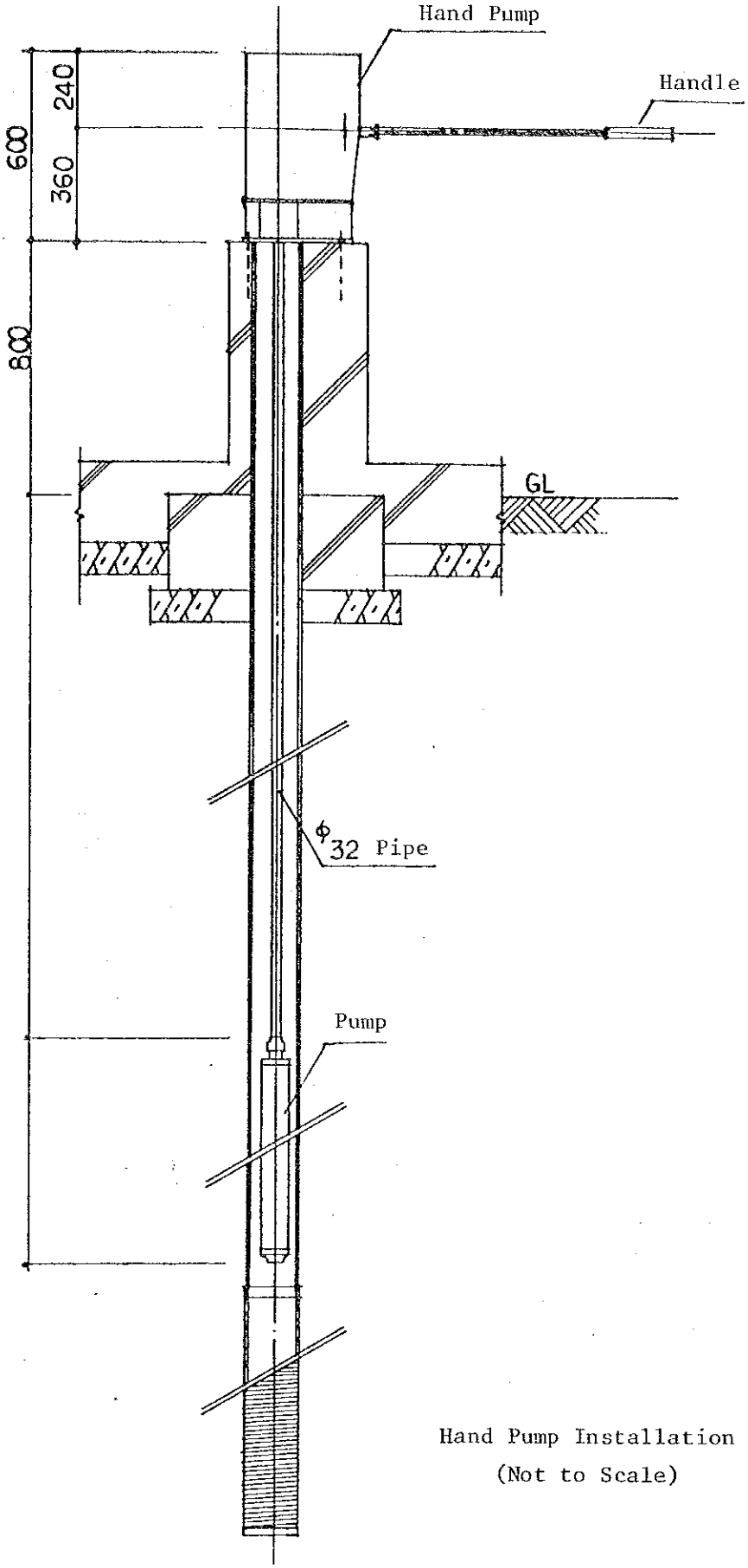


Water Supply Facilities Plan

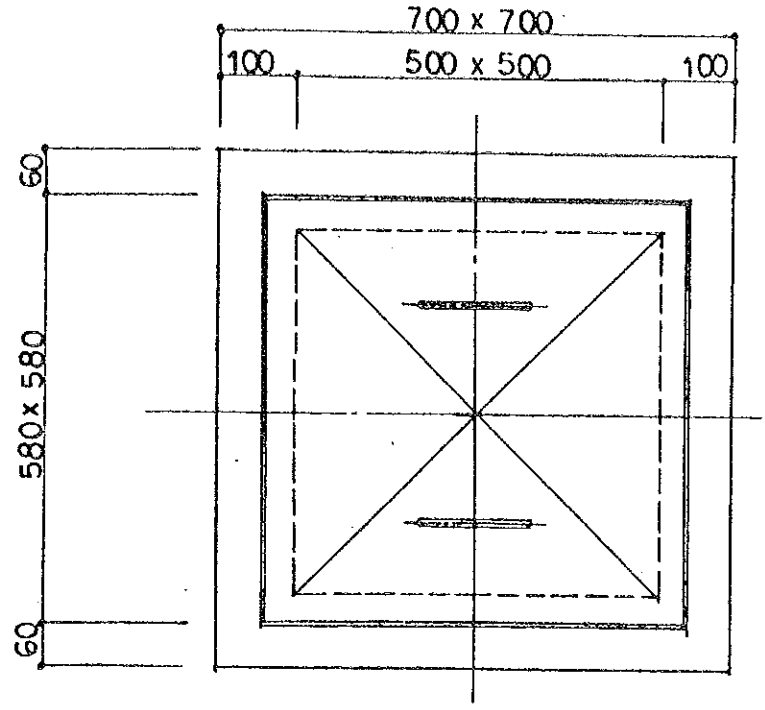
(Scale : 1/30)

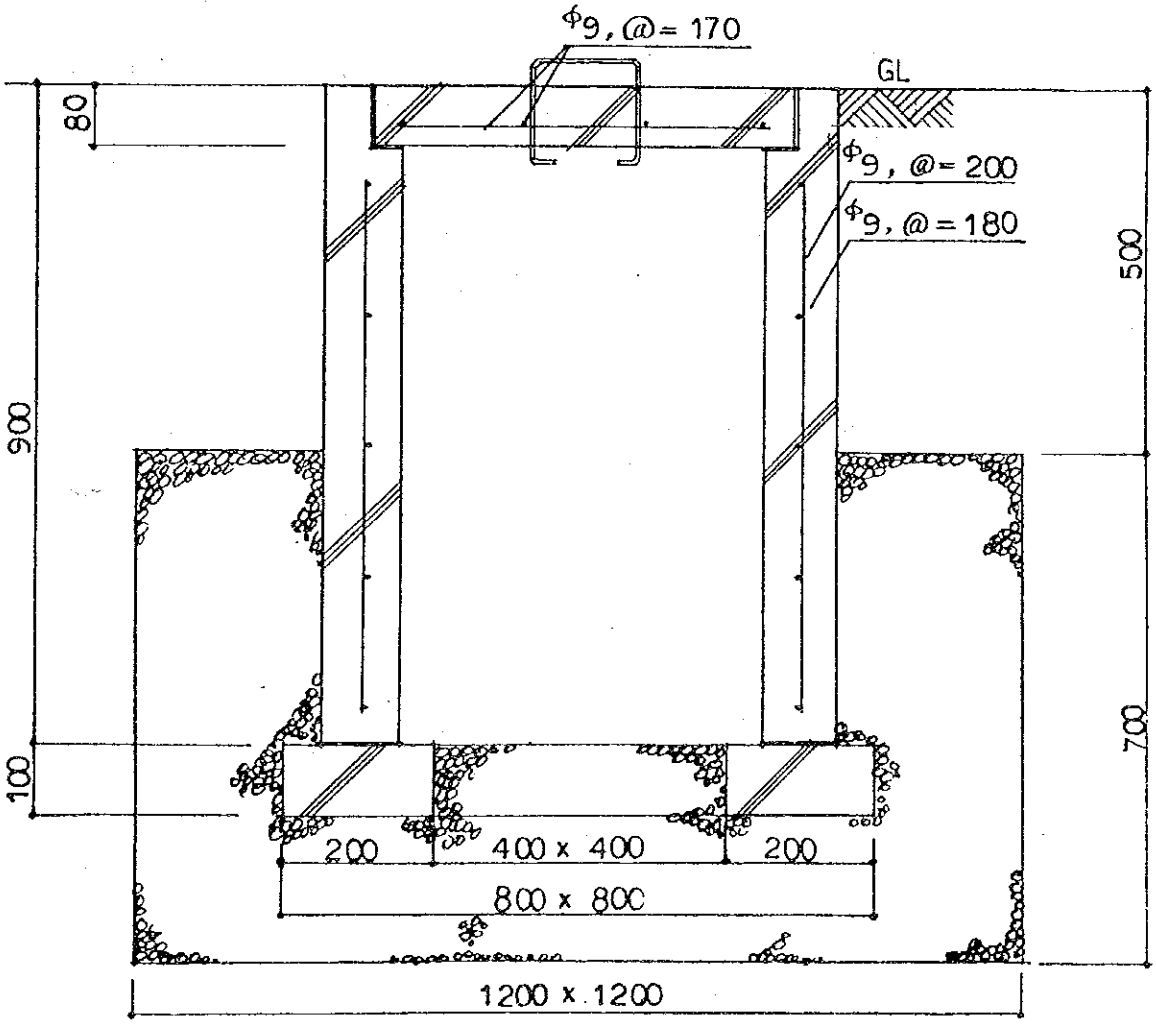


Well Structure
(Not to Scale)



Hand Pump Installation
(Not to Scale)





Drain Pit

(Scale : 1/10)

CHAPTER 6 PROJECT IMPLEMENTATION

CHAPTER 6

PROJECT IMPLEMENTATION

6-1 Organization for Project Implementation

The principal organization for implementation of this project is WSD of MWEP. After the exchange of notes, the detailed designing and construction supervision will be contracted to a Japanese consultant. The consultant will assist in the packaged tendering for construction of water supply facilities using surface and groundwater, and supply of related equipment and materials. As a result of evaluation on tenderers, a contract will be made between the Sierra Leonean government and a Japanese contracting firm. Under supervision of the consultant, the contractor will construct the required facilities and conduct an on-the-job training of WSD personnel during the contract period. Through the training, technology transfer on borehole type well drillings will be carried out. The Japanese contractor will drill a total of 177 wells inclusive of the successful and unsuccessfull ones during the contract period.

Operation and maintenance of the completed facilities for both surface and groundwater portions will be handled by WSD. However, with respect to groundwater supply facilities, WSD will only supply spare parts and handle specialized works, and the villagers will undertake the management responsibilities under the concept of VLOM. The management of well construction using the equipment and materials donated during the project will be executed by WSD.

6-2 Implementation Responsibilities

6-2-1 Responsibilities of Japanese Side

(1) Construction of surface water supply facilities in Rokupr.

(2) Construction of groundwater supply facilities at 142 sites in Bombali and Kambia Districts.

(3) Supply of well drilling rigs, related ancillaries, vehicles, machineries and materials for construction of groundwater supply facilities, and the ocean and inland transportation to the depot at Makeni.

(4) Consulting services on detailed designing and construction supervision and procurement of equipment and materials.

6-2-2 Responsibilities of Sierra Leonean Side

(1) Acquisition and clearing of land required for construction works as well as that for depots in Freetown and Makeni.

(2) Arrangement on duty clearance and tax exemption for equipment and materials imported into Sierra Leone.

(3) Arrangement on tax and duty exemption for accompanied equipment and materials of the Japanese consultants and contractors.

(4) Furnishing of data and information required for the project.

(5) Bear the commission charge for this project to the Japanese foreign exchange bank.

(6) Procurement of personnel and budget for the special task force to be organized for this project.

(7) Establishment of an operation and maintenance system for the constructed facilities and the equipment and materials supplied in this project.

6-3 Construction Supervision

As part of the Japanese grant aid program, this project will be contracted to a Japanese firm on a packaged basis. Since this project requires a combined work for both surface and groundwater portions, the contractor must have sufficient knowledge of the details of this project. In particular, for the groundwater portion, attention must be paid to the on-the-job training required on well construction. For the surface water portion, special handling of the antiquated existing facilities must be considered so as not to disturb the in-operation facilities. If local specialist firms are subcontracted for construction and required consulting and construction supervision are procured, the project can be implemented within a rational period and budget.

Detailed designing, followed by tendering, supervision of construction and operation guidance will be carried out by a Japanese consultant under the grant aid system reflecting upon the opinions of the Sierra Leonean government. The procedure is outlined below.

Pre-construction Stage
1. Detailed designing
2. Preparation of tender documents
3. Representation for tendering
4. Tendering result evaluation
5. Assistance in contracting

Construction Stage
6. Construction supervision
7. Preparation and performce of on-the-job training program
8. Testing and operational guidance
9. Reporting and others

That is, during the pre-construction stage, after the site survey, the survey results are compiled for detailed designing of facilities, followed by establishment of specifications for facilities construction and supply of equipment and materials, and preparation of tender documents. A tendering program will also be prepared and assistance will be given to the executing agency in tendering. The tendering results will be evaluated and support will be extended for contracting between the executing agency and the successful contractor.

During the construction stage, the consultant will control the quality and schedule of construction works. Also during this time, an on-the-job training program on well siting and construction will be offered. When facilities and well drillings are near completion, inspection and testing of machinery and materials to be installed will be carried out, and training on operation and maintenance will be given to facility operators. The constuction results will be organized into a report.

6-4 Supply of Equipment and Materials

Basic materials required for construction works such as water, sand and gravel can be purchased locally. Originally, other construction materials were also able to be procured locally, but at the present time, the supply of these other materials is drastically short and therefore, to obtain the required quantity within the limited time alloted for this project is almost impossible. As a consequence, equipment and materials for this project will be secured from neighboring countries and Japan.

For transportation from Japan, a direct route to Freetown, the unloading port, is not available. After a stop in southeast Asia, direct lines are available to Pointe Noire, Douala, Abidjan and Monrovia. Depending on the amount of the cargo, ships from Monrovia

can make a stopover in Freetown. In general, unloading at Monrovia or Abidjan is more economical. The required travel time is about 60 days.

6-5 Operation and Maintenance

6-5-1 Organization for Water Supply Facilities

The operation and management of surface water supply facilities to be constructed at Rokupr will be conducted by the regular staff of WSD who will continuously work with the existing facilities at Rokupr. Though increase in scale is not drastic, personnel increase is required. Therefore, WSD is planning to dispatch personnel from the 170 staff members of the conservation division in Freetown. The technical levels of these personnel is satisfactory.

The operation and maintenance of completed facilities using groundwater will also be carried out by WSD personnel. Since these facilities are scattered widely in Bombali and Kambia Districts, and though WSD will supply spare parts and give specialized guidances and support, based on the goals of VLOM, self-efforts by the rural inhabitants will be strived for in the future.

6-5-2 Organization for Equipment and Materials used in Well Construction

WSD is in charge of the operation and management of equipment and materials for well construction. After completion of the water supply facilities by the Japanese side, WSD, focusing on the special task force, will continue the construction using the supplied equipment and materials. However, since WSD is unexperienced in construction of borehole type wells, upon consideration of the technology tranfer, the reinforcement of the team by recruiting driller apprentices, drivers and simple workers is needed.

6-5-3 Operation and Maintenance Costs

The annual operation and maintenance costs are estimated as listed below.

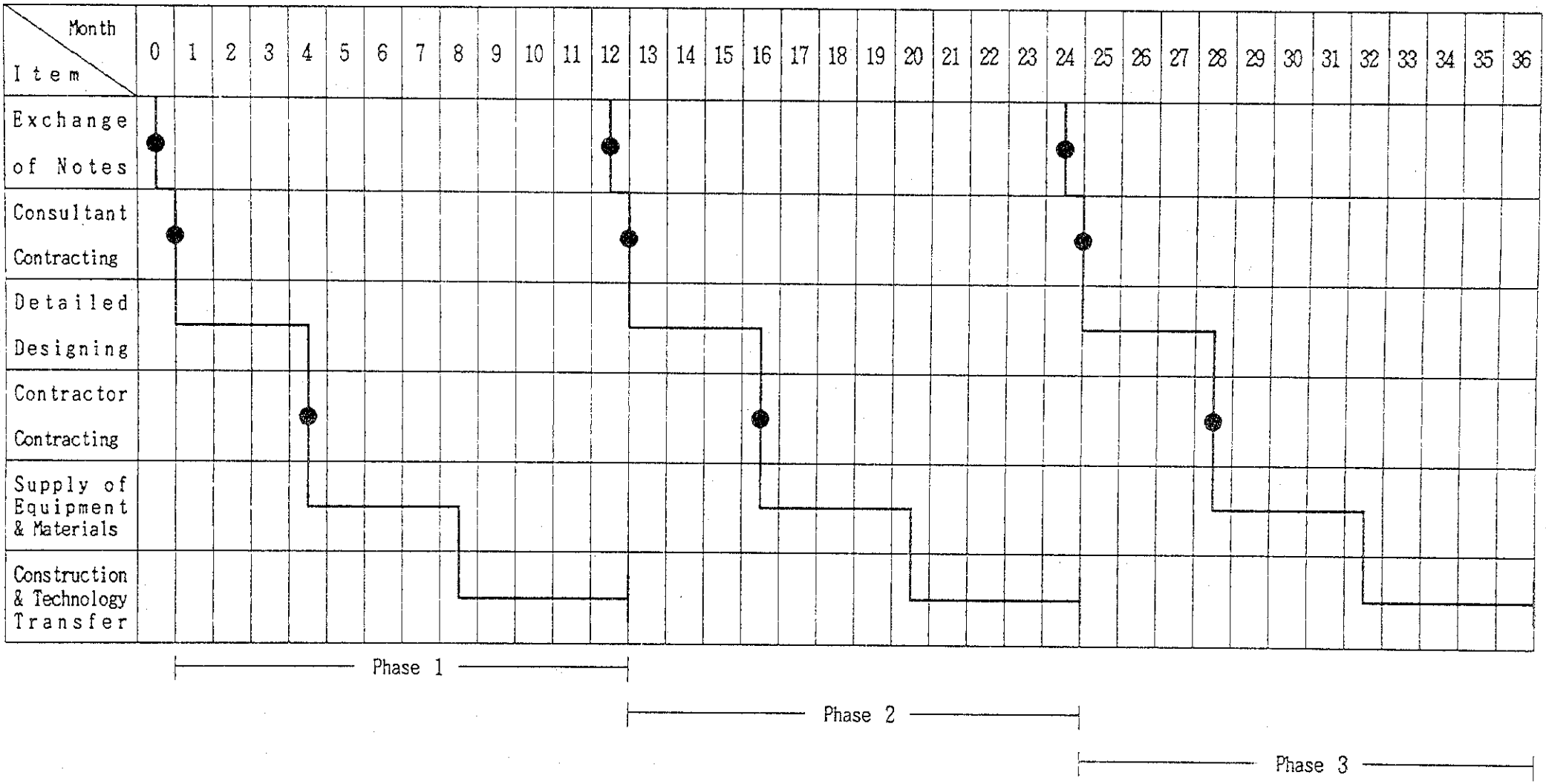
	Le/year	¥/year
Salaries	126,000	4,300,000
Fuel and Chemicals	431,000	14,640,000
T O T A L	557,000	18,940,000

6-6 Project Schedule

In consideration of the Japanese grant aid system, Sierra Leonean organization, project efficiency, procurement time for equipment and materials, local climate and other factors, a phasing of works into three phases is advisable. The characteristics of this project warrants that difficulties in implementation will not arise due to the phasing, since works of each phase will be self-accomplished.

Commencing from the consulting services and considering the rainy season, each phase is scheduled to last 12 months until completion and start-up of facilities for an individual phase. Therefore, completion of the total project will require 36 months. The project schedule is indicated in Table 6-1.

Table 6-1 Project Schedule



CHAPTER 7 PROJECT EVALUATION

CHAPTER 7

PROJECT EVALUATION

The importance and urgency of this project is quite obvious in view of its high priority among various policies of the government of Sierra Leone. Particularly, the contribution of this project to the welfare of the rural inhabitants, who form the nucleus of agricultural policies being promoted by the Sierra Leonean government, is great. Organizations such as UN and EEC, and countries such as UK and France are also actively supporting water supply projects, and their significance is being highly evaluated. As a result of this project, the benefiting population will be about 65,000 persons, which accounts for about 12% of the population in both Bombali and Kambia Districts. The contribution to solving the health problems caused by poor water quality in the project area is especially noteworthy. The project will have significance in complementing the IADPs being advanced as part of the National Action Plan and will contribute to the improvement of regional socio-economy. Furthermore, the groundwater development team to be organized during this project will contribute greatly to reinforcement of the country's hydrogeological studies and solving water resources development and conservation problems.

The executing agency for this project, WSD, has been accelerating many projects through bilateral and international cooperations. Consequently, problems will not arise with respect to operation and maintenance, organization for project implementation and personnel arrangements.

Rural water supplies have been provided without charge to the villagers. In this effect, the Sierra Leonean government is requesting that the rural inhabitants participate in operation and maintenance of water supply facilities through self-efforts.

WSD, being at the head of water supply undertakings, requires a large budget. However, not necessarily being financially strong, WSD has not been able to implement many organized projects centered on groundwater

development, which have been proposed for years. Therefore, the implementation of this project will mark a new era in Sierra Leone's water works with anticipations for receiving high acclaim.

In view of the above factors, this project is highly feasible for implementation under the Japanese grant aid program.

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8-1 Concluding Remarks

The Sierra Leonean government is under the pressure of necessity for a large number of water supply facilities to provide a stable supply of safe water to the rural inhabitants and is making efforts by implementing projects through foreign aid. The construction of facilities using both surface water and groundwater will be carried out in this project. Moreover, at the same time, equipment and materials for construction of borehole type wells will be supplied, in order to create the foundation for WSD to organize well construction works on their own.

The rural population, who are the focus of the priority policies in the agricultural sector of Bombali and Kambia Districts, to benefit from this project will be about 65,000 persons. The implementation of this project will contribute to the improvement of the sanitary environment and rise in living standards.

This project will complement the Integrated Agricultural Development Projects and other endeavors being proceeded in the project area. The conditions on the structural management of the executing agency is well organized. Therefore, in conclusion, the implementation of this project under the Japanese grant aid has significance and is feasible.

8-2 Recommended Concepts

The project sites which will use groundwater were selected based on hydrogeological analysis. Implementation will be carried out along the priorities of sites upon consideration of various factors.

Since the rainy season covers a large portion of the year and considering the conditions and project scale of the Japanese grant aid system, phasing of works is necessary. Each site and each facilities system of this project can be planned independently, and therefore, phasing will not cause any difficulties and each phase will be self-accomplished.

Since rehabilitation of existing facilities is included in the surface water use plan, the integration of the new facilities with the existing ones is important and construction must be carried out without hindrance in operation to the present system. Furthermore, the management cost for the completed facilities of this surface water portion, unlike that in other rural water supply projects, will be borne not only by the management compensation from the administration, but also by the inhabitants on their own initiative. As a result, a rational water fee system to correspond to the self-efforts of the villagers will be established.

With respect to the groundwater portion, the reinforced special task force will construct borehole type wells using the supplied equipment and materials after completion of construction by the Japanese side. However, the Sierra Leonean government must strive for acceleration of these undertakings and research on groundwater development by providing personnel, budget and other assistances. Furthermore, the timely utilization of the spare parts and related equipment and materials supplied from Japan is highly recommended.

APPENDICES

APPENDIX 1 MINUTES OF MEETING

MINUTES OF DISCUSSIONS

ON

THE RURAL WATER SUPPLY PROJECT

IN

THE REPUBLIC OF SIERRA LEONE

In response to the request of the Government of the Republic of Sierra Leone, the Government of Japan decided to conduct a basic design study on the Rural Water Supply Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Sierra Leone the study team headed by Mr Hiroshi Igarashi, Head of the Second Construction Section, Construction Division, Extension Department, Water Supply Bureau, Sapporo City Government.

The team had a series of discussions on the Project with the officials concerned of the Government of Sierra Leone and conducted a field survey in the Northern Province.

As a result of the study, both parties agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Freetown, 26th of February, 1986

Hiroshi IGARSHI
Team Leader
Japanese Study Team

Simon CAREW
Acting Director
Economic and Technical Cooperation Division

A T T A C H M E N T

1. The object of the Project is to construct water supply facilities and boreholes and to provide the necessary equipment and materials for the people of the rural area in the Northern Province where drinking water is urgently needed.

2. The scope of work for the Project is:

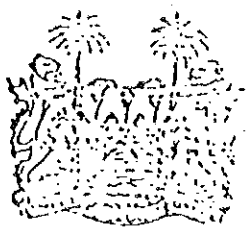
   (a) to install and rehabilitate water supply facilities such as pumping equipment, treatment plant and pipeline for the communities using surface water resources and drilled wells of borehole type for those tapping ground-water resources and the supply of well drilling machinery, pumping equipment, treatment plant units and related materials.

   (b) to provide on-the-job training under the programme of technology transfer utilising equipment and materials donated by the government of Japan.

3. The Ministry of Works, Energy and Power is responsible for the land acquisition, implementation, and operation and maintenance of the Project.

4. Before the Japanese Grant Aid is extended to the Government of Sierra Leone, the Government will take the measures listed out in the Appendix.

5. Both parties confirmed that the study team explained the Japanese grant aid programme and the Sierra Leonean side has understood it.



A P P E N D I X

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

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

2. To provide, secure, clear and level land at each construction site prior to the commencement of construction of water supply facilities (borehole, treatment plant etc.)

3. To provide and secure land to serve as base for workshop as well as storage of materials, equipment and other construction items both in Freetown and at the project sites. This land should be cleared and levelled before the start of construction.

4. To prepare access roads to the site before the start of construction.

5. To bear commissions to the Japanese foreign exchange bank for the banking arrangement.

6. To ensure prompt unloading, tax exemption, customs clearance of the products at the port of disembarkation in Freetown and prompt internal transportation therein of the products and related equipment under the grant.

7. To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in Sierra Leone with respect to the supply of the products and the services under the verified contracts.

.../...

8. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contracts, such formalities as may be necessary for their entry into Sierra Leone and stay therein for the performance of their work.

9. To bear all expenses, other than those to be borne by the grant aid, necessary for execution of the Project.

10. To organize necessary counterpart staff in the Water Supply Division for the execution (siting, drilling, installation of water supply systems and wells etc.) prior to the commencement of the project. The counterpart staff should preferably include the hydrogeological study team from the Land and Water Development Division of the Ministry of Agriculture and Natural Resources.

11. To indentify an appropriate institutional framework for item 10 mentioned above.

12. To take necessary measure to secure acquisition of essential local items necessary for the execution of the project.

13. To maintain and use properly and effectively the facilities constructed as well as the equipment and machinery provided under the grant.

APPENDIX 2 STUDY TEAM MEMBER LIST

Name	Function	
Hiroshi Igarashi	Leader	Chief of 2nd Construction Section Construction Division Extension Department Water Works Bureau Sapporo Municipal Government
Kaname Kita	Project Coordinator	2nd Experts Assignments Div. Experts Assignment Department Japan International Cooperation Agency (J I C A)
Kanji Takamatsu	Water Supply Planner	Pacific Consultants International
Yoshitaka Hamanaka	Equipment Planner	Pacific Consultants International
Tsutomu Yamauchi	Hydrogeologist	Pacific Consultants International

APPENDIX 3 ITINERARY OF FIELD SURVEY

No.	Date	Day	Schedule	Survey Activity
1	2/14	Fri	Leave Tokyo	
2	2/15	Sat	In transit	
3	2/16	Sun	Arrive Freetown (FRN)	
4	2/17	Mon	FRN MFA, MWEP (WSD)	Courtesy call, meeting
5	2/18	Tue	FRN WSD, MANR (LWDD)	Courtesy call, meeting
6	2/19	Wed	FRN Guma Valley Water Company	Observation
7	2/20	Thu	FRN Min. of Trade and Ind., WSD, MFA	Courtesy call, meeting
8	2/21	Fri	Kambia District	Field survey
9	2/22	Sat	Kambia District	Field survey
10	2/23	Sun	FRN	Data organization, team meeting
11	2/24	Mon	FRN WSD, LWDD	Meeting, WSD Workshop · Kissy Stores survey, Minutes preparation
12	2/25	Tue	FRN Kissy open space(WSD), MFA	Depot candidate site survey, meeting on Minutes
13	2/26	Wed	FRN MFA, WSD	Minutes signing, reporting
14	2/27	Thu	FRN WSD	Mr. Igarashi and Mr. Kita depart to Monrovia
15	2/28	Fri	FRN LWDD	Meeting
16	3/1	Sat	FRN WSD, LWDD	Meeting, data collection
17	3/2	Sun	FRN	Data organization, team meeting

No.	Date	Day	Schedule	Survey Activity
18	3／3	Mon	FRN WSD, LWDD	Meeting
19	3／4	Tue	FRN WSD, MFA, LWDD, others	Meeting on questionnaire, cost estimate data, Bombali survey
20	3／5	Wed	Bombali, Lunsar Health Center & Schools	Field survey
21	3／6	Thu	Bombali District	Field survey
22	3／7	Fri	Bombali District	Field survey
23	3／8	Sat	FRN WSD, LWDD	Meeting, reporting, data collection
24	3／9	Sun	FRN	Data organization, team meeting
25	3／10	Mon	FRN WSD, LWDD, UNDP, Min. of Health	Meeting, reporting, data collection
26	3／11	Tue	FRN WSD, MFA	Data collection, final meeting
27	3／12	Wed	Leave Freetown	
28	3／13	Thu	In transit	
29	3／14	Fri	In transit	
30	3／15	Sat	Arrive in Tokyo	