THE MINISTRY OF WATER DEVELOPMENT

THE REPUBLIC OF KENYA

BASIC DESIGN STUDY

ON

KAJIADO/NAROK GROUNDWATER DEVELOPMENT

MARCH, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Republic of Kenya, the Japanese Government decided to conduct a survey on Kajiado - Narok Underground Water Development Project and entrusted the survey to the Japan International Cooperation Agency (J.I.C.A.). The J.I.C.A. sent to Republic of Kenya a survey team headed by Mr. Kiyoshi KATOH, Director, Grant Aid Dept., J.I.C.A., from November 9th, 1981 to January 23th, 1982.

The team had discussions with the officials concerned of the Government of Republic of Kenya and conducted a field survey (in Kajiado - Narok area, in Republic of Kenya). 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 Republic of Kenya for their close cooperation extended to the team.

March, 1982

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency

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SUMMARY

Necessity of the Grant Aid to the Project has been identified by the Contact Mission of Japan International Cooperation Agency despatched to Kenya in the last September. The major objectives of this basic design study are to study feasibility of the requested grant aid to the project, to identify necessary items of the grant aid and to evaluate the proposed grant aid. In addition, hydrogeological investigation has been carried out for the purpose of technology transfer and technical assistance for the selected 10 sites.

The total area of the Republic is 580,000 km^2 located in the tropical eastern part of East Africa where a large dry land occupies in the inland area. The land is classified into six areas based on the ecological conditions in Kenya. According to the above classification, almost 70% of the total population distributes in the relatively dry areas extending over 80% of the total area of Kenya. The rest of 30% of national population is concentrated in urban areas. There found significant differences in the living standards and social service levels between the two areas. Development of dry areas in general aspect of living standard is far behind that of urban areas, however, development in dry areas especially for livestock development, is assumed to be high and a large number of people are engaged in cattle keeping. Under the circumstances, one of the most important development policies in the Republic is to eliminate these differences in living standards between urban and rural areas. An emphasis has been placed on the water development and the improvement of rural water supply. The Ministry of Water Development is responsible for these development.

Based on the above development policy the Government set up the target to complete water supply to everybody in the nation by the year 2000. Much effort have been made for this target. The importance and necessity of this development policy have been appreciated by the United Nations and foreign

countries. Various kinds of international cooperation have been provided for water development projects from many donor countries. A total of 4,800 million shillings was estimated for the water development in the National Development Plan from 1979 to 1983. Half of this estimate is supposed to be provided by various types of foreign assistance. Out of these assistance, about 126 million shillings has been contracted already.

Although there are difficulties in crop cultivation in the dry areas, the development potential in livestock development is high. Since 1968, Kenya Livestock Development Project (KLDP) has started to increase beef production assisted by International Development Association (IDA). For the Phase 1 of KLDP 36 million U.S. dollars was provided to the project for the fund of local loans. Following to the Phase 1, another 60 million U.S. dollars were available for the Phase 2 of KLDP for which foreign assistance was obtained from IDA, Canada, the United Kingdom and the United States. One of the important objectives of KLDP is to supply water to cattle and people engaged in livestock keeping. For this purpose, an indented branch, Ranch Water Branch, has been established in the Engineering Department of the Ministry of Water Development.

The Ministry of Water Development has responsibility for the water supply schemes. In the Ministry, the Water Resources Department has responsibility for an assessment of water resources and construction of production wells and the Engineering Department is responsible for planning, design and construction of water supply schemes.

The major development programmes for rural water supply are:

Rural Water Supplies Programme: This is a development programme started in 1979. From the first phase to the third phase of this programme completed more than 130 rural water supply schemes at the total cost of 440 million shillings.

Since 1978, sixty-five schemes are planned in the Phase IV with the total cost of 1,000 million shillings. The implementation of Phase IV is undergoing and additional planning of Phase V is under preparation.

Ranch Water Development Programme: This is a water supply programme for livestock development as an integral part of KLDP. Planning of water supply schemes of this programme started in the first half of 1970s and the construction commenced in the second half of 1970s. Already five water supply facilities were constructed for livestock and people engaged in ranches.

As described above, many rural water supply schemes have been planned and constructed in dry areas. Most of the water sources of these rural water supply are obtained from the groundwater since surface water is scarce. Therefore, the demand for the groundwater has been increasing so rapidly in the dry areas that the working capacity of the drilling section of the Ministry cannot afford boreholes to the demand.

Under the circumstances, the Ministry planned the project to intensify water supply in Kajiado and Narok Districts which have the highest potential for livestock development among these dry areas in the Republic. For this poupose the Government determined to organize special drilling teams for these two Districts. The Grant Aid is requested for Japanese Government to obtain the drilling equipment and machinery with necessary quantity of casings and screens for the project.

At present, there are 12 communal water supply facilities and 164 boreholes in the project area. The total capacity of these facilities and boreholes is 8,900 m^3/day. On the other hand, the total existing demand is 55,500 m^3/day. Only 16% of population has access to the clean water. Considering the total demand of the target year 2000, 102,000 m^3/day, it is very urgent to implement water supply schemes in Kajiado and Narok Districts.

For the groundwater development project the Ministry has selected 66 sites according to the priority list:

Rural Water Supplies Programme Phase V : 19 sites
Ranch Water Development Programme : 47 sites

The total construction cost is estimated at 86 million shillings to supply water for 30,000 people and 15,000 km^2 of ranch lands as summarized below:

	Rural Water Supply Phase V			Ranch Water Development			Total
	No. of Sites	No. of Population Served	Construction Cost (Mil. Sh.)	No. of Sites	Area (km^2)	Construction Cost (Mil. Sh.)	(Mil. Sh.)
Kajiado District	9	16,000	13.8	30	9,800	39.3	53.1
Narok District	10	14,000	11.7	17	5,200	20.9	32.6
Total	19	30,000	25.5	47		60.2	85.7

The construction period is estimated for four years starting from 1982.

The average construction cost is estimated at 850 shillings for each person of the Rural Water Supply and 40 shillings for one hectare of ranch land of Ranch Water Development. These unit costs are considered to be a reasonable size compared with other unit cost of the rural water supply of the same type in the Republic.

The maximum borehole yield of 16 m^3/hr is recorded in the area and the most common yield ranges from 4 m^3/hr to 6 m^3/hr. However, more yield will be obtainable when the hydrogeological investigation is carried out for the site selection. In the most cases these boreholes will meet only small scale water supply schemes which are common in the project area.

The groundwater in the project area tends to be relatively high salinity, however, most of the chemical analysis indicates these groundwater meet the drinking water quality standard grade II of W.H.O. criteria except some cases which have high content of fluoride in valcanic area.

By the implementation of this project the percentage of pupulation served by improved water supply will increase to 30 % from the existing percentage of 16 %. The magnitude of 30 % is not impressive, however, this project will double the existing pupulation with clean water and will supply water to 15,000 km^2 of ranch lands. Considering the above effects, the contribution of the project to water shortage problems and the livestock development in the area can be appreciated. In addition, through the project implementation the new fully equipped drilling teams will be organized and operational within the Water Resources Development.

Based on the Basic Design Study including discussions made with the government officials concerned, it is proposed to provide two sets of drilling machines and the necessary screens and casings for the project by the Grant Aid as listed in Appendix 1. The total cost of the items necessary for the Grant Aid is estimated at 48 million shillings at C.I.F. Mombasa.

The total cost of the project is estimated at 86 million shillings. Out of this the Grant Aid will contrubute to almost 60 % of the total project cost. Therefore, the balance of 38 million shillings is the responsibility of the Government of Kenya.

Since the type of drilling machines are new to the Ministry and the drilling operation will be carried out with various combinations of equipment and machines, operational and mechanical training for the drillers and mechanics will be necessary. The training service to be provided by the supplier of the equipment should be at least 6 months and preferably one year.

Further international technical cooperation following to this training service will be benefitial to the project.

There are many different kinds of foreign assistance in the Ministry and in many cases a coordinator is dispatched from the donor agency. The coordinator's function is to coordinate the smooth operation of the project. It is desirable to have Japanese experts for this purpose within the Ministry. A design engineer or a planning engineer of rural water supply in the Engineering Department is recommended.

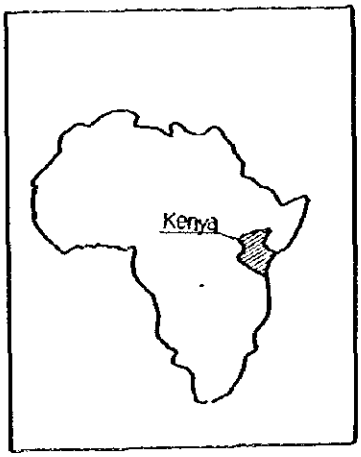
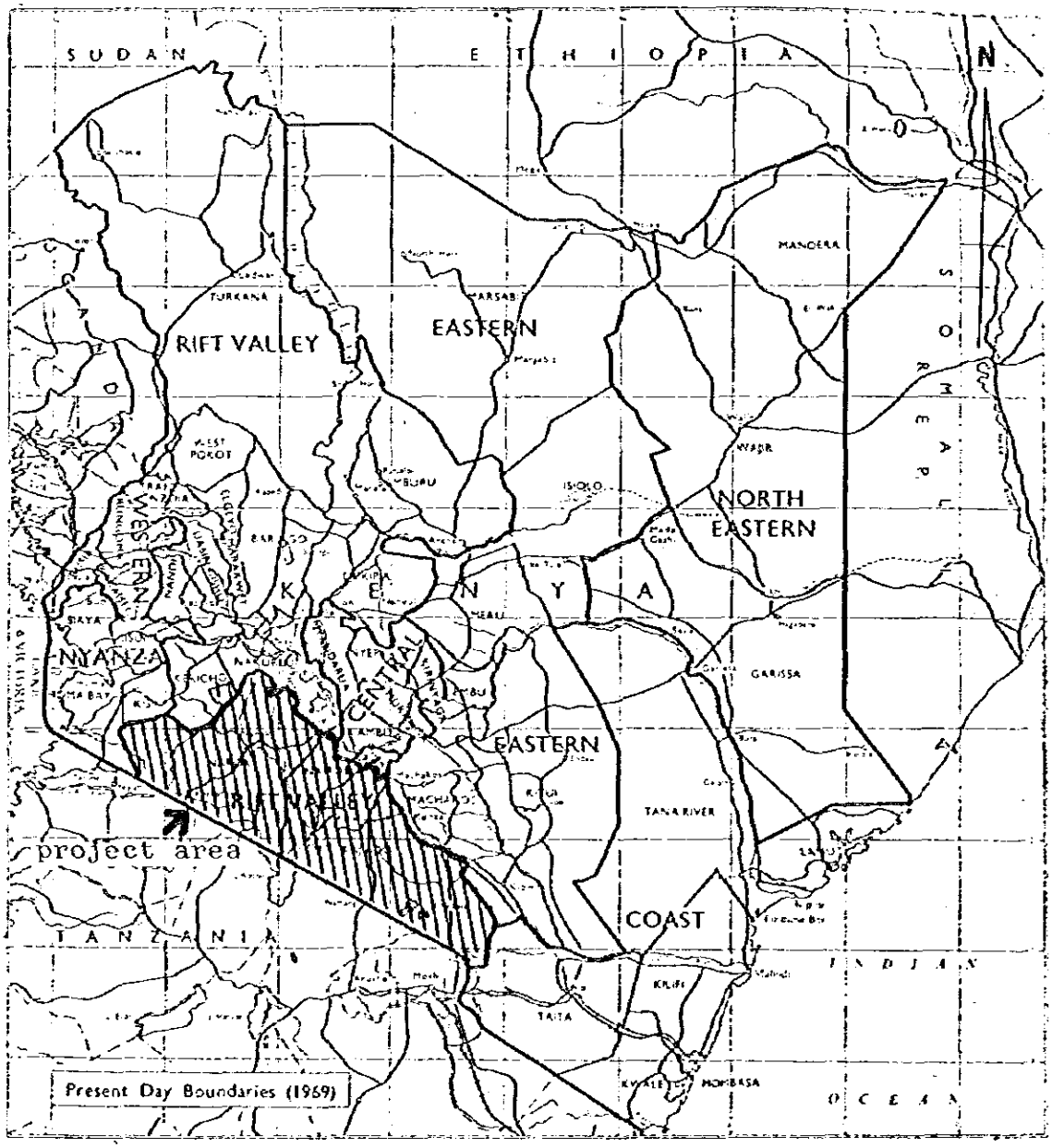


Fig.-1 PROJECT SITES



CHAPTER 1

BACKGROUND OF REQUEST FOR GRANT AID PROJECT AND CONTENT OF THE BASIC STUDY

1-1 Background

Due to the severe climatic conditions, a greater part of the country is covered by dry areas, and amount of available water resources is limited both in time and space. In order to utilize such precious water resources efficiently and to allocate it equitablly, the water development is one of the national development plicies with the highest priority. In the national development plan during 5 years from 1979 to 1983 a total of 6,400 million shillings has been allocated for this purpose.

In 1970, the government declared to complete water supply to everybody in the country to serve clean and adequate water by the year 2,000. Accordingly, enormous efforts have been made for improvement and construction of water supplies. However, conditions influencing this intension have not been favourable. There has been shortage of skilled manpower, inflation, financial problems, and limited availability of water sources.

At present about 2,600,000 people are served by improved water supply in urban areas and only 1,480,000 people have access to safe and clean water in rural areas. The total number of people served by improved water supply at present is estimated 4,100,000 people out of 14,900,000 of entire national population.

Only about 28% of the total population has opportunity to have clean and safe drinking water. To achieve above mentioned target for water supply development, much efforts will be required.

Including water supply development the government set up the water development programme target as below:

Programme Targets

5.231. Development activities in the water sector can be classified according to whether they are primarily concerned with the water supply needs of rural dwellers or primarily aimed at expanding water supplies in urban places. Within these two broad classes, and taking into account the resource constraint, programme targets have been set for the 1979-1983 plan period. These are:-

i To expand the coverage of improved water supplies to include more people residing in the rural areas thereby increasing the total rural population served to over 4 million people by 1983.

ii To increase the number of people served by an improved water supply in urban places by 1,360,000 so that the total urban population served will be approximately 3,945,000 people by 1983.

iii To achieve a better balance between the sewerage systems and the water supplies in some of the larger urban places.

iv To complete Stage I of the National Master Water Plan concerned with data collection, and then to move into Stage II concerned with the master plan for the national use of water resources over the next thirty years or so.

v To increase substantially the effort applied to water conservation over the plan period in recognition of the increasing importance of conserving as much as possible of the nation's water resources and relate it to the soil conservation programme.

vi To expand activities in the areas of flood protection and drainage of swamps and valley floors as part of the effort to increase the quantity of agriculturally productive land in the country.

vii To expand the use of water for minor irrigation activity throughout the country.

viii To upgrade substantially the role of the private sector water development activity and to integrate this effort more completely with planned public sector activities and self-help activities.

In addition, necessary measures against desertification and one step ahead, development of dry areas are also emphasized in the 5 year development plan. The purpose of this emphasis is to eliminate difference of social service levels and living standards in the dry areas compared to those of more advanced areas in humid climate. In order to attain above target the livestock development programme has high priority in the national development plan to activate economy in dry areas. Again water supply has to play one of key roles in the course of this objective.

Aiming at attainment of these targets the water resources department was established in the Ministry of Water Development in 1974. Major function given to this new department are to assess available water sources both of surface water and groundwater for their most efficient usage. Construction of production wells is also another important function of this department.

Since its establishment, however, the activity of the water resources department is not satisfactory. This has been due in part to a shortage of skilled man-power and insufficient equipment and machineries.

Insufficient drilling equipment has caused delay in construction of boreholes which results in the set-backs of livestock development and improvement of water supply in dry areas.

Aiming at distruption of this vicious circle the Ministry of Water Development determined to organize well equipped drilling teams for groundwater development for Kajiado/ Narok Districts in Rift Valley Province. These two Districts have higher productity potentials among other dry areas suffering from shortage of water. (see Chapter 4)

For this purpose a request is made by the Ministry for the grant aid project of the Government of Japan to be incorporated into the intensive rural water supply project for Kajiado/Narok Districts.

1-2 Content of Basic Design Study

This basic design study for Kajiado/Narok Groundwater Development Project has been based on the results of the previous study made by the contact mission for the Project. Objectives of the basic design study are to study feasibility of the grant aid to the project to identify necessary contents of the proposed grant aid and to evaluate the proposed grand aid.
Additionally, groundwater investigation including resistivity survey was carried out at 10 sites selected by the Ministry and District Development Committee. These sites are either high priority sites or sites where hydrogeological conditions are infavourable for easy exploration of groundwater. Another objective of the groundwater investigation was training of counter part staff members with new resistivity meters provided by the Government of Japan to the Ministry. (APPENDIX 6)

This training as well as data analysis of resistivity survey has been performed satisfactorily.
Conclusion and recommendations of the groundwater investigation is summarized in APPENDIX 2 of this report.

In order to identify necessity of the proposed grant aid and to assess its feasibility, it is required to throw a light to the Rural Water Supplies Programme including

Ranch Water Development to figure out the proposed schemes. The Basic Study has been started with this in mind.

According to the regulations and operation system in the Ministry for rural water supply scheme which take their water sources from groundwater, it is necessary to have inter-departmental cooperation between the Engineering Department and Water Resources Department. The Water Resources Department is responsible for studies and surveys for water source planning and construction of production wells, while the Engineering Department is responsible for planning, design and construction of the water supply schemes.

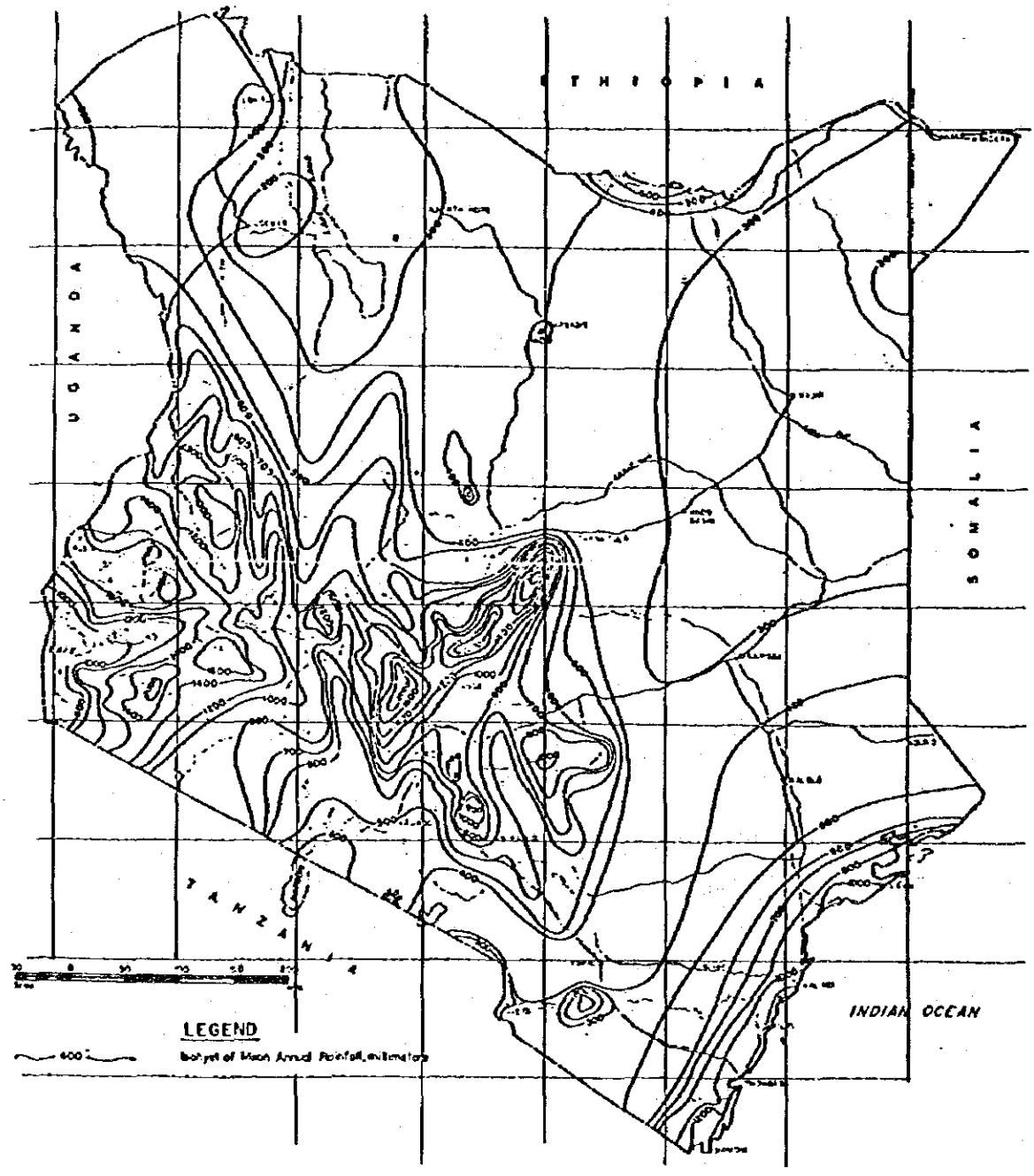
Therefore, cooperation has been obtained from both of the Departments for the Basic Study. In addition to such cooperation a request was made by the Engineering Department for Dam Construction Units (D.C.U.) to be included in this proposed grant aid.
This is an idea to construct small scale earth dams or dikes to store surface water which would otherwise lost downstream. This idea has been proved to be effective in northern dry areas and a grant aid for D.C.U.s has been made by West Germany. Additional D.C.U.s will be available in a similar grant from IRDB. In dry areas in Kenya, the majority of reliable water sources are groundwater. However, it may take a long time and a large amount of capital may be required to fully equip the drilling section with drilling machinery in the Ministry. Until that time D.C.U.s can be used for watering points for livestock and mini-irrigation as an urgent solution of the problem.
The usefullness and importance of D.C.U.s is generally admitted. At that point in time, however, it is difficult to give consideration to D.C.U. within the scope of work for the Basic Design Study.

For the introduction to D.C.U., a list of typical equipment for D.C.U.s is shown in APPENDIX 5 of this report.
The sites of Rural Water Supplies Programme and Ranch Water Development Programme in relation to Kajiado/Narok Groundwater Development Project have recently been selected by the District Development Committee of each District and their implementation has been determined by the Ministry. However, all of these water supply schemes are still in the initial stage of the project implementation.

Details are to be further studied and final designs will be completed by the Engineering Department of the Ministry.

Under the circumstance, the Basic Design Study has been proceeded to identify the outline of the project by using estimates and some assumptions for the purpose of assessment of Grant Aid feasibility and identification of necessary items of Grant Aid in relation to the water supply project under preparation by the Ministry.
Finally discussions were made between Basic Design Study Team and Government officials concerned to determine the proposed specification and quantity of items to be provided by the Grant Aid Items.

Fig.-2 AVERAGE ANNUAL RAINFALL IN KENYA



CHAPTER 2

GENERAL DESCRIPTION OF ECONOMY AND DEVELOPMENT POLICY OF THE REPUBLIC OF KENYA

2-1 Natural Environment

Kenya is located in the eastern part of the African Continent and covers an area of 580,367 km^2. The eastern part faces the Indian Ocean and the northern part touches the border of Somali, Ethiopia, and the Sudan. The western part borders Uganda and its southern part borders Tanzania. Extreme difference in the weather, from very dry to fair conditions, greatly influences agriculture production.

The Rift Valley divides Kenya geographically into west and east regions. The width of the Rift Valley varies from 50 to 80 km and the height of the cliff of the valley varies from 600 to 1500 m. There are 9 lakes between the Ethiopian and Tanzanian border. Lake Turkana, located in the far north of the country, and Lake Victoria, located on the Ugandan border are the centers of fresh water fisheries. The high lands in the central part of the country range from 1000 m to 2000 m above sea level. In the central part of Kenya, which is right beneath the equator, Mt. Kenya rises to a height of over 5000 m. There are 5,300,000 hectares of woodland, and 80,000 hectares of high or mountainous region which has no vegitation. Total cultivatable agricultural land is 10,600,000 hectares. Land which is suitable for livestock farming (30,000,000 hectares), makes up the largest part. Out of the total area available, about 18% of the land is suitable for agriculture with another 9% marginally suitable. Grassy plains suitable for livestock farming covers 52% of the land and the remaining 21% is wasteland.

The climate of this area is generally divided into three zones as follows:

Dry climate Zone - North-eastern border area
Tropical climate Zone - Indian Ocean area
Semi-tropical Climate Zone - Western highlands located west of Mt. Kenya

The average annual maximum temperature on the coast of the Indian Ocean is 32.7°C and the annual minimum temperature is 20°C. The climate in the highland area is relatively mild although the temperature is high. These climatatic features as well as location, altitude and volume of rainfall directly affect the productivity of the land. From a climatic point of view, the best suitable agricultural land is the western highlands which vary from 1,000 to 2,000 m above sea level. Because its climate is very mild and there is plenty of fertile soil available it was developed from early days.

The northern and northeastern regions, which make up 60% of the total land, are semi-desert dry zones and are not suitable for agriculture. Table 1 shows the annual temperature of the country by month and city.

Table 1

Mean Monthly Maximum and Minimum Air Temperature at Major Towns in Kenya

Month / City	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Nairobi	25.3	26.6	25.6	24.8	23.8	23.4	22.5	23.7	26.7	26.4	25.1	24.3
	(11.3)	(12.6)	(14.3)	(15.0)	(12.5)	(11.4)	(11.0	(11.2)	(11.5)	(13.2)	(13.2)	(14.1)
Nakuru	25.6	27.0	29.4	24.3	24.4	24.3	23.1	24.3	24.6	24.1	24.2	24.9
	(8.5)	(9.7)	(12.3)	(11.3)	(10.3)	(10.2)	(10.6)	(10.5)	(8.5)	(9.5)	(9.1)	(10.9)
Mombasa	32.9	32.3	32.2	30.2	29.5	28.3	27.9	28.5	29.8	30.3	30.4	31.3
	(24.1)	(23.4)	(23.8)	(23.2)	(22.0)	(21.4)	(20.5)	(20.5)	(21.1)	(22.4)	(23.3)	(23.3)
El Dolet	22.5	24.5	23.1	23.4	23.3	22.2	20.8	22.0	22.4	22.8	23.0	23.2
	(9.8)	(10.8)	(12.0)	(11.8)	(10.0)	(9.6)	(9.9)	(10.0)	(9.0)	(10.9)	(10.7)	(11.2)
Kisumu	29.8	30.3	28.1	28.5	28.3	27.7	27.4	29.2	29.1	30.4	29.0	28.8
	(16.2)	(17.4)	(17.6)	(17.3)	(16.7)	(16.1)	(15.9)	(16.5)	(15.7)	(16.9)	(16.3)	(17.6)

( ) Minimum Temperature

Rainfall in many regions average 600 mm per year. In the northeastern semi-dry zone, there is less than 250 mm of rainfall per year. In the western part, such as the coastal region of Lake Victoria and the southern slope of Mt. Kenya, there is approximately 2,000 mm of rain per year. Thus, there are great differences in the amount of rainfall by region and this causes a difference in agricultural productivity. When dividing the country into regions according to rainfall, we come up with the following four:

(1) the region from Kitale to Nairobi with approximately 1,300 mm of rain per year,
(2) the coastal area of Lake Victoria which averages 1,000 mm of rain per year,
(3) the region from Nairobi to the Tanzanian border with 600 mm of rain per year, and
(4) the coastal area of the Indian Ocean around Mombasa which has about 800 mm of rain per year.

Differences in the length of cycle between the rainy season and dry seasons in each region regulate the cultivation of crops - the time for planting seeds and for harvesting. Although rain falls throughout the year in Kenya, there are two main rainy seasons. The time for planting seeds and harvesting is coordinated with these seasons. For instance, planting seeds of maize is generally done in the first rainy season. The matured crop is then harvested at the end of the dry season before the next rainy season. A typical example of agricultural operation is seen in the farms of the Kikuyu Tribe. In this region, the average rainfall per year ranges from 900 to 1,000 mm. The rainy season and dry season are each divided into two sub-seasons. The season for planting is largely in the rainy season and the season for cultivating is mainly in the first half of the small dry season.

2-2 Population

Although the latest census was in 1978, the detailed results of the census have not yet been published. According to the population census done in 1969, the total population of Kenya was 10,942,705. The estimate for the total population of Kenya in 1979 was 15,000,000. This makes the average population increase between 1969 and 1978 about 3.4%. According to statistics and estimates published by FAO in 1977, the farming population was about 78.5% of the total population. But it decreases slightly every year.
In the whole continent of Africa, many different tribes live together in small regions. Kenya is no exception. The living condition and style of each tribe varies depending on the natural conditions of the region where they live. The following is a list of major tribes in the country.

Language	Tribe
Bantu	Kamba, Kisil, Luhya, Kikuyu
Nifotes	Samburu, Luo
Nilo-Manites	Turkane, Masai
Cushites	Sowali

2-3 Description of National Economy

In 1963, the Republic of Kenya gained its independence from colonial British rules. The guideline for the economic policy after independence is outlined in sessional paper No. 10 of "African Socialism and its Applications to Planning in Kenya", published in 1965. Following this guideline, the first 5-year plan (1966 - 1970) stated clear targets for economic development. In this 5-year plan, the target is to achieve an increase in the per capita income while following

the basic rules of political equality, socialism, human respect and equal opportunity. Kenya decided to build its economy under a free market system. The economic development concept of the government can be summerized into the following three items; increase of per capital income, Kenyanization of the economy, and fair distribution of wealth. The fair distribution of wealth under the free market economy is planned through the development of various public corporations and cooperatives.

The average annual progress rate of the GDP by elemental expenditures from 1964 to 1972 was 6.6 percent. This figure combines both the monetary and traditional sectors of the economy. The former sector showed a growth rate of 7.5 percent and the later 3.7 percent.

In the field of agriculture, the monetary economic sector marked a 6% growth rate and non-monetary sector showed a 3.6% growth rate. The first 5-year development plan gave top priority to the Kenyanization of the economy while development of the agricultural village was given lower priority. The second 5-year plan, from 1970 to 1974, set its priority in the development of farming villages. Although the capital investment of the agriculture sector had been allocated to mechanization and livestocks, it was not given enough for land reformation and development of plantations. The third 5-year development plan from 1974 to 1978, followed the major policies of the second 5-year plan. Increased agricultural production was set as its ultimate target with special attention given to the fair distribution of wealth. Emphasis was placed on agricultural village development and the increase of employment opportunities.
As Kenya is not an oil producing country, its economy was heavily hit by the Oil Shock and after taking the inflation rate into account the net GDP growth rate per capital was only an average of 1.9% per year during the third 5-year plan.

At the beginning of the fourth 5-year plan (1979-1983), the government of Kenya reaffirmed the basic principle of its economic development. They are: 1) participation of the people throughout the country, 2) diversification of development methods, 3) positive participation of the government, and 4) "Harambee" (Mutual cooperation).
In this fourth development plan, the highest priority was given to the elimination of poverty and the increase of living standard.
Table 2 and 3 show the GDP growth rate in the years after 1976. (GDP per capital is calculated based upon a 3.6% growth rate population.)

Table 2 GROSS DOMESTIC PRODUCTION (1976 - 1979)

(Unit: 1,000,000 Kenya Pond)

	Actual Price				Price of Year, 1976			
	1976	1977	1978	1979*	1976	1977	1978	1979*
A. TRADITIONAL ECONOMY								
Forestry	9.40	10.77	13.30	15.21	9.40	9.88	10.04	10.32
Fishery	0.29	0.29	0.43	0.47	0.29	0.30	0.34	0.36
Construction	21.86	25.99	31.01	36.70	21.86	22.71	23.32	24.00
Water Supply	8.90	11.11	12.66	14.35	8.90	9.41	9.56	9.84
Housing Property	29.36	35.68	43.15	52.06	29.36	30.59	31.86	33.17
TOTAL	69.81	83.84	100.55	118.79	69.81	72.89	75.12	77.69
B. MONETARY ECONOMY								
1. Manufacturing, Organization								
Agriculture	466.15	668.01	631.73	648.78	466.15	513.60	533.31	529.05
Forestry	6.24	6.89	8.25	10.70	6.24	6.72	6.94	7.17
Fishery	2.36	2.33	3.52	3.87	2.36	2.36	2.75	3.00
Mineralizer	3.41	4.17	4.41	5.04	3.41	4.05	4.14	4.52
Production	144.18	179.04	219.32	249.84	144.18	167.10	188.16	201.56
Construction	45.22	53.94	66.88	80.83	45.22	49.34	55.26	60.29
Electricity, Water Supply	14.20	19.96	23.05	27.06	14.20	16.42	17.82	19.57
Export, Restaurant, Hotel	132.54	164.63	189.34	209.22	132.54	143.59	155.92	154.36
Transport & Communication	69.15	78.62	100.84	114.65	69.15	73.74	81.40	87.26
Bank, Insurance, Movable	68.03	82.98	96.22	108.73	68.03	71.98	77.59	81.31
Housing Property Property	58.06	67.50	78.43	84.89	58.06	60.48	62.49	64.85
Other Service	27.00	30.80	35.46	43.01	27.00	28.69	30.46	32.67
Service Charge of Bank	− 23.88	− 31.80	137.31	− 42.16	− 23.88	− 26.79	− 28.76	− 30.64
TOTAL	1012.66	1327.97	1420.14	1545.36	1012.66	1111.28	1187.48	1214.97
2. Internal Service	10.93	13.44	17.06	20.56	10.93	12.04	13.91	15.51
3. Governmental Service								
Public Administration	43.08	48.52	56.91	..	43.08	44.08	47.47	..
Self Defense	9.63	11.73	13.49	..	9.63	10.63	11.37	..
Education	82.75	94.43	107.51	..	82.75	83.99	89.20	..
Social Welfare	17.43	21.90	27.40	..	17.43	19.43	20.63	..
Agricultural Service	11.36	13.78	16.51	..	11.36	13.52	13.68	..
Other service	20.46	25.04	28.84	..	20.46	22.40	24.08	..
TOTAL	184.70	215.40	250.66	290.26	184.71	194.05	206.43	221.09
Total of Monetary Economy	1208.29	1556.81	1687.86	1856.18	1208.29	1317.37	1407.82	1451.57
Total of G.D.P.	1278.10	1640.65	1788.41	1974.97	1278.10	1390.26	1482.94	1529.26
G.D.P./Person (Kenya Pond)	92.30	114.43	120.38	128.16	92.80	96.97	98.82	99.24

* : Estimation

Source: Central Bureau of Statistics, Economic Survey, 1980.

Table 3 GROWTH RATE OF G.D.P. (1976 - 1979)

(Unit: %)

	Actual Price				Price of year, 1976			
	1976-77	1977-78	1978-79	1976-79 Average	1976-77	1977-78	1978-79	1976-79 Average
A. TRADITIONAL ECONOMY								
Forestry	14.6	23.5	14.4	17.4	5.1	1.6	2.8	3.1
Fishery	—	48.3	9.3	17.4	3.4	13.3	5.9	7.4
Construction	18.9	19.3	18.3	18.9	3.9	2.7	2.9	3.2
Water Supply	24.8	14.0	13.3	17.2	5.7	1.6	2.9	3.1
Housing Property	21.5	20.9	20.6	21.0	4.2	4.2	4.1	4.1
TOTAL	20.1	19.9	18.1	19.4	4.4	3.1	3.4	3.6
B. MONETARY ECONOMY								
1. Manufacturing, Organization								
Agriculture	43.3	— 5.4	2.7	11.6	10.2	3.8	— 0.8	4.3
Forestry	10.4	19.7	29.7	19.6	7.7	3.3	3.4	4.7
Fishery	— 1.3	51.1	9.9	17.9	—	16.5	9.1	8.3
Mineralizer	22.3	5.8	14.3	14.0	18.8	2.2	9.2	9.8
Production	24.8	21.9	13.9	20.1	15.6	12.6	7.1	11.7
Construction	19.3	24.0	20.9	21.4	9.1	12.0	9.1	10.1
Electricity, Water Supply	40.8	15.5	21.3	25.2	15.7	8.5	9.8	11.3
Export, Restaurant, Hotel	24.2	15.0	10.5	16.5	8.3	8.6	— 1.0	5.2
Transport & Communication	13.7	28.3	13.7	18.4	6.7	10.4	7.2	8.0
Bank, Insurance, Movable Property	22.0	16.0	13.0	17.0	5.8	7.8	4.8	6.1
Housing Property	16.3	16.2	8.2	13.4	4.2	3.3	3.8	3.8
Other Service	14.1	15.1	21.3	16.7	6.3	6.2	7.3	6.6
TOTAL (incl.Govn't.service)	31.1	6.9	8.8	15.2	9.7	6.9	2.3	6.3
2. Internal Service	23.0	26.9	20.6	23.4	10.2	15.5	11.5	12.4
3. Governmental Service								
Public Administration	12.6	17.3	..	..	2.3	7.7	..	..
Self Defense	21.8	15.0	..	..	10.4	7.0	..	..
Education	14.1	13.9	..	..	1.5	6.2	..	..
Social Welfare	25.6	25.1	..	..	11.5	6.2	..	..
Agricultural Service	21.3	19.8	..	..	19.0	1.2	..	..
Other Service	22.4	15.2	..	..	9.5	7.6	..	..
TOTAL	16.6	16.4	15.8	16.2	5.1	6.4	7.1	6.2
Total of Monetary Economy	28.8	8.4	10.0	15.4	9.0	6.9	3.1	6.3
Total of G.D.P.	28.4	10.5	10.4	15.8	8.8	6.6	3.1	6.2

Source: Economic Survey

2-4 The Basic Policy of the National Economic Development Plan

The most highly visible problems of the Kenyan economy are the wide spread poverty and uneven distribution of the wealth. Although the government of Kenya has put great effort into solving these problems they have been straggled, the same as other developing countires, by the ever increase population and unemployment.

Since independence, the government of Kenya has sought to increase income, Kenyanize the economy, and distribute the wealth fairly. Under the present 5-year development plan the government Bureau of Statistics has been carrying out comprehensive agricultural village surveys in order to determine an appropriate social index. At the same time, government financial aid is being given to universities to conduct socio-economic surveys of the agricultural sector.

From these surveys, differences of the people's incomes in the different districts can clearly be seen. One of the most important objectives of the government development plan is how to decrease such differences of income between each district. The lower income districts centered in the dry and semi-dry regions are of special concern but there are many areas where income levels are low.

These low income districts generally lack employment opportunities, land with water, good markets, financing, modern science technology, energy education and medical care. One of the basic policies for development is to provide equal distribution of these public services.

The development plan's object is to provide fair and equal services to the following 5 groups of the society.

1) Nomadic Pastoralists - those whose income is mainly from the care of livestock in a nomadic setting.

2) Small farmers - those with land who derive the majority of their income from working the land.
3) Landless rural workers - those who have little or no land and who derive the majority, perhaps all of their income from farm employment and non-farm rural activities.
4) Urban poor - those who live in poverty in the urban areas with limited income derived from self or wage employment.
5) The handicapped - those who must be given skills commensurate with their abilities, and opportunities to use those skills productively.

The two groups with the largest number of people are the nomadic pastoralists and small farmers. The key to eliminate poverty in these groups are to provide active economic promotion.

The Nomadic pastoral group is spread over half the total area of the Republic of Kenya and they own a majority of the livestock in the country. The greatest possibility for development is probably in the livestock industry.

It is essential to supply enough water to the people and livestock. Those regions, where the nomadic pastoral groups currently live, aŗe dry zones and groundwater is the main source of water. It is obvious its development is very important.

CHAPTER 3

GENERAL DESCRIPTION OF RURAL WATER SUPPLY IN KENYA

3-1 General Aspects of Water Supply in Kenya

Immediately after independence of the Republic, the government set a goal to provide clean and adequate water to everybody in the country by the year 2,000. Following this policy of water supply development, more than 3,000 water supply schemes have been completed, especially in rural areas.

Generally speaking, rural water supply schemes consist of very simple facilities. Water sources are commonly taken from springs and wells and design capacity is relatively small in dry areas. This can be attributed to the fact that the population density is very low and the capacity of water sources is limited due to dry conditions in the rural area. Of course, there are many medium to large scale rural water supply schemes in the Republic, but the majority of rural water supply schemes are on a small scale.

Since 1968, the Kenya Government has put a lot of effort into achieving the stated goal and have received foreign assistance from the World Health Organization and the United Nation International Children's Emergency Fund. The Ministry of Water Development and the Ministry of Health of the Government have been playing important roles in the improvement of water supplies. The increasing demand of rural water supplies, however, exceeds these efforts.

At present, about 2,700,000 people are served by improved water supply facilities in urban areas and only 1,480,000 people have access to safe and clean water in rural areas. The total number of people served by improved water supply at present is estimated at 4,151,000 out of the entire national population of 14,900,000.

Only about 28 percent of the total population have clean and safe drinking water.

The number of people having access to safe and clean drinking water in the Republic is summarized by province in Table 4.

Table 4

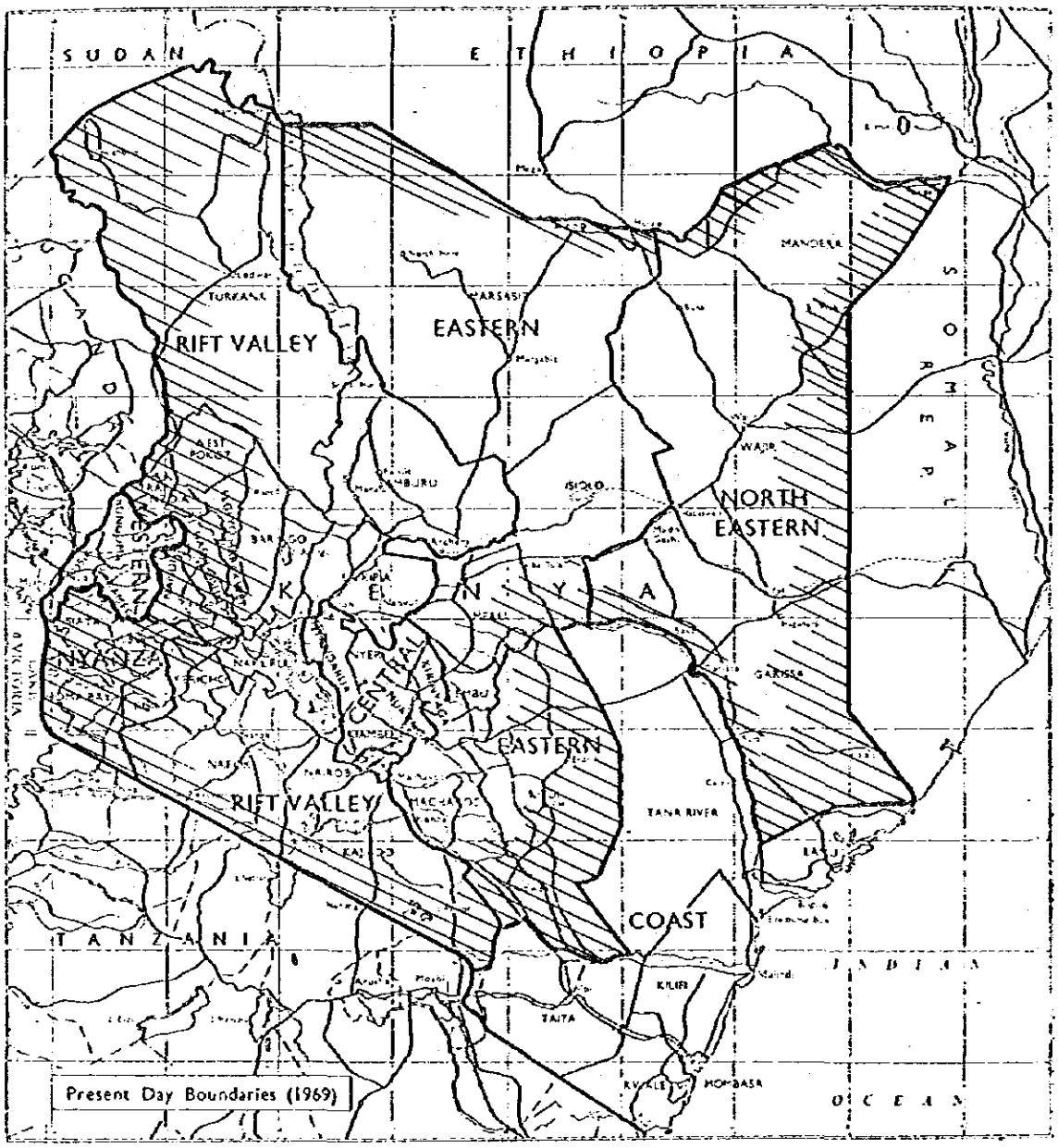
Size of Population Served by Improved Water Supply in Rural Areas by Province

Province	Population with Water Supply	Total Population	Percentage
Nairobi	877,000	965,000	91
Mombasa/Coast	880,000	1,331,000	66
Rift Valley	565,000	2,902,000	19
Nyanza	510,000	2,895,000	17
Eastern	435,000	2,486,000	17
Central	433,000	2,221,000	19
Western	430,000	1,795,000	24
Northern	21,000	278,000	7
TOTAL	4,151,000	14,873,000	27.9

Source: Min. of Water Development

At present, only about 28 percent of the people have access to improved water supply. This percentage is only an average and as can be readily seen the percentage for each province varies widely. The provinces of Nairobi and Mombasa/Coast have a high percentage of their population with improved water supply while the majority of the remaining Provinces have a very low percentage. Nairobi Province is very small and covers only a limited area extending from the capital, Nairobi.

Fig.-3 AREA WITH 20% OF POPULATION SERVED BY IMPROVED WATER SUPPLY



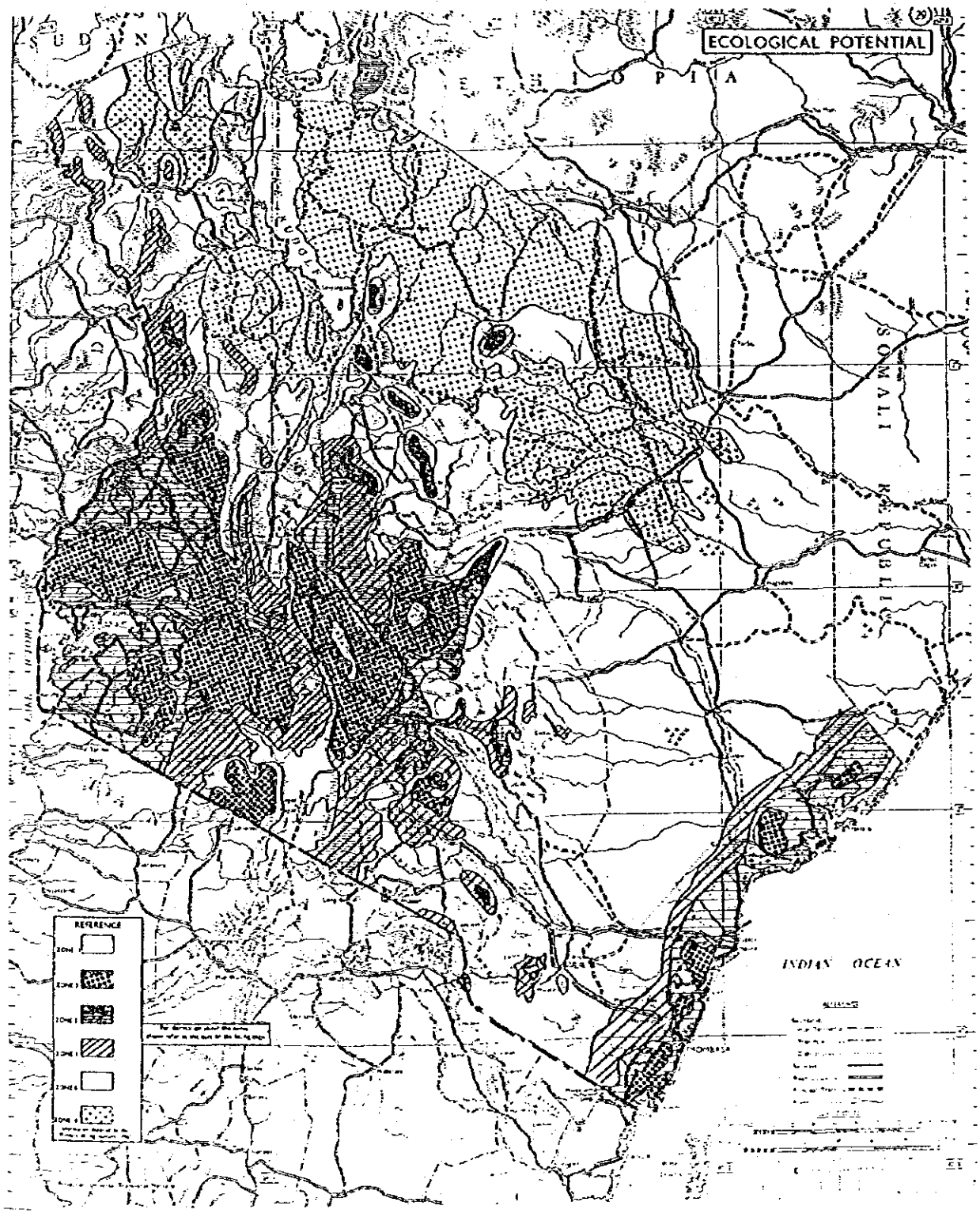
The second largest city, Mombasa and most other cities along Indian Ocean Coast are in Mombasa/Coast Province.
Table 4 indicates that there is significant difference in accessibility to the improved water supply for urban and rural areas.

Among these provinces unable to receive the benefits of the improved water supply, Western Province has relatively favourable natural conditions. The rest of these provinces however, are covered to a much greater extent by dry areas. This is characteristic of the water supply problem in the Republic since more than 70% of the national population is distributed in these dry areas which occupies almost 80% of the land.

The land area in the Republic is ecologically classified (See Fig. 4) into 6 categories as follows:

Zone	I	Mountain Moorland and Forest
Zone	II	High Potential Zone
Zone	III	Medium Potential Zone
Zone	IV	Dry Farming Zone
Zone	V	Non-Arable Range Zone
Zone	VI	Non-Arable Pastoral Zone

Fig.-4 POTENTIAL PRODUCTIVITY



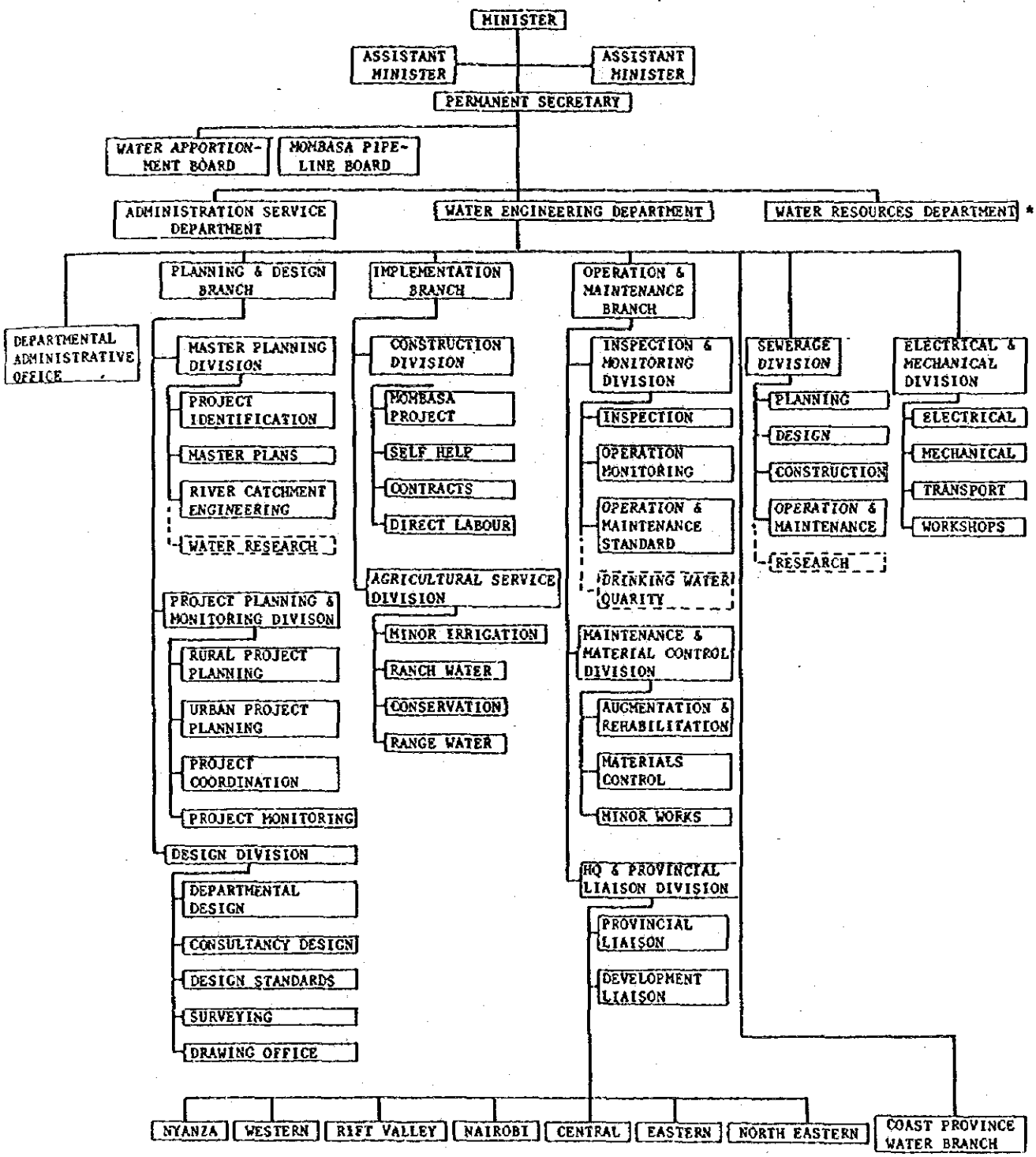
As shown in Fig. 4 excluding the Non-Arable Pastoral Zone (Zone VI) in the northern part of the Republic, people in wide areas of Zone III-V have a very low percentage of accessibility to improved water supply. The productivity of these areas should be incorporated in the plans for future economic activities of the Republic.
Both the Government concerned and the local people need to put greater effort into eliminating the significant difference in accessibility to improved water supply for urban and rural areas.

3-2 Working Body of Water Supply in Kenya

The Ministry of Water Development is responsible for all aspects of water development in the Republic.
As shown in Fig. 5, the Ministry consists of various functional Departments, Divisons, and Sections.
Since the Ministry was established in 1974 as an organization of different groups concerned with water development, a lot of effort has gone into improving reinforcing its functions. The Creation of the Water Resources Department is one example.

There have also been various kinds of international cooperation efforts from many donor countries and international organizations.

Fig.-5 ORGANIZATION CHART OF THE MINISTRY OF WATER DEVELOPMENT



* See Table 2

3-3 Groundwater Development

About 12% of the Republic receives annual rainfall of more than 850 mm/year and about 74% of the country has annual rainfall of less than 650 mm/year. There are two different seasons; namely, the dry season and the rainy season. In most of the drier areas surface water is available only for limited periods of the rainy season. Accordingly, groundwater is a more reliable and favourable water source than surface water where groundwater aquifers exist.

Groundwater development currently is of high priority in the Republic. The Groundwater Division of the Water Resources Department (See Figs. 5 and 6.) plays an important role in groundwater development. Its major activities are to assess the available amount of groundwater in the country and to construct production wells. At present 91 government officers are working there.

Geologists	28
Groundwater Inspectors	27
Groundwater Technicians	17
Drilling Engineers	3
Drilling Inspectors	16
TOTAL	91

There are more than 10 drilling crews working at different drilling sites all over the country. Even so, these crews cannot meet the current demand for borehole construction in the country. For this reason, the Ministry is looking for help from business in the commercial drilling market. Reinforcement of the drilling section with equipment and machinery, together with skilled staff, is an urgent necessity.

During the past fifty years, more than 4,000 boreholes have been constructed in the country. Out of these boreholes, 190 boreholes were constructed between 1928 and 1934. These are called P-Series holes. Another 133 boreholes were drilled during World War II and these are referred to as the SA-Series holes.

After that an additional 4,279 boreholes were constructed for various purposes. However, about 20% of these boreholes were abondoned and no details are available at present. (See Appendix 2.)
Existing boreholes with recorded details are classified as below:

Purpose	Number of B/H	Depth m	Yield l/min.	l/min.-n
Irrigation	782	124	143	26
Industry	126	128	189	147
Livestock	96	127	63	35
Water Supply	586	115	137	42

Table 5

WATER RESOURCES DEPARTMENT

CHIEF ENGINEER	Mr. D. M. Kirori
SECRETARY	Ms Elizabeth Kungu

GROUND WATER DIVISION

DIVISION HEAD	(Mr. E. M. Mwai)
DRILLING	Mr. Ali Sheihk
	Mr. W. Hagstrom
GEOLOGY	Mr. E. M. Mwai
	Mrs. Oswana
SECRETARY	Mrs. Karugutu
	Mr. M. K. Migwi

SURFACE WATER DIVISION

DIVISION HEAD	Mr. S. H. Charania
MONITORING	Mr. O K. Bobotti
ANALYSIS	Mr. J. H. Kirimi
WATER LAW	Mr. P. J. Odero
KENYA HYDROLOGY PROJECT	Mr. J. M. Kanyanjua

WATER QUALITY AND POLLUTION DIVISION

DIVISION HEAD	Mr. Meadows
	Mr. Thitai
	Mr. G. N. Monda
ADMINISTRATION	Mr. P. F. Allube
	Mr. J. K. Ikumu
	Mr. E. M. Bosiye

3-4 Development Programmes Related to Rural Water Supply and Implementation System

At present, the Ministry of Water Development is responsible for rural water supplies. Previously, however, water supply was handled by many different institutions and organizations and transfer of responsibility for water supply from the different institutions to the Ministry is not entirely completed today.
Since the 1970s, new ideas such as integrated area development have been introduced into development programmes.
The development programmes and their coordination with rural water supply has become more complicated.

In the National Development Plan, from 1979 to 1983, there are 16 Development Programmes related to water supplies. (See Table 7.)

Table-6

Numbers of Government Employees in the Water Resources Department

NUMBER OF	GROUND WATER DIVISION		POLLUTION AND WATER QUALITY CONTROL DIVISION	SURFACE WATER DIVISION
	GEOLOGY SECTION	DRILLING SECTION		
GEOLOGISTS	20	8		
GROUND WATER INSPECTORS	27			
GROUND WATER TECHNICIANS	17			
DRILLING ENGINEERS		3		
DRILLING INSPECTORS		16		
Principal Chemists Senior Chemists Chemists I Chemists II			1 3 4 18 — 26	
Senior Lab. Technologists LAB. Technologists Grade I Grade II Grade III			1 4 8 20 — 33	
HYDROLOGISTS				28
Assistant Hydrologists				42
Technicians In Surface Water Division (JOB G. C - F				200

Table 7

Development Programmes Related to Water Supply

1. Headquarter, Provincial and District Infrastructure
2. Rural Water Supply
3. Livestock Water Supply
4. County Council Water Supply
5. Self-help Water Supply
6. Mombasa and Coastal Water Supply
7. Mombasa Pipeline Board
8. Water Resource & Pollution Control
9. Minor Urban & Service Center Water Supply
10. Sewerage & Sewerage Research
11. Water Conservation
12. Miscellaneous Water Programme
13. Rehabilitation of Water Supply
14. Water Supply for Integrated Rural Development Programme
15. Training
16. Tana River Development Authority

The budget allocation for water development is estimated as shown below for the 1979-1983 National Development Plan.

K£ 1,000 at 1978 Price

Year	1978/79	79/80	80/81	81/82	82/83	TOTAL
Development Fund	38,567	40,500	41,000	40,000	40,000	200,067
Current Fund	6,587	7,200	7,870	8,602	9,402	39,661
Total	45,154	47,700	48,879	48,502	49,402	239,728
Foreign Assistance	16,198	18,342	16,077	16,830	11,930	79,377
Local Fund	20,956	29,358	32,793	31,772	31,472	160,351

The water development budget from 1979 to 1983 is estimated at about 4,800 million shillings.
Almost 50 percent of this is expected to be provided by International Organizations and donor countries.

The Ministry receives foreign assistance for its various activities and many water supply projects.
In a recent record the following international assistance was received from different donors.

Table 8

Recent International Cooperation Provided for Water Development

1.	IBRD	:	Group Ranch Water Supply '80/'81 Sh 29.1 million
2.	IBRD	:	Rural Water Supply Phase IV
3.	ADB	:	Ranch Water Supply
4.	U.S.AID	:	Ranch Development Northern Kenya
5.	U.S.AID	:	Arid & Semi-Arid Land Study K£80,000
6.	CIDA	:	Rural Water Supply Phase IV (one project)
7.	U.K.	:	Meru, Embu, Isiolo Rural Water Supply Phase IV
8.	E.E.C.	:	Design of Self Help Project
9.	Holland	:	Pipes for Self Help Project Sh 14 million
10.	ADB	:	Self Help Project
11.	K.T.Z.	:	Urban Water Supply
12.	K.T.Z.	:	Construction Units for Northern Ranch Development
13.	K.T.Z.	:	Construction of Store and Workshop
14.	SIDA	:	Rural Water Supply Phase III
15.	SIDA	:	Rural Water Supply Phase IV
16.	SIDA	:	Construction of Workshop for Drilling Division
17.	Norway	:	Urban Water Supply and Sewerage
18.	CIDA	:	Training of Harambee
19.	DANIDA	:	Rural Water Supply Phase III

Among these development programmes to be undertaken by the Ministry of Water Development, the following four programmes fall into the category of rural water supply.

1. Rural Water Supplies Programme
2. Ranch Water Development Programme
3. Self-Help Water Supplies Programme
4. County Council Water Supplies Programme

The Rural Water Supplies Programme and Ranch Water Development Programme will undertake major activities in rural water supplies. The number of schemes and the size of population to be served will be decided under these programmes. (See Chapter 4.)

Under the Self-Help Water Supplies Programme, technical and financial assistance are provided by the government to private water supply schemes. A total of Sh 253 million is budgeted for this purpose in the National Development Plan from 1979 to 1983.

The County Council Water Supplies Programme provides necessary assistance for County Council Water Supply.
Several water supply facilities used to be maintained and operated by the local government County Council.
Since 1972, operation and maintenance of most local water supply facilities were transferred to the Ministry of Water Development. However, some of these water supply facilities are still operated by the County Council with assistance from the Ministry. A total of Sh 10 million is allocated for this purpose in the National Development Plan from 1979 to 1983.

One of the most important policies of the National Development Plan is the participation of community members in the development programme. Accordingly, District Development Committee gives due weight to the local majority's interests to projects when determining the priority of rural water supply projects. The final priority list is submitted to

the Planning Division of the Engineering Department of the Ministry of Water Development. After the Planning Division finishes the feasibility study, the Designing Division and the Construction Division make final decisions on project implementation.

CHAPTER 4

GENERAL DESCRIPTION OF RURAL WATER SUPPLY DEVELOPMENT PROGRAMME AND ITS PLANNING

4-1 General Description of Rural Water Supply Programme

The target to complete 100% water supply to everybody in the country by the year 2,000 is still the basic guide line of the water development in Kenya. To help meet this target, water supply facilities have to be constructed to serve an additional 10 million people within the next 20 years.

Major development programmes following this development guide line are the Rural Water Supplies Programme and Ranch Water Development Programme. However, at present there is no fixed programme to be completed by the year 2,000. Water supply schemes are constructed at full speed by the Ministry where and when financial sources are available. The criteria to determine the priority of the project implementation is project's effect on eliminating the difference in service levels between advanced areas and these areas far behind. In this sense, dry areas where the percentage of population in the Province served by improved water supply is less than 20% in the ecosystem Zones II, III, IV, V, have high priority for project implementation. Kajiado/Narok districts are identified as one of these high priority areas.

Rural Water Supplies Programme Phase I was completed by 1970. Providing 72 new rural water supply schemes at a cost of Shs 43.1 million. Phase II completed 29 schemes in 1972. Cost for Phase III is recorded as Shs 56.7 million. An additional 70 rural water supply schemes were planned for Phase III and its progress as of April, 1981 is as shown below:

Planning Stage	12 schemes
Design Stage	26 schemes
Construction Stage	18 schemes
Completed	14 schemes.

Cost for the above progress was Shs 391 million. Cost for the entire Rural Water Supplies Programme Phase III was estimated at Shs 1,780 million. Out of this estimate Shs 45 million and Shs 75 million are supposed to be provided by Sweden and the United Kingdom.

Rural Water Supplies Programme Phase IV commenced in 1978 with a total construction estimate of Shs 1,043 million. Progress report indicates achievements as of April, 1981 as shown below (Also see Fig. 6.):

Planning Stage	24 schemes
Design Stage	34 schemes
Construction Stage	4 schemes
Completed	1 scheme
Abondoned	2 schemes

Also in Phase IV, various kinds of cooperation in the form of grants and loans from donor countries and organizations are provided as summarized below:

Source of Aid	Number of Schemes	Proposed Amount Shs (millions)	Contracted Amount by Oct.'81
ADB	4	41.5	0
CIDA	7	515.0	0
DANIDA	2	77.5	0
IBRD	33	1,098.2	138.0
Japan	1	15.1	15.1
Netherland	16	329.0	0
U.K.	2	38.0	0
TOTAL	65	2,168.5	125.8

At present, the total amount proposed by foreign donors is estimated at Shs 2,168.5 million. This includesthe Ithanga scheme completed by a Grant Aid from the Japanese Government.

In the middle of the 1970s, the Ranch Water Development Division began preparation for the Ranch Water Development and construction started in the late 1970s. The present status of the Ranch Development Division is summarized as shown below (Also see Fig. 7.):

Present Status of Ranch Water Development

Progress Stage	Number of Schemes	Districts
Planning Stage	12	Kajiado, Narok, Lamu, Tana River
Construction Stage	10	Kajiado, Kware, Isiolo
Completed	5	Kajiado

Total cost spent for the above progress is estimated at Shs 3 million. This provided 30 cubic meters of water per hour for 50,000 cattles and 1,000 people engaged in ranching.

4-2 Future Schedule

According to the schedule, the remaining schemes of Phase III and Phase IV of the Rural Water Supply Programme are to be completed in the near future. Phase V is currently in the planning stage.

For the formulation of Rural Water Supplies Programme Phase V, the Ministry has requested each District Development Committee to submit a priority list of rural water supply schemes with necessary details of each scheme for further planning purpose. As of the end of April, 1981 all the lists of priority schemes were submitted except for four districts. These proposed priority lists are being studied by the ministry for further planning.

At present 80 schemes have been selected for a feasibility study to be undertaken by the Planning Division of the

Ministry. According to the Ministry's schedule for Phase V, all the feasibility studies will be completed by the end of October 1982.

Water supply schemes under KLDP Phase II were proposed for about 130 sites, however, implementation has been delayed due to lack of equipment and manpower. Ranch Water Development Programme has undertaken about 200 schemes in KLDP Phase II and III but these cover only less than 50% of the total present demand.

The procedure to determine priority of the schemes is the same as that of rural water supply schemes. The priority lists of Ranch Water Development are first submitted to the Ministry of Livestock Development and then to the Ministry of Water Development.

Fig.-6 TIME SCHEDULE FOR RURAL WATER SUPPLY PROGRAMME PHASE III

FEASIBILITY STUDY | PRELIMINARY DESING | FINAL DESIGN | TENDER PREPARATION | MATERIAL PROCUREMENT | CONSTRUCTION

SER. NO.	SCHEME	DISTRICT	DESIGN POPULATION	MoWD/ CONSULTANT	MoWD/ CONTRACTOR	SPONSOR	ESTIMATED CONSTRUCTION COST PRICES AS AT OCTOBER 1981 100 x K.Shs. FOREIGN COMPONENT	LOCAL COMPONENT	TOTAL COST	PRINTED ESTIMATES F.Y. 1981/82 1000 x K.Shs. INVEST DES.	CONVERTR.	F.Y 1981/82 O N D J F M A M J	F.Y. 1982/83 J A S O N D J F M A M J	F.Y. 1983/84 J A S	NOTES	SER NO.
1	ARCHER'S POST	SAMBURU	3,000	N.H.S.	-	-	-	8,000	8,000	40	0	CONSTRUCTION CAN COMMENCE AS SOON AS FUNDS ARE AVAILABLE				1
2	BAMBA I	KILIFI	1,000	M.o.W.D.	M.o.W.D.	-	-	1,100	1,100	0	0	COMPLETED IN 1980				2
3	BANGALE	TANA RIVER	3,000	M.o.W.D.	-	(SIDA)	1,000	0	1,000	10	400				PROPOSED FOR SWEDISH FINANCING	3
4	BANISA	MANDERA	4,000	M.o.W.D.	M.o.W.D.	-	0	4,000	4,000	10	0					4
5	BATHI I	KIAMBU	10,000	GAUFF	20TH.CEN.	-	0	7,500	7,500	0	0	COMPLETED IN 1978				5
6	BATHI II	KIAMBU	30,000	GAUFF	K.SINGH	-	0	20,000	20,000	0	1,500					6
7	BATHI DAM	KIAMBU	-	GAUFF	DAM IRRI	-	0	6,000	6,000	0	0	COMPLETED IN MARCH 1987				7
8	BISSEL	KAJIADO	1,000	M.o.W.D.	M.o.W.D.	-	0	600	600	0	0	COMPLETED BY PWE IN 1979				8
9	BUSIA-MUNDIKA I	BUSIA	10,000	IBPM	T.SINGH	-	0	10,000	10,000	0	100	COMPLETED IN 1980				9
10	BUSIA-MUNDIKA II	BUSIA	15,000	IBPM	NATIONAL	-	0	15,000	15,000	0	0	CONSTRUCTION CAN COMMENCE AS SOON AS FUNDS ARE AVAILABLE				10
11	CHEMUNDU	NANDI	-	-	-	-	-	-	-	-	-	DELETED INCLUDED IN KURGUNG AND KIPSIGAK WATER SUPPLIES TO BE CONSTRUCTED UNDER RWS IV				11
12	CHEPALUNGU III	KERICHO	190,000	BISH	-	-	0	210,000	210,000	20	0					12
13	CHESARAKI	BUNGOMA	16,000	GIBBS	I.S.DOGRA	-	0	16,000	16,000	0	2,000	COMPLETED IN JUNE 1981				13
14	DEBEL	MARSABIT	2,000	M.o.W.D	-	(SIDA)	1,500	0	1,500	0	0				PROPOSED FOR SWEDISH FINANCING	14
15	EL WAK	MANDERA	2,000	C.BRO	-	(SIDA)	4,000	0	4,000	80	400				PROPOSED FOR SWEDISH FINANCING	15
16	EMBU RURAL II	EMBU	15,000	EAEC	H.SINGH	-	0	12,000	12,000	0	900	COMPLETED IN JANUARY 1981				16
17	EMBU RURAL III	EMBU	134,000	EAEC	-	(UK)	75,000	0	75,000	1,000	0				PROPOSED FOR BRITISH FINANCING	17
18	ILIKA	KITUI	4,000	M.o.W.D.	-	(SIDA)	4,000	0	4,000	10	0				PROPOSED FOR SWEDISH FINANCING	18
19	KABLUK	BARINGO	18,000	C.KIPTOON	-	-	0	10,000	10,000	40	1,000					19
20	KAHUTI II A	MURANGA	2,000	GIBBS	ORIENTAL	-	0	2,000	2,000	0	0	COMPLETED IN JUNE 1980				20
21	KAHUTI III	MURANGA	2,000	GIBBS	NJANGOGI	-	0	2,200	2,200	0	200	COMPLETED IN AUGUST 1981				21
22	KAHUTI III A	MURANGA	3,000	GIBBS	NJANGOGI	-	0	2,700	2,700	0	0					22
23	KAMPI YA SAMAKI	BARINGO	2,000	M.o.W.D.	-	-	0	1,000	1,000	10	0					23
24	KARGI	MARSABIT	-	-	-	-	-	-	-	-	-	DELETED REPLACED BY SAGANTE				24
25	KARIMENU	KAMBU	78,000	VIAK	M.o.W.D.	-	0	23,000	23,000	0	2,000					25
26	KARINGANI I	MERU	8,000	G.MELVIN	MOWLEM	-	0	7,500	7,500	0	0	COMPLETED IN 1977				26
27	KATILU	TURKANA	12,000	C.BRO	-	(SIDA)	1,000	11,000	12,000	180	2,000				PROPOSED FOR SWEDISH FINANCING	27
28	KEMELOI	NANDI	60,000	COWI	-	-	0	55,000	55,000	40	5,000	CONSTRUCTION CAN COMMENCE AS SOON AS FUNDS ARE AVAILABLE				28
29	KIBAUNI	MACHAKOS	-	W.A.P.	G.SINGH	-	-	-	-	-	-	DELETED INCLUDED IN THE INTEGRATED DEVELOPMENT PROJECT MACHAKOS				29
30	KIBICHORI	BUNGOMA	14,000	GIBBS	T.S.DOGRA	-	0	14,000	14,000	0	1,600	COMPLETED IN 1980				30
31	KIKUMBULYU I	MACHAKOS	12,000	C.BRO	ALCON	-	0	15,000	15,000	600	2,200					31
32	KIKUMBULYU II	MACHAKOS	200,000	C.BRO	-	-	0	150,000	150,000	0	0					32
33	KIMININI	T.NZOIA	1,000	M.o.W.D.	-	(SIDA)	4,000	0	4,000	10	0				PROPOSED FOR SWEDISH FINANCING	33
34	KIPIPIRI	NYANDARUA	41,000	WANJOHI	-	-	0	56,000	56,000	200	0					34
35	KISIMA	SAMBURU	2,000	M.o.W.D.	-	(SIDA)	2,000	2,000	4,000	10	0				PROPOSED FOR SWEDISH FINANCING	35
36	KIUNGA	LAMU	4,000	M.o.W.D.	-	(SIDA)	2,000	0	2,000	14	0				PROPOSED FOR SWEDISH FINANCING	36
37	LITEIN RURAL	KERICHO	-	COWI	-	-	-	-	-	-	-	DELETED CONSTRUCTED UNDER RWS IV				37
38	LORENGUMU	TURKANA	9,000	M.o.W.D.	-	(SIDA)	1,500	0	1,500	10	600				PROPOSED FOR SWEDISH FINANCN	38
39	LUMI	TAITA	-	PENCOL	-	-	-	-	-	-	-					39
40	MADO GASHI	ISIOLO	4,000	M.o.W.D.	-	(SIDA)	2,000	0	2,000	10	0					40
41	MALAVA	KAKAMEGA	2,000	GIBBS	-	(SIDA)	2,000	0	2,000	0	600					41
42	MATHIRA II & IV	NYERI	35,000	VIAK	ORIENTAL	-	0	35,000	35,000	0	4,000					42
43	MATINYANI	KITUI	-	EAEC	BROAD W.	-	-	-	-	-	-	DELETED, INCLUDED IN KI TUI W/S UNDER M UWS				43
44	MASINOI	KISUMU	26,000	BISH	EPSIL	-	0	26,000	26,000	0	2,800	CONTRACT TERMINATED CONSTRUCTION TO START WHEN FUNDS ARE				44
45	MELKA MARI	MANDERA	-	-	-	-	-	-	-	-	-	DELETED REPLACED BY BANISA				45
46	MKONGANI	KWALE	6,000	C.BRO	-	(SIDA)	3,000	2,000	5,000	200	400				PROPOSED FOR SWEDISH FINANCING	46
47	MOI'S BRIDGE	UASINGISHU	60,000	GIBS	-	-	0	30,000	30,000	50	0					47
48	MOSIRO	NAROK	26,000	AES	-	(SIDA)	1,000	149,000	150,000	66	400				PROPOSED FOR SWEDISH FINANCING	48
49	MOYALE ODA	MARSABIT	-	-	-	-	-	-	-	-	-	DELETED REPLACED BY BEBEL				49
50	MUKURWEINI IA	NYERI	120,000	IBPM	BROADWA	-	-	26,400	26,400	0	6,000					50
51	MUKURWEINI IB	NYERI	4,000	IBPM	-	-	0	4,200	4,200	0	-	CONSTRUCTION CAN COMMENCE AS SOON AS FUNDS ARE AVAILABLE AVAILABLE				51
52	MUNDIKA	BUSIA	--	IBPM	-	-	-	-	-	-	-	SEE BUSIA MUNDIKA				52
53	MWASOKO	TAITA	6,000	AES	-	(SIDA)	6,000	0	8,000	94	0				PROPOSED FOR SWEDISH FINANCING	53
54	MWIMBI I	MERU	9,000	VIAK	MOWLEM	-	0	8,500	8,600	0	0	COMPLETE IN 1977				54
55	NAIRAGE ENGARE	NAROK	15,000	MOWD	-	-	0	15,000	15,000	10	0					55
56	NAIVASHA RURAL	NAKURU	-	-	-	-	-	-	-	-	-	DELETED INCLUDED UNDER RWS IV				56
57	NAMANGA	KAJIADO	2,000	MOWD	-	-	-	-	-	-	-	DEETED FROM RWS III				57
58	NDARUGU	KIAMBU	67,000	VIAK	MOWD	-	0	14,700	14,700	0	1,000					58
59	NGARIAMA I	KIRINYAGA	36,000	MOWD	MOWD	-	0	4,000	4,000	0		COMPLETED IN 1980				59
60	NGARIAMA II	KIRINYAGA	-	MOWD	MOWD	-	0	6,800	6,800	0	2,000					60
61	NGUNI ANZUI	KITUI	3,000	MOWD	MOWD	-	0	2,000	2,000	0	650					61
62	NYAMIRA	KISII	20,000	CBRO	C.E.B	-	0	13,700	13,700	0	0	COMPLETED IN 1977				62
63	OTNAYA I	NYERI	9,000	IBPM	ORIENTIAL	-	0	9,000	9,000	0	2,000				ONLY ACCESS ROAD REMAINS	63
64	OTNAYA II	NYERI	22,000	IBPM	ORIENTIAL	-	0	22,000	22,000	0	2,000	COMPLETED IN 1978				64
65	OYUGIS I	S.NYANZA	16,000	NORCONS	BROADW	-	0	16,900	16,100	0	0					65
66	SAGANTE	MARSABIT	3,000	-	-	(SIDA)	1,500	0	1,500	0	0				PROPOSED FOR SWEDISH FINANCING	66
67	SAMEIR	KISII	25,000	TAMS	ISSAKO	-	0	21,800	21,800	0	0					67
68	SERETUNIN	BARINGO	6,000	GKP	S.SINGH	-	0	5,500	5,500	0	1,000					68
69	SERGOIT	E.MARAKWET	22,000	GAUFF	-	-	0	22,000	22,000	0	0	CONSTRUCTION CAN COMMENCE AS SOON AS FUNDS ARE AVAILABLE				69
70	SERICHO	ISIOLO	2,000	MOWD	-	(SIDA)	2,000	0	2,000	0	400				PROPOSED FOR SWEDISH FINANCING	70
71	SHITOLI I	KAKAMEGA	27,000	COWI	W.RES	-	0	27,000	27,000	0	4,000					71
72	SIDINOI I	SIAYA	70,000	MAP	W.RES	-	0	70,000	70,000	200	8,000					72
73	SIGOR	W.POKOT	3,000	MOWD	-	(SIDA)	3,000	0	3,000	10	1,500					73
74	SIGOR LONGISA	KERICHO	190,000	IBPM	-	-	0	190,000	190,000	10	1,500	FINAL DESIGN DOCUMENTS ARE READY				74
75	SIYOI	W. POKOT	32,000	VIAK	-	-	0	32,000	32,000	0	0					75
76	SOI	KERICHO	160,000	HHS	-	-	0	156,000	156,000	300	0					76
77	SOLOLO	MARSABIT	2,000	-	-	(SIDA)	1,500	0	1,500	0	0				PROPOSED FOR SWEDISH FINANCING	77
78	SOSIANI	UASIN GISHU	2,000	MOWD	MOWD	-	0	2,000	2,000	0	100	COMPLETED IN APRIL 1981				78
79	SOUTH NORR	SAMBURU	2,000	MOWD	-	(SIDA)	1,000	0	1,000	10	0				PROPOSED FOR SWEDISH FINANCING	79
80	TAVETA-LUMI	TAITA	50,000	PENCOL	-	-	0	50,000	50,000	10	0					80
81	THIRARIKA	KIAMBU	30,000	VIAK	C.E.B	-	0	30,000	30,000	0	4,000	CONTRACT TERMINATED WORK NOT COMPLETED				81
82	TIGANIA I	MERU	10,000	COWI	MOWLEM	-	0	6,000	6,000	0	0	COMPLETED IN 1977				82
83	URAN	MARSABIT	-	-	-	-	-	-	-	10	600	DELETED REPLACED BY SOLLOW				83
84	WASINI	KWALE	3,000	C.BRO	-	(SIDA)	1,000	9,000	10,000	10	0	DESIGN WORK SUSPENDED			PROPOSED FOR SWEDISH FINANCING	84
	TOTAL		2,063,60				120,000	1,667,700	1,787,7	3,274	62,650					

Fig.-7 TIME SCHEDULE OF RURAL WATER SUPPLIES PROGRAMME PHASE IV

FEASIBILITY STUDY | PRELIMINARY DESIGN | FINAL DESIGN | TENDER PREPARATION | MATERIAL PROCUREMENT | CONSTRUCT

SER NO.	SCHEME	DISTRICT	DESIGN POPULATION	MoWD/ CONSULTANT	MoWD/ CONTRACTOR	SPONSOR	ESTIMATED CONSTRUCTION COST PRICES AS AT OCT.1981 100 x K sh			PRINTED ESTIMATES F.Y. 1981/82 100 x K sh		NOTES	SER NO.
							FOREIGN COMPONENTS	LOCAL COMPONENTS	TOTAL COST	DESIGN	CONSTR.		
1	BAHATI	NAKURU		RHS		IBRD	7,000	1,500	8,500	1,000	0	DESIGN WORK NOT ONGOING	1
2	BAMBA II	KILIFI	5,000	KITOLOLO	-	IBRD	11,000	1,000	12,000	300	0		2
3	BATHI III(KIJA	KIAMBU	7,000	MOWD		IBRD	6,000	1,200	7,200	400	0		3
4	BUNGOMA AURAL	BUNGOMA	133,000	RHS	-	IBRD	4,600	86,400	91,000	600	0		4
5	CHEPARERIA	W.POKOT	4,000	-	-	-	0	1,500	1,500	-	-	DESIGN WORK NOT YET STARTED	5
6	CHEPSIGOT II	E.MARAKWET	7,000	GAUFF	-	-	0	12,000	12,000	0	4,000		6
7	CHERENGAN	T.NZOIA	136,000	EAEC	-	IBRD	13,000	177,000	190,000	300	0		7
8	DAMASA (LEFI)	MANDERA	8,000	MOWD	-	IBRD	1,100	400	1,500	8	0	GROUNOW WORK TO BE CARRIED OUT	8
9	DURANOTO	TANARIVER	2,000	MOWD	-	IBRD	200	100	300	10	0		9
10	DURRANA	MARSABIT	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0		10
11	EBURRU	NAKURU	56,000	WANJOHI	-	-	0	70,000	70,000	0	0	THE DESIGN WORK ON EBURRU SCHEME HAS BEEN SUSPENDED	11
12	ENYARONI	KAJIADO	2,000	MOWD		-	0	1,500	1,500	0	0		12
13	FLAX CENTRE	UASINGISHU	47,000	COWI	-	-	0	50,000	50,000	200	0	GROUNOW INVEST. TO BE CARRIED OUT	13
14	FUNYULA II	BUSIA	62,000	-	-	-	0	60,000	60,000	100	-	FINAL DESIGN NOT STARTED	14
15	GANZE	KILIFI	-	-		ICRD	-	-	-	-	-	GANZE W/S IS INCLUDED IN BAMBA II	15
16	GEMBE HILLS II	S. NYANZA	68,000	ITALCONS	-	-	0	82,000	82,000	1,500	0	NEW DESIGN ENGINEER TO BE	16
17	GODOMA	MARSABIT	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0	GROUNOW INVEST. TO BE CARRIED OUT	17
18	HANGARI	WAJIR	2,000	MOWD	-	IBRD	1,100	400	1,500	8	0		18
19	HULUCHO	GARISSA	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0		19
20	ITHANGA	MURANGA	30,000	NISHO	-	JAPAN	15,100	22	15,122	-	-	STHANGA W/S WAS COMPLETED IN JULY 1979	20
21	KAKUMA	TURKANA	2,400	MOWD	-	IBRD	1,100	400	1,500	10	0		21
22	KALACHA	MARSABIT	3,000	MOWD	-	IBRD	1,100	400	1,500	8	0	AWAITING REQUEST FROM PPC	22
23	KAPCHEROP	E.MARAKWET	14,000	C.BRO	-	-	0	12,000	12,000	100	0		23
24	KAPRONG II	BARINGO	5,100	C.K.P			0	31,500	31,500	100	13,500		24
25	KARINGANI II	MERU	19,200	G.MELVIN	-	(UK)	0	10,000	10,000	60	0		25
26	KERIO FISHING V	TURKANA	5,000	C.K.P	-	IBRD	2,000	600	2,600	50	0		26
27	KHOROF HARAR	WAJIR	2,000	MOWD	-	IBRD	1,100	400	1,500	8	0	GROUNOW INVEST. TO BE CARRIED OUT	27
28	KIGUMO II	MURANGA	230,000	GAUFF	-	-	11,000	88,000	99,000	50	0		28
29	KIRONENI DAM	KWALE	16,000	MOWD	-	-	0	8,500	8,500	0	1,000	CONSTRUCTION WORK COMPLETED	29
30	KIRANGONI	KWALE	7,000	-	-	-	0	6,000	6,000	-	-	NO PLANNED ACTIVITIES AT PRESENT	30
31	KIPSIGAK	NANDI	40,000	C.A.LIBURD	-	-	0	61,000	61,000	0	0	THE DESIGN WORK ON KIPSISAK SCHEME HAS BEEN SUSPENDED	31
32	KURGUNG	NANDI	213,000	C.A.LIBURD	-	IBRD	11,200	175,100	186,300	1,000	0		32
33	LAKE KENYATTA	LAMU	100,000	COWI	-	IBRD	9,000	61,000	70,000	500	0	GROUNOW INVEST. TO BE CARRIED OUT	33
34	LEKWA	RAKWET	3,000	MOWD	-	IBRD	1,100	400	1,500	10	0		34
35	LITEIN RURAL	KERICHO	220,000	COWI	-	-	0	51,500	51,500	0	8,000		35
36	LOKITAUNG	TURKANA	5,000	C.K.P	-	IBRD	5,500	4,500	10,000	40	0		36
37	LOKORI	TURKANA	2,600	MOWD		-	0	3,000	3,000	-	-	NO PLANNED ACTIVITIES AT PRESENT	37
38	MANGA	KISII	70,000	TANAS	-	-	0	30,000	30,000	50	0		38
39	MARMANET	LAIKIPIA	56,000	IBPM	-	-	0	42,100	48,800	0	12,000		39
40	MARUNGU	TAITA	4,300	MOWD	-	-	0	2,000	2,000				40
41	MASENO II	KISUMU	218,000	BESH	-	-	0	105,000	105,000	600	2,800		41
42	MATNYANI	KITUI	-	EAEC	-	-	-	-	-	-	-	MANYANI WATER SUPPLY IS INCLUDED IN KITUI WIS INCONSTRUCTION	42
43	MATUNDA	UASIN	-	GIBBS	-	-	0				-	INCLUDED IN MOU'S BRIDGE W/S KWS III	43
44	MBALE III	KAKAMEGA	1,000	MOWD	-	IBRD	1,000	0	1,000	140	0	REHABILITATION	44
45	MIROGI	S.NYANZA	40,000	-	-	IBRD	4,000	35,000	40,000	250	0	NO PLANNED ACTIVITIES AT PRESENT	45
46	MORIJO LOITA	NAROK	3,000	-	-	-	0	1,500	1,500	-	-	CONSULTANT NOT YET APPOINTED, DESIGN NOT STARTED	46
47	MWIMBI II	MERU	60,000	VIAK	-	-	-	26,000	26,000	0	0	CONSTR. WORK CAN COMMENCE AS SON AS FUNDS ARE AVAILABLE	47
48	NAIVASHA RURALI	NAKURU	46,000	MOWD	-	IBRD	13,000	4,000	17,000	300	0		48
49	NAMADAK	TURKANA	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0	GROUNOW INVEST. TO BE CARRIED OUT	49
50	NAUKOPIR	KAJIADO	3,000	-	-	-	0	1,500	1,500	0	-		50
51	OL DONYO NGIRO	ISIOLO	3,000	-	-	-	0	2,000	2,000	-	-	NO PLANNED ACTIVITIES AT PRESENT	51
52	OYUGIS II	S.NYANZA	140,400	NORCONS	-	-	0	40,000	40,000	10	0	NO PLANNED ACTIVITIES AT PRESENT	52
53	OZA	TAITA	4,000	-	-	-	0	2,000	2,000	-	-		53
54	RATAT	BARINGO	3,000	-	-	-	0	1,500	1,500	-	-		54
55	SABATIA	KAKAMEGA	-	-	-	-						INCLUDED THE SHITOLI II	55
56	SHITOLI II	KAKAMEGA	160,000	COWI	-	-	0	160,000	160,000	-	-		56
57	SIDINDI II	SIAYA	310,000	WAP	-	-	0	120,000	120,000	-	-		57
58	SUBUKIA	NAKURU	90,000	S.K.P	-	IBRD	3,000	129,000	132,000	1,000	0	FINAL DESIGN NOV. STARTED	58
59	TARABA	MANDERA	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0	ON DESIGN BY A TEAM IN WAJIR	59
60	TARAKWA	UASIN	3,000	-	-	-	0	1,500	1,500	-	-	NO PLANNED ACTIVITIES AT PRESENT	60
61	TIGANIA II	MERU	30,000	COWI	-	(UK)	0	28,000	28,000	60	0	GROUNOW INVEST. TO BE CARRIED OUT	61
62	WAMBA	SAMBURU	6,900	WANJOHI	-	-	0	28,000	28,000	200	0		62
63	WANGURU	KIRINYAGA	236,000	RKL	-	IBRD	15,000	128,300	143,300	700	0		63
64	WARDEGLO	GARISSA	2,000	MOWD	-	IBRD	1,100	400	1,500	10	0	GROUNOW INVEST. TO BE CARRIED OUT	64
65	W. KARACHUONYO III&IV	S.NYANZA	105,000	BESH	-	IBRD	8,000	62,000	70,000	600	0		65

Fig.-8 RANCH WATER DEVELOPMENT PROGRAMME

PLANNING | DESIGN | TENDERING | CONSTRUCTION

Project	Land Size ha	Population P:People LU:Live Stock	Type of Water Source	Design Capacity	District	1981 S O N D	1982 J F M A M J J A S O N D	
I Project				m^3/hr				
Completed								
1. Olkilorit	6,436	P 87 LU 3536	BH	(4.0)	Kajiado			Const Cost Ksh 148309
2. Embolioi	23,722	P 204 LU 10732	BH	7.3	"			225,482
3. Oloyiangalani	9,606	P 117 LU 4680	BH	4.5	"			441,863
4. Torosei	46,445	P 176 LU 3779	BH	10.7	"			1,013,116
5. Elangatawuas	59,499	P 315 LU 27734	BH	7.9	"			1,077,532
II Project Under-Construction								
1. Masai Mara			-	-	Narok			326,906
2. Ilmasharia	4,998	P 48 LU 2508	-	-	"			446,078
3. Oldonyonyukie	68,566	P 162 LU 19257	BH	4.3	Kajiado			-
4. Mashurulmararo	29,970	P 335 LU 12965	BH	11.4	"			-
5. Empuyankat	15,093	P 76 LU 10235	BH	9.7	"			205,970
6. Olkeri	24,852	P 164 LU 23424	River	-	"			-
7. Olkeramatian	21,612	P 200 LU 10201	"	-	"			6,000,000
8. Shombole	62,690	P 366 LU 24405	"	-	"			-
9. Soi	-	-	"	-	Baringo			1,465,168
10. Koitegan	-	-	"	-	"			810,078
III Project Under-Planning & Design								
1. Marijo Narok	1,574	P 21 LU 509	Spring	-	Narok			
2. Olamutai/ Nkraitaniza	1,405	P 106 LU 3513	"	-	"			
3. IdasagadanaGiritu	-	-	Dam	-	TanaRiv			
4. Wachu-Kilongale	-	-	Dam	-	"			
5. Witu	-	-	-	-	Lamu			
6. Amu Ngongoini	-	-	-	-	"			
7. Maparasha/ Osilalei	-	-	-	-	Kajiado			
8. Naibo Ajikik	8,929	P 119 LU 2587	-	-	"			
IV Design Completed								
1. Kenya Triangle					Kwale			3,000,000
2. Kilonito			Dam		Kajiado			
3. Lunga Lunga					Kwale			
4. Loborua					Isiolo			
V Project Identified for Planning								
1. Enkaroni					Kajiado			
2. Masai Mara					Narok			
3. Kenyan					"			
4. Mkuki					Taita			
5. Kishushe					"			
6. Maung Buguta					"			
7. Torosei			Dam		Kajiado			
8. Longopit					Isiolo			
9. Olomismis					Narok			

CHAPTER 5

THE PROJECT: KAJIADO/NAROK GROUNDWATER DEVELOPMENT

5-1 Project Area

The project area encompases the Kajiado/Narok Districts at the southern end of the Rift Valley Province next to the boarder of Tanzania. Geographical location of the project area is between 0°35' and 3°15' South and between 34°30' and 37°55' East.

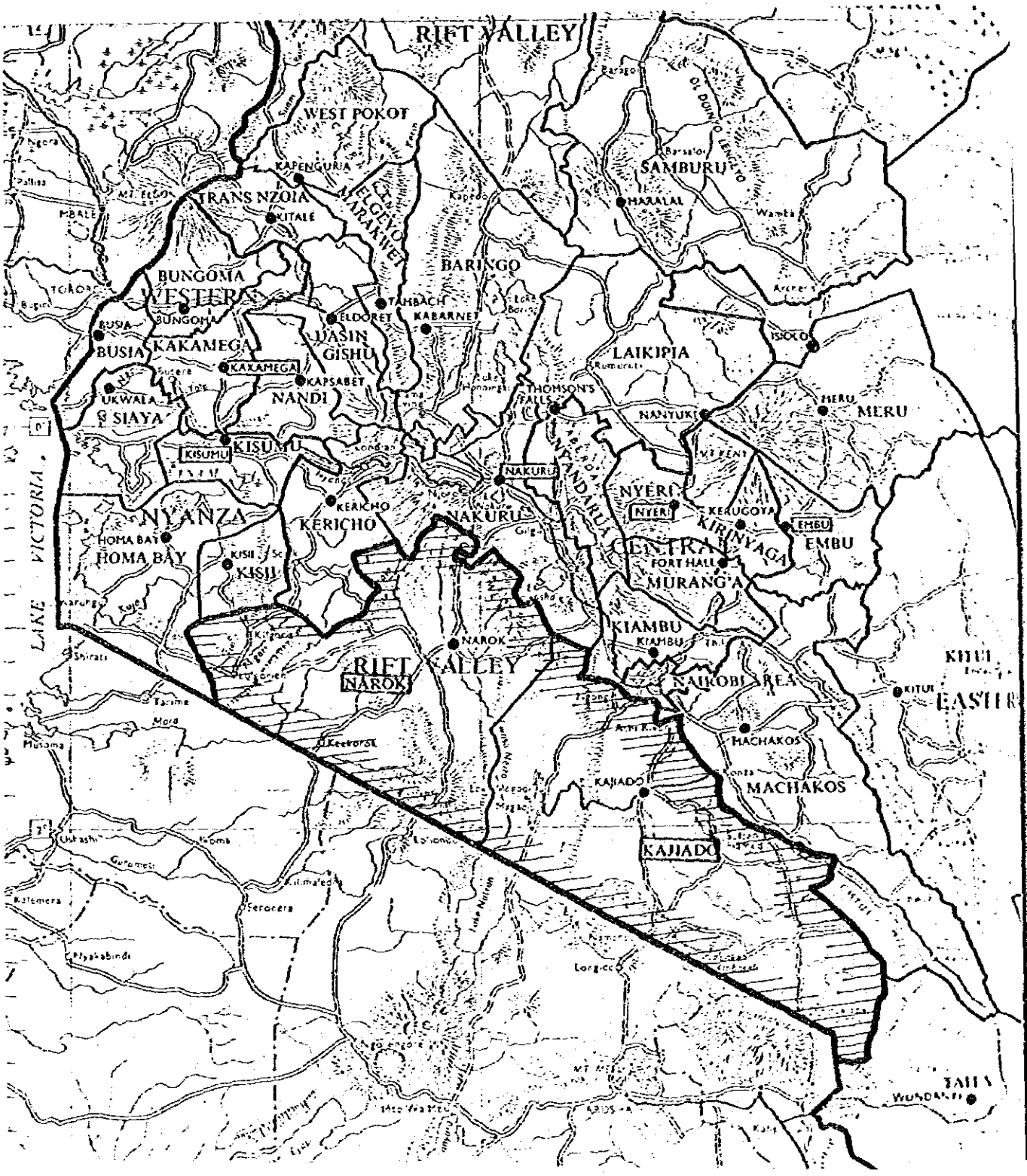
There are seven rivers in the project area, however, surface water is available only in limited areas and period due to relatively dry climatic condition. An average annual rainfall ranges between 400 mm and 500 mm a year. There is more rainfall in some places of high altitude like Mau Narok, Loita and Chyulu hills.

Population in the project area at the 1978 Census was estimated at 350,000. Some people are living in the hilly areas but a majority of the population is scattered over the flat and rolling dry land covering 40,000 km^2. This area's economy relies mainly on livestock. The number of livestock is estimated at 2 million including goats and sheep.

By the target year 2,000, the population is estimated to increase to about 700,000. The number of livestock will also increase to about 50% more than the existing number assuming a minimum growth rate of 3%.

Kajiado and Narok are among the districts where the percentage of population served by improved water supply is less than 20%. Future development of these two districts appears easier than other remote areas due to their geographical location, easy access to major national highways, and closeness to the capital, Nairobi. In addition, as shown in Fig. 4, these two districts have higher potential for agricultural and livestock development compared with other districts with dry conditions.

Fig.-9 PROJECT AREA OF THE KAJIADO/NAROK GROUNDWATER DEVELOPMENT PROJECT



5-2 Supply and Demand Balance of Rural Water Supply in the Project Area

In the census of 1978, population was estimated at 350,000. It is assumed this figure will double by the year 2,000. Another significant aspect of this area is that since the climatic condition is relatively dry, the major industry is livestock. This is expected to be the same in the future. According to the livestock census in 1970, the number of livestock in the project area is as shown below:

District	Cattle	Goat and Sheep
Kajiado	580,000	210,000
Narok	580,000	680,000

Assuming an annual growth rate of 3 percent, the number of livestock in the year 2,000 is estimated to be almost 3,000,000.

Assuming the water consumption rate shown below:

Domestic Purpose	60 ℓ/day/cap
Cattle	25 ℓ/day/head
Goat and Sheep	12 ℓ/day/head

total demand of water in the year 2,000 is estimated to be 102,000 m^3/day.

The number of existing water supply facilities in the project area is 12 and their total design population is 30,000 people. At present, the total amount of water produced by these water supply facilities is estimated to be 1,070 m^3/day as shown in Table 9.

Table 9

Existing Rural Water Supply Facilities

Name	Year of Consumption	Construction Programme	Design Population	Design Capacity
				(m^3/day)
NAROK DISTRICT				
Narok	1948	-	6,000	300
Angata	1974	RWS III	800	40
Lemek	1972	RWS I	500	25
Bolgnen	1974	RWS I	1,000	50
Motijo Loita	1971	RWS I	1,500	75
TOTAL			9,800	490
KAJIADO DISTRICT				
Kajiado	1972		3,000	150
Ngong	1947	-	2,000	100
Loitokitoki	-	-	1,000	50
Namanga	-	RWS III	1,000	50
Bissel	-	RWS III	400	20
Ongata	1974	RWS III	3,200	160
Ilassit	1972	RWS I	1,000	50
TOTAL			13,600	580

In addition to the water supply facilities shown above, there are 164 boreholes recorded in the project area. According to the borehole records in the Ministry, total yield of these boreholes is estimated at 7,800 m^3/day assuming 10 hours of pump operation. The total amount of water available in the project area for drinking purposes is estimated to be 8,870 m^3/day.

Table 10

Supply and Demand Balance of Rural Water Supply in Kajiado/Narok Districts

	Existing Supply	Existing Demand	Demand at Year 2,000	Additionally Required Amount by Year 2,000
Domestic		15,750	42,000	
Cattle		29,000	43,500	
Goat & Sheep		10,680	16,000	
TOTAL	8,870	55,430	101,500	92,380

As shown in Table 10, existing design capacity and borehole yields can supply only 16% of the present demand for drinking water. In order to satisfy the future demand, estimated for the year 2,000, an additional 90,000 m^3/day will be required.

To meet this future water demand, this project will provide water for local people through the Rural Water Supply Programme and for livestock and people engaged in ranching through the Ranch Water Development Programme.

5-3 Concept of the Project

The intent of this project is to construct rural water supply facilities under the Rural Water Supplies Programme to contribute to the national target of 100% rural water supply by the year 2,000 and to improve water supply for livestock development under KLDP for which IRDB loans are available.

At the same time, the project will reinforce the drilling division in the Water Resources Department of the Ministry of Water Development by organizing new special drilling crews for the project area fully equipped with new machines and equipment to be provided by a Grant Aid from the Japanese Government. The need for this can easily be appreciated because the capacity of the Drilling Division of the Water Resources Department has so far been insufficient for the increasing demand of groundwater development. To meet this need, private drilling companies were sought in the commercial market. This, of course, costs more for the ministry than operating their own equipment and machines.

5-4 Proposed Project Sites and Their Hydrogeological Conditions

5-4-1 Project Sites

Sixty-six sites were proposed for this project as a part of the Rural Water Supplies Programme Phase V and Group Ranch Water Development Programme in accordance with the project formation procedure.

Proposed Project Sites

	RWS Phase V	R.W.D.
Kajiado District	9 sites	30 sites
Narok District	10 sites	17 sites
Total	10 sites	47 sites

These project sites are distribute over a wide area in Najiado/Narok Districts as shown in Fig. 10.

The sites proposed for Rural Water Supplies Programme Phase V are as shown in Table 11.

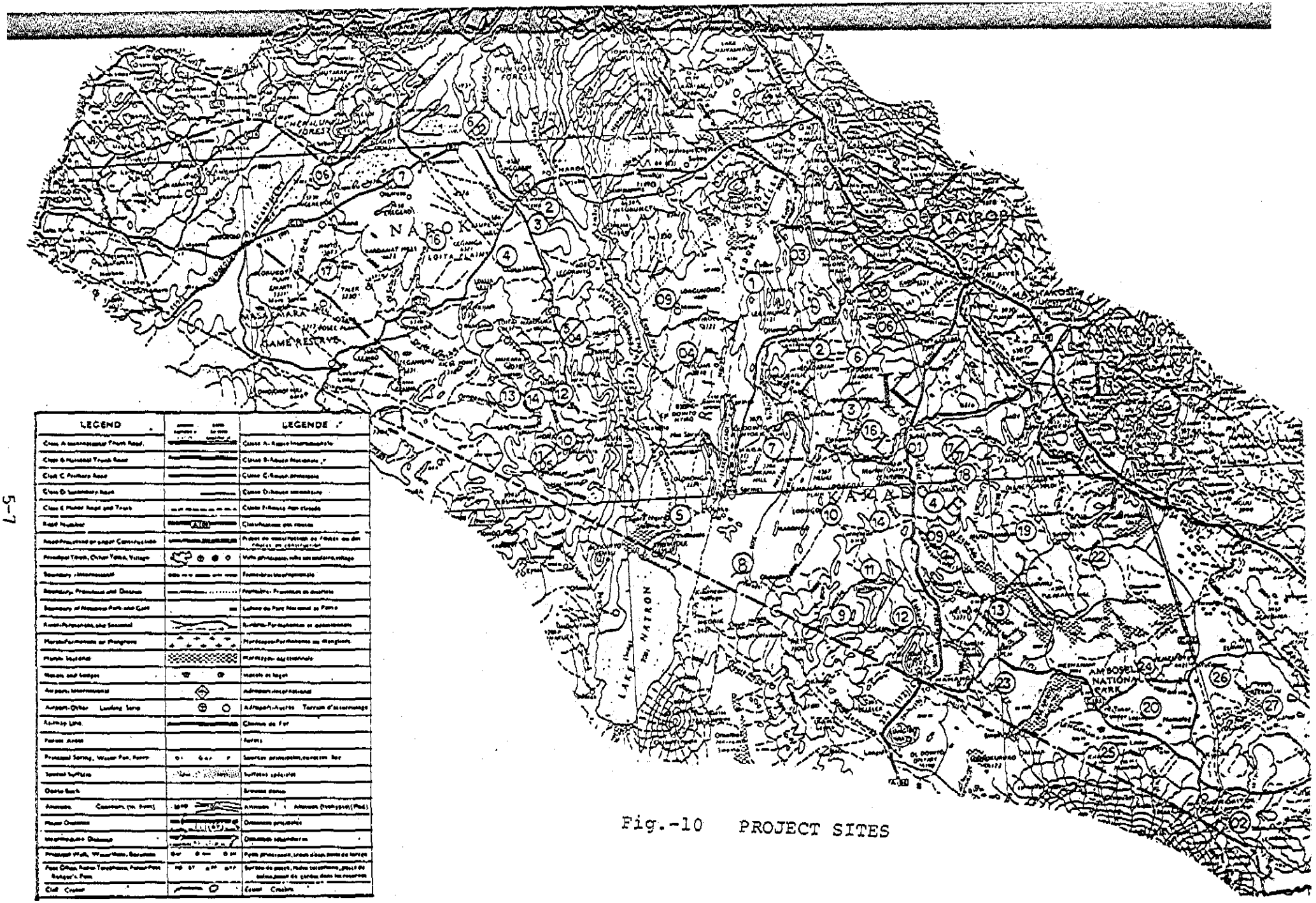


Fig.-10 PROJECT SITES

Table 11

Proposed Project Sites for Rural Water Supply Programme Phase V

Narok District	Kajiado District
1. Nairage Nkare	1. Kajiado Town
2. Ololounga	2. Nol Turesh
3. Ewaso Ngiro	3. Kibiko
4. Narosura	4. Kisamis
5. Olmasutie	5. Elangata Mkorai
6. Emarti	6. Oloorera
7. Enabelbel	7. Eukorika
8. Enengetia	8. Kiseria Nkorai
9. Mosiro	9. Mparasha Pipeli
10. Olopironit	

In addition, 47 project sites have also been selected for the project under the Ranch Water Development Programme as shown in Table 12.

Table 12

Proposed Project Sites for

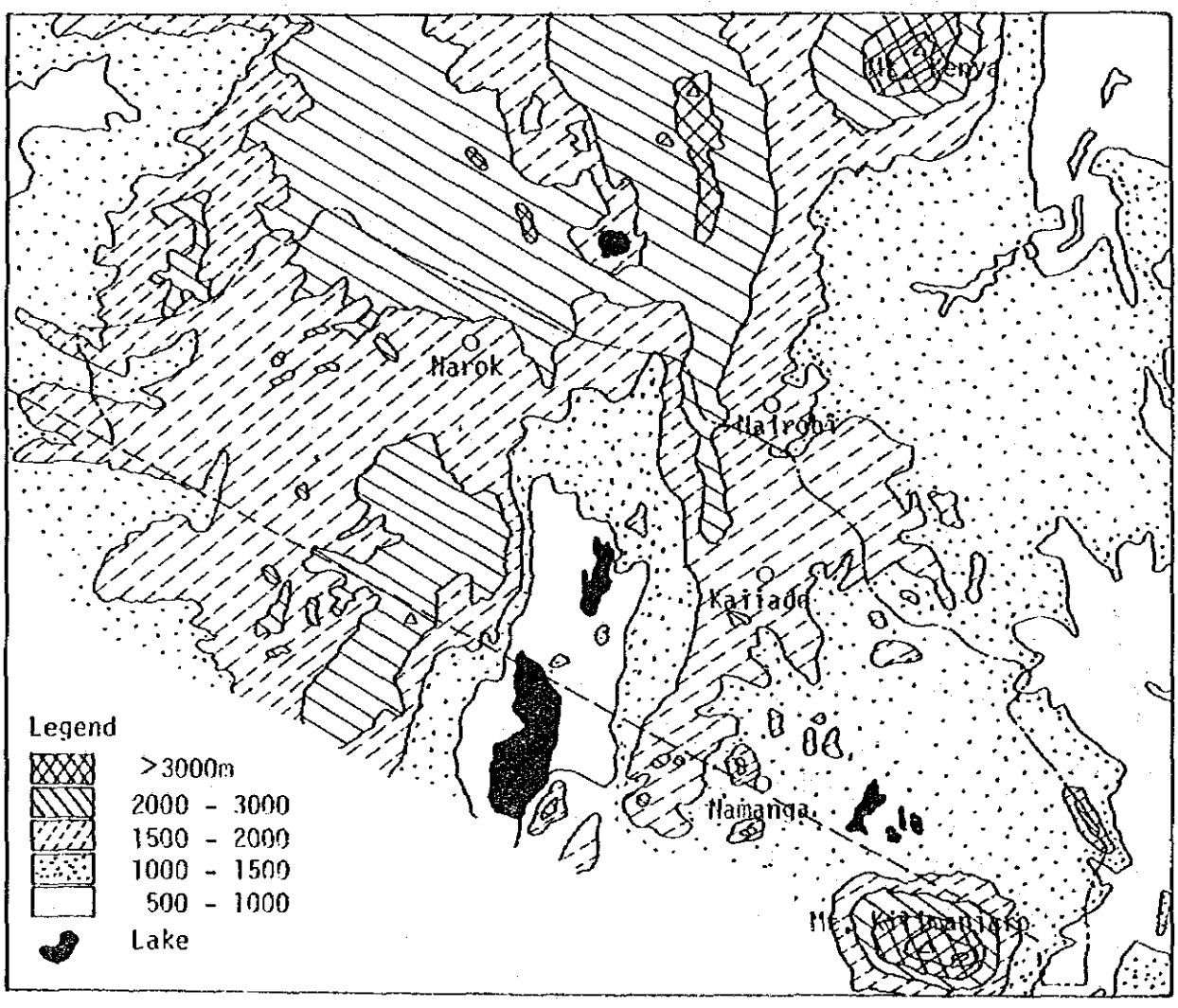
Group Ranch Water Development Programme

Kajiado District	Narok District
1. Ewuaso Onkidongi	1. Ewaso Nyiro
2. Loodoariak	2. Oldonyo Rasha
3. Kilonito	3. Olenkuluo
4. Oldonyio-Onyokie	4. Maji Moto
5. Shombole	5. Narosura
6. Endoinyio Narok	6. Ololulunga
7. Olkeri	7. Nkorkorri - Lemek
8. Torosei	8. Moyoi Transmara
9. Meto	9. Oloirien - Transmara
10. Lorngosua	10. Entasekera
11. Ilpartimar	11. Olmetie
12. Oldonyio-Orok	12. Morijo Loita
13. Mailua	13. Naikarra
14. Enkaroni	14. Leshota
15. Nkoile	15. Noorpopong - Suswa
16. Esokata	16. Olkinyei
17. Sajiloni	17. Koiyaki
18. Endorika	
19. Lolgirra	
20. Olkulului	
21. Osilalei	
22. Emotoroki	
23. Lolarash-West	
24. Lolarash-North	
25. Lolarash-South	
26. Mbirikani	
27. Kuku	
28. Individual Ranches - Ilbissil Area 2B/H	
29. Individual Ranches - Kaputiei Plain 3B/H	
30. Individual Ranches - Kajiado Area 2B/H	

5-4-2 Land Form and Geology of The Project Area

The object of this survey is in the south western part of Kenya. The Kajiado and Narok districts are adjacent to Tanzania. Together there are 425 km long and 125 km wide, or 40,619 km^2 in area.
(Kajiado district; 22,106 km^2 and Narok district; 18,513 km^2).

Fig. 11 Topography of the Project Area



As is seen in the topographical map (Fig.11), the surveyed area is located on a plateau whose elevation varies from 1,000 to 3,000 m above sea level. This area extends from the foot of the central mountains to the southern part of Kenya. The typical treeless plain of this area is called savanna. They are covered with a scattering of small and grass fields which turn green only during the rainy seasons. The land is basically flat with small rolling hills. A large graben called the Rift Valley runs through this area from north to south. This graben is very large and starts far north in Syria and runs through the Red Sea, Ethiopia and Kenya, then via Tanzania, Malaui, Mozanbique and to the Inidan Ocean covering more than 6,000 km with width of 70 km, and depth said to reach as deep as 700 m.

In the center of this area, there are depression lowlands from which Lake Magadi and Lake Natron were formed. Both Mt. Kenya (5,199 m) and Mt. Kilimanjaro (5,895 m) were volcanos produced as the result of this depression. They are the two highest mountains in Africa. The majority of rivers running through the area are dry except for some in the Narok district. On the whole, they are small rivers. The Ewaso Ngiro River is one important river which receives water from the central mountains and passes through Narok and runs west to the Rift Valley.
The major components of the geology in the project area are Pre-Cambrian metamorphic rocks Tertiary rocks along the Rift Valley and Quarternary surface deposits. Distribution of these rocks are shown in Fig. 12.

Pre-Cambrian, Tertiary and Quarternary formations are distributed in the Kajiado district in a ratio of 4 to 3 to 3. From central to eastern part, basements of Pre-Cambrian widely distributed while Tertiary formations spread along the Rift Valley structural line and the foot of Mt. Kilimanjaro. Thin Quarternary formations cover the rest of the alluvial plain basins.

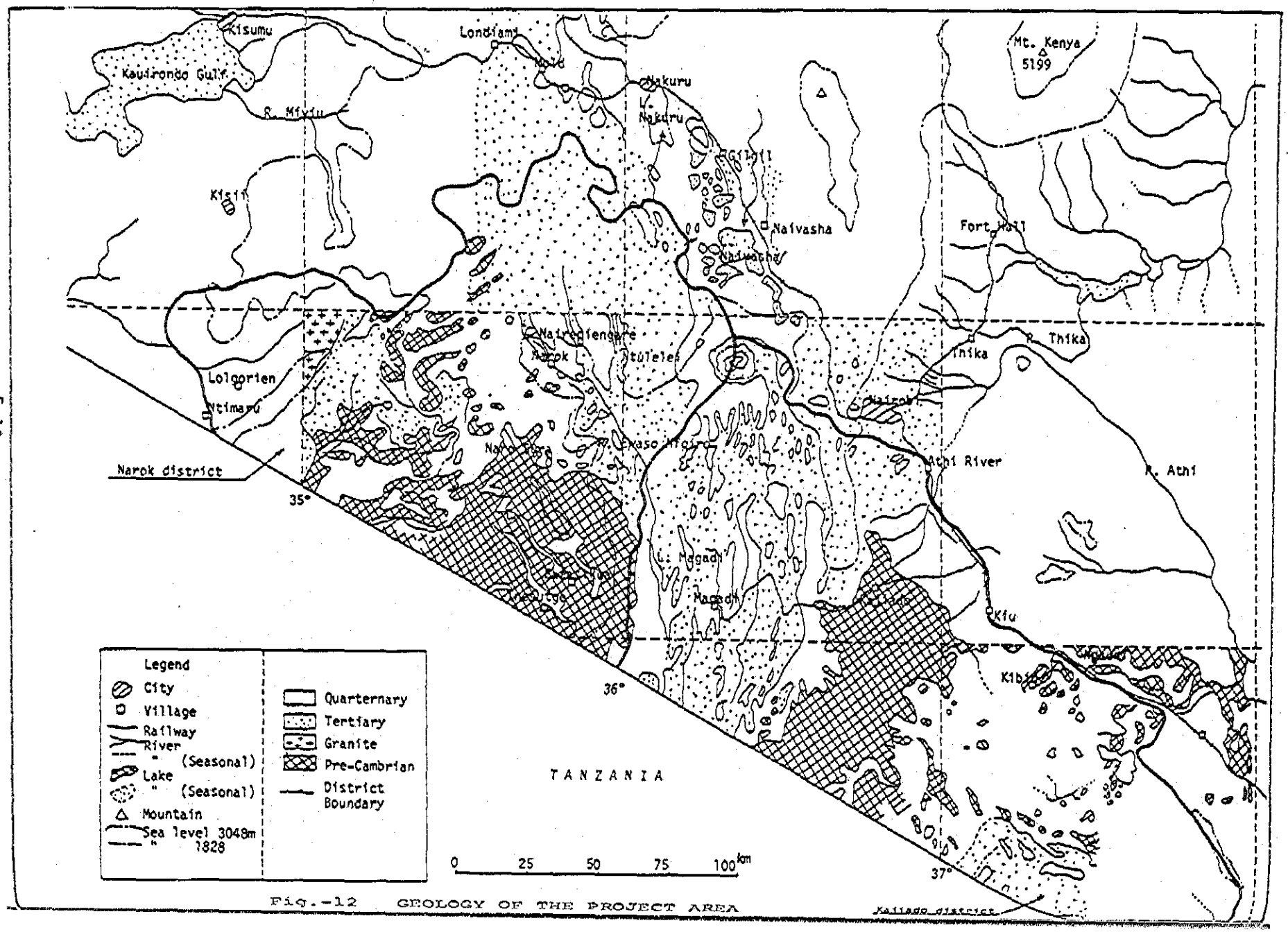


Fig.-12 GEOLOGY OF THE PROJECT AREA

In the Narok district, this ratio is 5 to 3 to 2. Pre-Cambrian basements are distributed from the central to southern part of the district. Tertiary rock lies along the Rift Valley structural line and in the western side of the district while a wide range of the central part is covered by Quarternary rock.
The major part of the Pre-Cambrian layer is composed of gneiss, which is one of the metamorphic rocks, being followed by Quartzite, marblex and schist. The Tertiary layer is composed of volcanic rocks such as Basalt, Trachyte, Phonotite, Tuffbreccia and Tuff.

The Quarternary layer was formed by material shot out during volcanic eruptions such as Volcanic sand, agglomerate, and ashes and by other alluvial layers made of clays and sands. Since the Pre-Cambrian layer is the oldest stratum of the earth, rocks have been highly consolidation due to compression over a long time. The Tertiary layer is relatively new and less consolidated. The Quarternary is a much newer layer and consists of soft stratum not yet consolidated.

5-4-3 Hydrogeological Conditions in the Project Area

As the Pre-Cambrian layer is highly consolidated it would normally be difficult to find any good aquifers with high permeability. However, it is believed that this layer had been subjected to considerable weathering over an extended period. There is hope that aquifers storing water can be found in the weathered zones.
The Tertiary layer which is less consolidation may have considerable openings and thus could have some gocd aquifers. The Quarternary is not yet consolidated so the largest amount of water is expected to be found in this layer. However, on plains where this layer is not thick, there can be little storage.

Good storage areas should be found however, at the foot of volcanos.
Fig. 13 is the hydrogeological map of the area. Looking at this figure, the following areas are considered to be the most promising groundwater basins for this project.

Kajiado District

- o District along the Rift Valley structural line.
  (Excluding surrounding areas of Lake Magadi, a salt lake and mountain tops.)
- o Foot of Mt. Kilimanjaro
- o Areas south of Nairobi
- o Alluvia around Lake Aboseli. (Except areas close to Amboseli.)

Narok District

- o Districts along the Rift Valley structural line
- o Foot of Mau Escarpment
- o Plains west to Narok.

During the basic survey, these areas were carefully checked for groundwater storage.

5-4-4 Occurrence of Groundwater Aquifer in the Project Area

Occurrence of aquifers appears to be concentrated in recent deposits of sands and gravels and also in weathered zones of Pre-Cambrian formations. In the project area, Pre-Cambrian formations are predominate. Existing the 164 boreholes in the project area are marked in Fig. 14. There boreholes are classified as shown in Table 13.

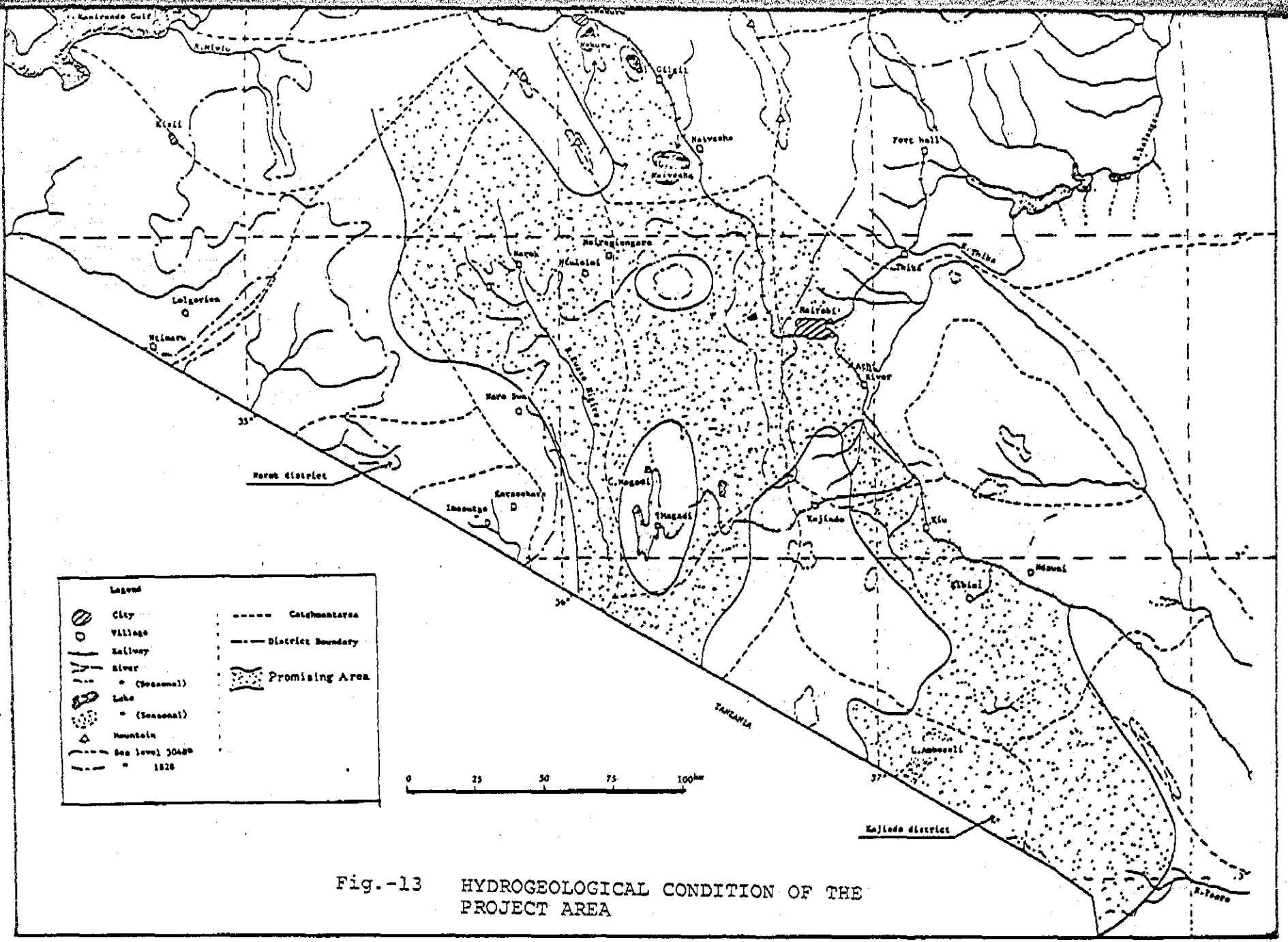


Fig.-13 HYDROGEOLOGICAL CONDITION OF THE PROJECT AREA

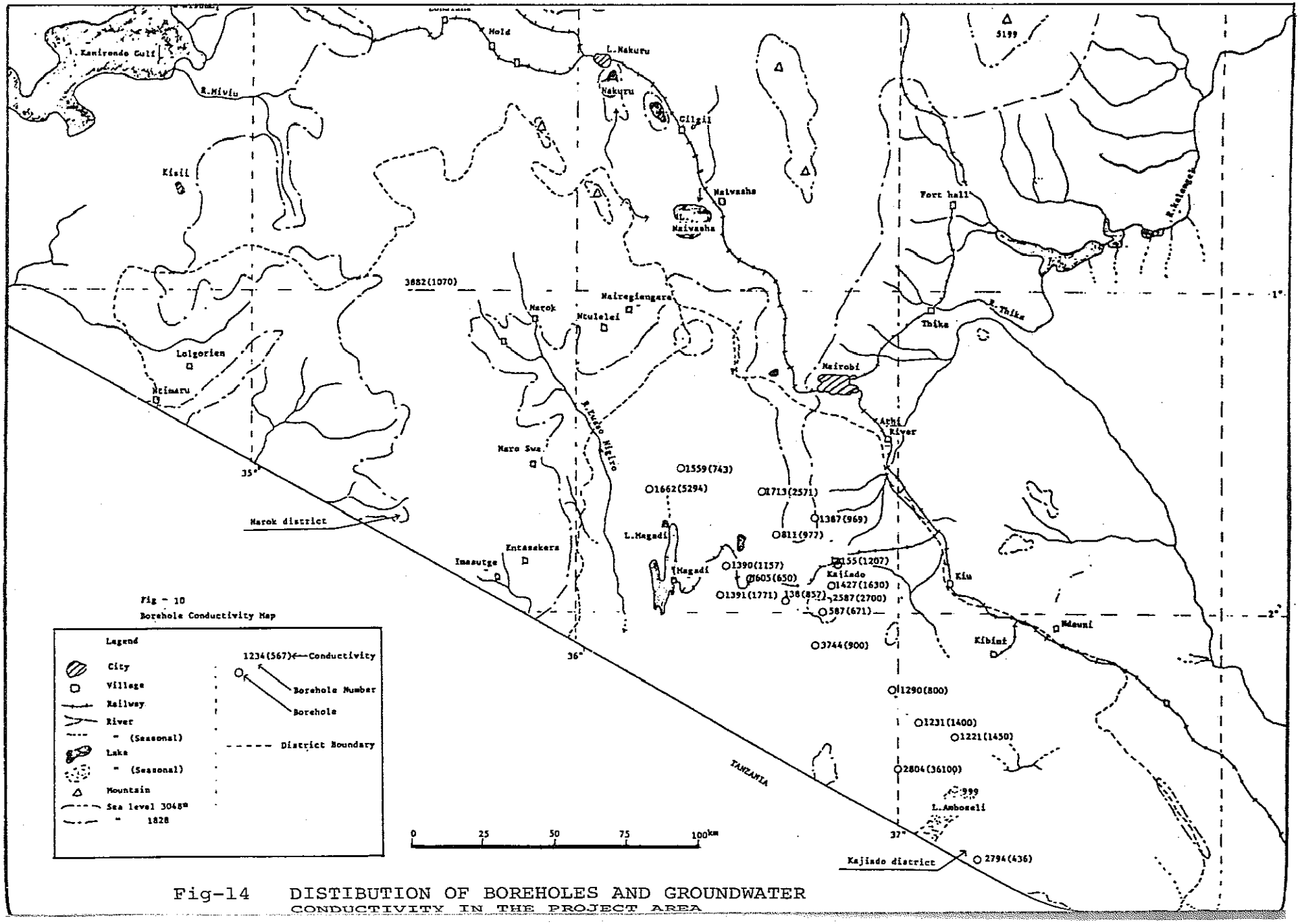


Fig - 10
Borehole Conductivity Map

Fig-14 DISTIBUTION OF BOREHOLES AND GROUNDWATER CONDUCTIVITY IN THE PROJECT AREA

Table 13

Classified Boreholes in the Project Area

	Tertiary & Quaternary		Pre-Cambrian		No. of Boreholes	
	Total No. drilled	No. of dry wells	Total No. drilled	No. of dry wells	Total No. drilled	No. of dry wells
Kajiado	40	7 (18%)	115	21(18%)	155	28(18%)
Narok	7	5 (71%)	2	1(50%)	9	6(67%)
Total	47	12 (26%)	117	22(19%)	164	34(21%)

The contour of the static water level is drawn in Fig. 15 and summarized as below:-

i. Within the Rift Valley area, static water level is approximately 100 m. Further north, at the foot of volcanos, it lowers to about 200 m.
ii. Half way up Mt. Kirimanjaro, the static water level is also low.
iii. In basin low lands of Amboseli, Lengesim, Stong and Athi districts in the Kajiado area, it is within 25 m.
iv. In districts of the Narok area, close to the Rift Valley, static water level is also low.

Generally, static water levels in areas around the foot of volcanos are low due to high permeability and the difference in elevation from sea level. This is also the case for the volcanos in the project area.
Deep receiving bed rock is thought to be the reason why the static water level in and around the Rift Valley is low.

Water resting conditions generally observed in groundwater storage have also been observed in the project areas; for example, water levels in basins have been found to be shallow.

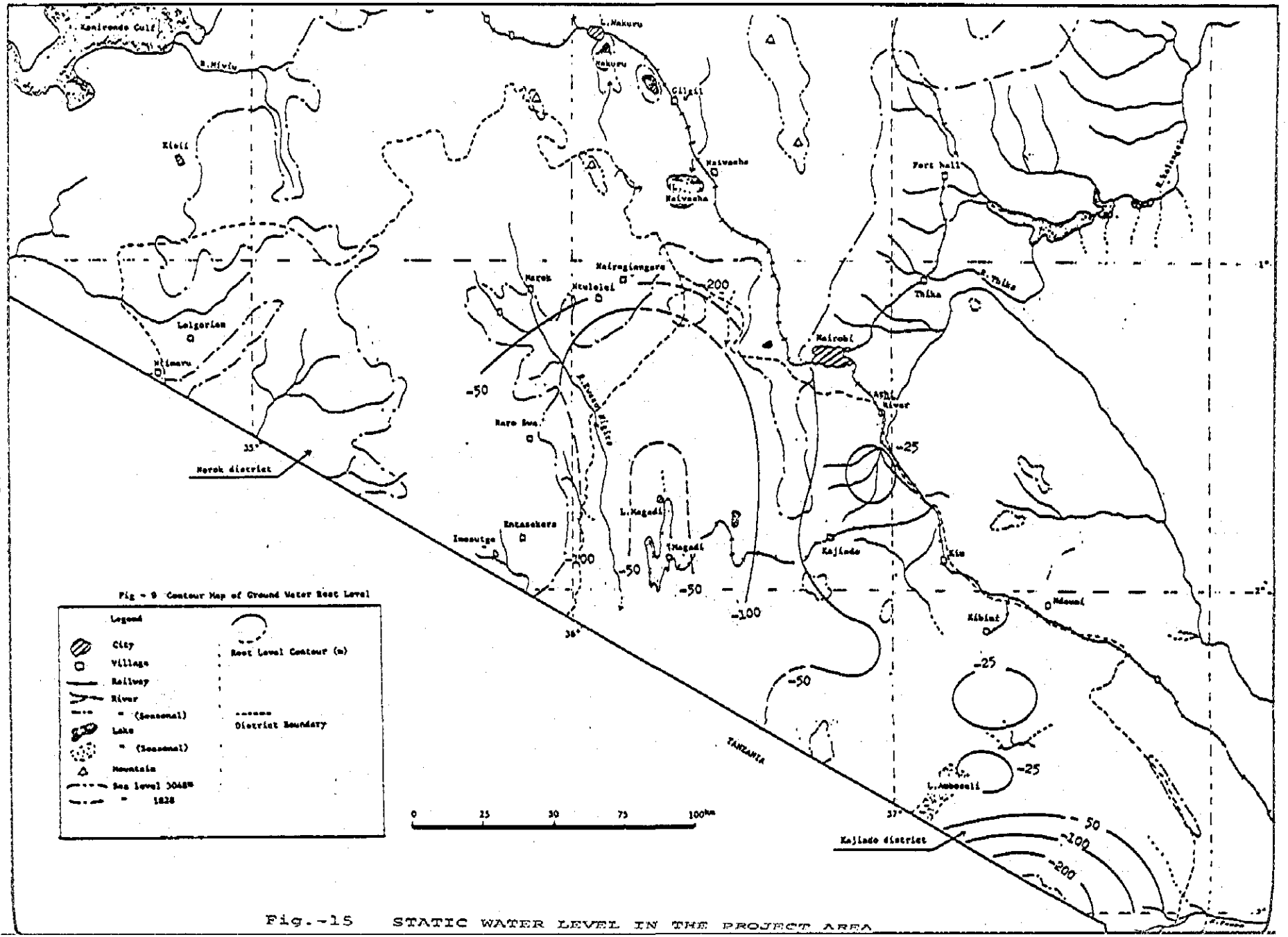


Fig - 9 Contour Map of Ground Water Root Level

Fig.-15 STATIC WATER LEVEL IN THE PROJECT AREA

This is particularly evident in the vaste Amboseri basin at the foot of Mt. Kirimanjaro where there is plenty of water recharge and even artesian wells.

5-4-5 Hydrogeological Constants

Hydraulic constants such as the coefficient of permeability, differ greatly in aquifers according to the grain dia-meter, grain composition, consolidation degree, and various other factors. The coefficient of permeability represent the degree of easiness with which water can pass through under ground voids and the coefficient of transmissibility shows the dimension of the aquifer by multiplying the coefficient of permeability by the thickness of the aquifer. Permeability, a property of the aquifer, is determined by the coefficient of permeability.

Although there were many wells checked during this basic study, no hydraulic constant is available yet. Efforts however, have been made to obtain an approximate hydraulic constant based on the dynamic water level data of some wells and using certain assumption as shown in APPENDIX 2.

Based on the hydrogeological constants determined during the basic study, a preliminary analysis was made as summarized below:-

1. There are 16 wells which show specific yield of one-figure number (60%) showing that there are many wells yielding small amount of water. On the other hand, there are 6 good wells which have a specific yield of three-figure number representing 40% of the wells tested, together with normal wells with specific yield of two-figure number.
2. As for the coefficient of permeability, generally 1×10^{-4} cm/sec. is used as a standard to distinguish aquifers and aquiclude. In the above examples, 14 wells

out of 27 wells (52%) are more or less at this level indicating some aquifers are in unfavourable condition for yield. There were 6 good aquifers with a coefficient of permeability of more than 1×10^{-2} cm/sec.

3. Generally, all wells are with deep dynamic water levers and some of them exceeding 75 m.

Based on this information, an averaqe yield for each borehole in the project area is estimated at 60 ℓ/min. - 120 ℓ/min. Although this is a relatively small amount, it is possible that groundwater can be developed for small scale rural water supply schemes.

5-4-6 Water Quality

During the geoelectric survey for this study, electric conductivity of groundwater was measured.
The results are summarized on the geological map in Fig. 16.
The characteristics of groundwater conductivity distribution are as explained below:-

1. Generally speaking, electric conductivities of these groundwater are relatively high about 1,000 MΩ/cm. Only some of them indicates low conductivity of 650 MΩ/cm. This can be attributed to the day condition of climate.
2. There appears a fendancy that conductivities of groundwater increase as location of boreholes goes to downstream in catchment areas.
3. Around the salt water lakes of Lake Magadi and Lake Amboseli, mineral content shows a sharp increase. This reflects increased salt content due to evaporation.

In addition to the above study on water quality, all available data on water analysis were reviewed as shown in APPENDIX 2. The groundwater has relatively high salinity however, most of the water satisfies the standard drinking water quality grade 2 established by W.H.O.

5-5 General Description of the Project

Since details of the water supply facility for each proposed site is subject to further planning and design only a general concept for each scheme is possible. In order to estimate the size of the project for analysis assumptions were made for unit water consumption according to the design criteria for rural water supply projects as shown below:-

Unit Water Consumption

People	Private connection	50 ℓ/day/cap
	Public tap	25 ℓ/day/cap
Cattle	Livestock unit	75 ℓ/day/cap.

Also the size of population was estimated for each proposed site of Phase V of the Rural Water Supply Programme, as shown in Table 14. Using these assumptions, the design capacity of each water supply scheme is estimated.

In the same manner the design capacity for each Ranch Water Development scheme is estimated assuming that 4 ℓ of water are required for each hectare of ranch area. (See Table 15.)

According to Table 15 and Table 16, about an additional 30,000 people will be served safe and adequate drinking water by the water supply schemes proposed. Total design capacity for proposed schemes and Rural Water Supplies Programme Phase V for the project area is estimated at 1,560 m^3/day.

At the same time 47 schemes proposed under the Ranch Water Development Programme will serve an additional 15,000 km^2 of ranch area. Total design capacity of these schemes is estimated at 6,000 m^3/day. The results of the above estimate is summarized as shown in Table 16.

Table 14

Outline of Rural Water Supplies Phase V

	Population	Size of Area km^2	Design Capacity ton/day	Estimated Cost million K Shs
Narok District				
1. Nairage Nkare	5,600	225	640	4.8
2. Ololounga	750	75	38	0.6
3. Ewaso Ngiro	500	50	30	0.4
4. Narosura	500	50	30	0.4
5. Olmesutie	1,000	100	50	0.9
6. Ewarti	1,000	100	50	0.9
7. Enabel	500	50	25	0.4
8. Enengetia	500	50	25	0.4
9. Mosiro	2,800	115	150	2.4
10. Olopironit	600	60	30	0.5
Total	13,750		748	11.7
Kajiado District				
1. Kajiado Town	8,000	6	400	6.8
2. Nolturesh	600	25	30	0.5
3. Kibiko	900	80	45	0.9
4. Kisamis	1,800	-	90	1.5
5. Elangata Mkarai	530	240	27	0.5
6. Oloorev	1,800	80	90	1.4
7. Eakorika	800	36	40	0.7
8. Kiseria	1,200	50	60	1.0
9. Mparasha	600	24	30	0.5
Total	16,230		812	13.8

Table 15

Outline of Ranch Water Development Programme

	Size of Area km^2	Design Capacity m^3/day	Approximate Cost Estimate K Shs Million
Narok District			
1. Ewaso Nyiro	277	110	1.1
2. Oldonyo Rasha	100	40	0.4
3. Olenkuluo	152	61	0.6
4. Maji Moto	300	120	1.2
5. Narosura	600	240	2.4
6. Ololulunga	250	100	1.0
7. Nkorkorri-Lemek	749	300	3.0
8. Moyoi Transmara	370	148	1.5
9. Oloirien-Transmara	174	70	0.7
10. Entasekera	200	80	0.8
11. Olmetie	90	36	0.4
12. Morijo Loita	157	6	0.06
13. Naikarra	120	48	0.5
14. Leshota	80	32	0.3
15. Noorpopong-Suswa	44	18	0.2
16. Olkinyei	78.7	322	3.2
17. Koiyaki	876	350	3.5
Total	5,185	2,081	20.9

Table 15

Outline of Ranch Water Development Programme

	Size of Area km^2	Design Capacity m^3/day	Approximate Cost Estimate K Shs Million
Kajiado			
1. Ewaaso Onkidongi	713	285	2.9
2. Loodoariak	570	228	2.3
3. Kilonito	684	101	1.0
4. Oldonyio-Onyokie	684	274	2.7
5. Shombole	618	247	2.5
6. Endinyio Narok	360	144	1.4
7. Olkeri	258	103	1.0
8. Torosei	482	193	1.9
9. Meto	290	116	1.2
10. Lorngosua	380	152	1.5
11. Ilpartimar	200	80	0.8
12. Oldonyio-Orok	274	110	1.1
13. Mailua	658	263	2.6
14. Enkaroni	113	45	0.5
15. Nkoile	60	24	0.3
16. Esokata	40	16	0.2
17. Sajiloni	205	82	0.8
18. Endorika	276	110	1.1
19. Lolgirra	130	52	0.5
20. Olkulului	150	60	0.6
21. Osilalei	391	156	0.6
22. Emotoroki	195	78	0.8
23. Lolarash-West	425	170	1.7
24. Lolarash-North	388	155	1.6
25. Lolarash-South	323	130	1.3
26. Mbirikani	110	44	0.5
27. Kuku	980	392	3.9
28. Ilbissil Area	100	40	0.4
29. Kapuhei Plairs	100	40	0.4
30. Kajiedo Area	100	40	0.4
Total	9,826	3,930	39.3

Table 16

Outline of the Project

	No. of Sites	Population/ Size of land	Design Capacity (m^3/day)
Rural Water Supply Programme			
Kajiado	9	16,230 people	812
Narok	10	13,750 "	748
Total	19	29,980 people	1,560
Ranch Water Development			
Kajiado	30	9,826 km^2	3,930
Narok	17	5,185 km^2	2,081
Total	47	15.011 km^2	6,011

5-6 Cost Estimate of the Project

In order to estimate construction costs of the project, assumptions were made as described below. As shown in Fig. 6 and 7, various types and sizes of rural water supply schemes have been designed in the past for Rural Water Supplies Programme Phase III and IV. According to the design data of these schemes an average consturction cost per capita is estimated as shown below:-

Unit Cost per Capita

Rural Water Supplies Programme Phase III (an average out of 84 schemes)	860 Sh/Cap.
Rural Water Supplies Programme Phase IV (an average out of 64 schemes)	716 Sh/Cap.

Among these schemes there were some extreme values for construction cost per capita, however, a safe average taking this into consideration was estimate to be about 850 Sh/per capita. Another factor which might affect the accuracy of the estimate is that there were only 15 schemes for the Ranch Water Development Programme which have been completely designed.

These, however, are the only available records.
For the estimate of construction costs for ranch water supply schemes, 40 Sh/ha is used in the Ranch Water Development Division. This is equivalent to Shs 4,000/km^2,

Using these figures, construction costs for each proposed scheme is estimated as shown in Table 14, and 15, and summarized in Table 18.

Table 18

Estimate of The Project Cost

	R.W.S. Phase V			Ranch Water Development			
	No. of Schemes	Size of Population	Cost mil. (Kshs)	No. of Schemes	Size of Population	Cost mil. (Kshs)	Total Kshs
Kajiado	9	16,230	13.8	30	9,826	39.3	53.1
Narok	10	13,750	11.7	17	5,185	20.9	32.6
Total	19	29,980	25.5	47	15,011	60.2	85.7

Based on the above, total construction cost of the Project will be Shs 85.7 million.

5-7 Working Body of the Project Implementation

The implementation of the project will be performed according to the procedures set up by the Ministry of Water Development. The flow chart of the procedure for each related division is summarized as shown below:-

DEPARTMENT	BRANCH	DIVISION	TYPE OF WORK
1. Water Resources	Groundwater	Drilling	Water Source Planning
2. Engineering	Planning & Designing	Project Planning	Planning & Design
3. Engineering	Implementation	Construction	Construction of Phase V
4. Engineering	Implementation	Agricultural Service	Construction of Ranch Water
5. Water Resources	Groundwater	Drilling	Construction of Boreholes for RWS Phase V and Ranch Water