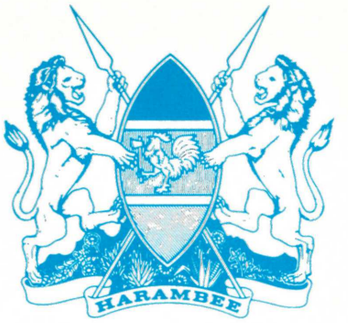
REPUBLIC OF KENYA



MINISTRY OF WATER DEVELOPMENT

MERU

EXECUTIVE SUMMARY

OF

WATER RESOURCES ASSESSMENT STUDY AND DISTRICT WATER DEVELOPMENT STUDY

June 1991

WATER RESOURCES
ASSESSMENT SECTION
NAIROBI, KENYA

WRAP
WATER RESOURCES
ASSESSMENT & PLANNING

TNO – INSTITUTE
OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

PREFACE

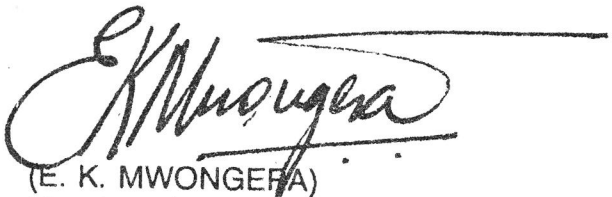
It gives me great pleasure to introduce the District Water Development Study for Meru District.

The Ministry of Water Development has the task of planning for water resources development, both at national and district levels. Districts have been assigned a major role in the development of the country as illustrated by the District Focus Strategy for Rural Development Policy. Consistent with this policy the Ministry of Water Development has put great emphasis on the studies for District Water Development Planning.

Water resources development can only be successfully undertaken if the long-term planning reflects the balance between availability and exploitation of water. Extensive investigations and monitoring are needed to determine the potential of the water resources and the effects of development on long-term basis. Presently, the Districts do not have the research capacity to carry out the necessary studies independently. To overcome this situation, the Ministry of Water Development has established a Water Resources Assessment Section that supports the Districts in carrying out these studies. The Section is being strengthened by the Water Resources Assessment and Planning Project.

The present study provides extensive information on the availability of water resources, the existing supply, the future water demand and the investments involved in developing the water resources in Meru District. Equipped with this information the District will be in a better position to plan its supply facilities. It is only after the District succeeds in explaining to the people the limitations of the natural system and the vulnerability of the environment involving them as much as possible in the planning and construction of their water supplies, that the difficult task of providing water to the people will see a good end.

I express the wish that this important study will be optimally used to achieve this common goal.



(E. K. MWONGERA)
Director of Water Development

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1. OVERVIEW AND CONTEXT OF THE STUDY

1.1 Purpose and Context

The District Water Development Study (DWDS) of Meru District is aimed at providing the basis for the District Water Development Plan (DWDP), which in turn will be the sector input to the District Development Plan (DDP).

The study was undertaken by the Ministry of Water Development in its role of supporting the districts in their task to develop the available water resources in a safe and sustainable way. Two conditions will have to be fulfilled to achieve this goal.

- The development of water resources must be in balance both with the capacity of these resources and with the conditions set by the environment.

- Supply of water to the community must be sustainable, meaning that the proposed schemes be designed in agreement with the technical and financial support capability of the people for whom they will be constructed.

These conditions require a thorough assessment of the situation in the district and a planning that is well tuned with the socio-economic and technical development of the district as laid down in the District Development Plan. In this respect it should be understood that the water resources are not necessarily the key limiting factor in the economic development of a district.

The water resources assessment study covers both groundwater and surfacewater and is intended to give an overview of the available water resources in the District. Drilling of boreholes forms part of the activities and even though drilling is mainly for exploration purposes, drilling sites are selected in such away that after the boreholes are used for investigation purposes, they may be used later as production wells.

The methodology for planning of water resources development, embarked upon by the Ministry facilitates full participation of the district authorities, community groups and individuals concerned in all stages of the planning process which is in line with the District Focus Policy. The DWDS can be considered the first stage of this process. The study provides insight into sustainable water supply options and the investments required to realize them. It also supports the district authorities in their search for donor contributions.

1.2 General Approach

The model for preparation of a District Water Development Plan is shown in figure 1. Three phases are distinguished in the planning procedure.

Phase 1 - focusing on the analysis of water demand and water resources. This part of the study includes assessment of current and projected demands and verification of the compatibility with available resources. It results in a description of water development options.

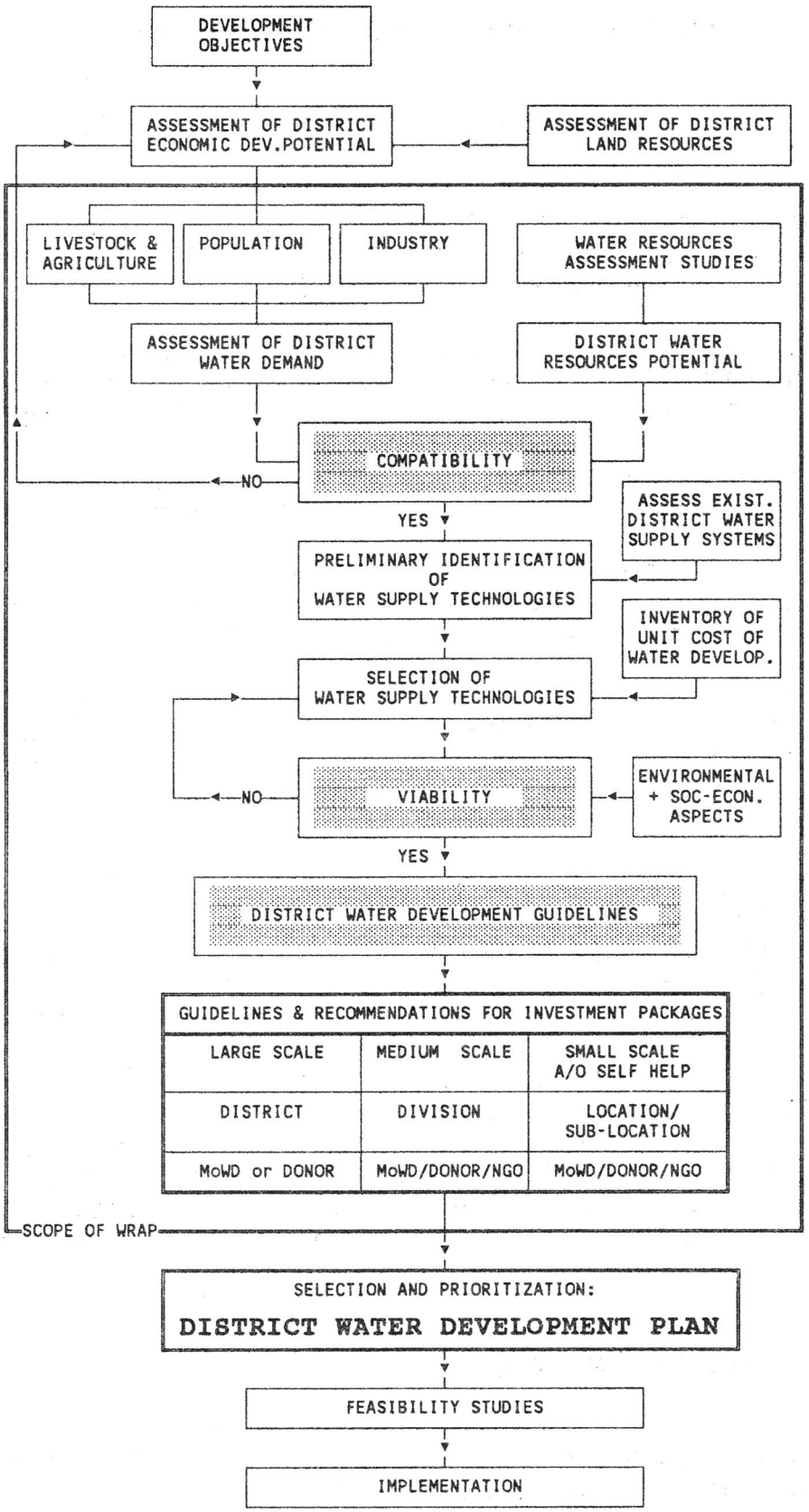


Figure 1 **Model for Preparation of District Water Development Plan**

Phase 2 - focusing on the existing water supplies, the technical options for further water supply development and cost comparison of these technology options. The results provide insight into the viability and affordability of identified supply options.

Phase 3 - focusing on assessment of the social, technical/environmental, institutional and economic/financial elements involved in the design of the necessary investments and O & M structures. This part of the study provides cost estimates and recommendations for investment packages and includes a proposal for feasibility studies.

The studies and results (phases 1 through 3) are described in the respective parts of the DWDS report. The water resources assessment study is presented in a separate assessment report. A summary of the key findings is given in the following chapters.

1.3 International Co-operation

The District Water Development Study was undertaken under a Technical Co-operative Agreement between the Governments of Kenya and The Netherlands.

The studies were carried out by the Water Resources Assessment Section of the Ministry of Water Development, Nairobi, Kenya, in co-operation with the TNO Institute of Applied Geoscience, Delft, The Netherlands, within the framework of the **Water Resources Assessment and Planning Project (WRAP)**.

Consultancy services were provided by the Netherlands Economic Institute, Rotterdam, The Netherlands and the International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands.

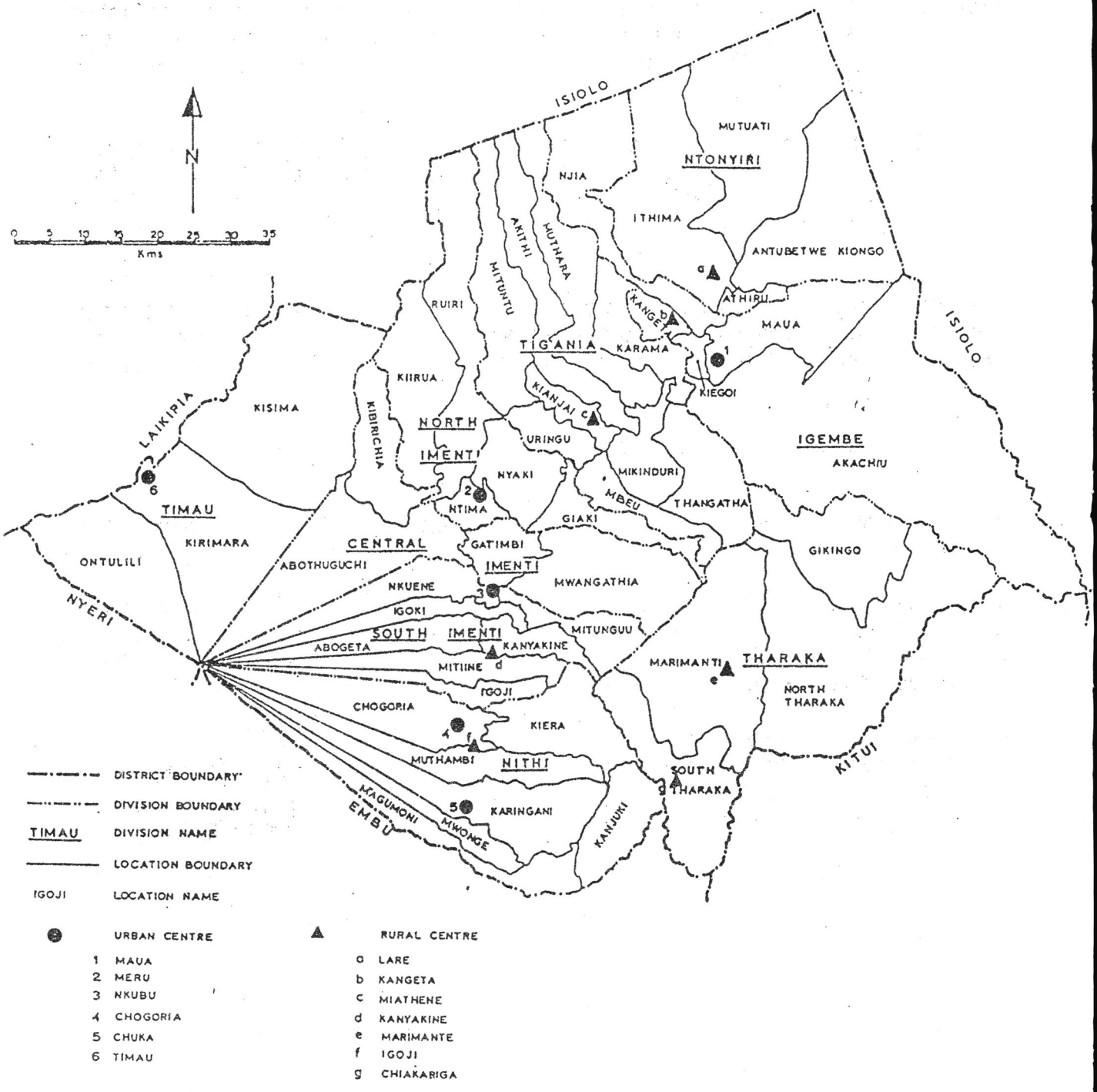


Figure 2 Meru District Administrative Boundaries

From: Meru District Development Plan, 1989-1993

2. DESCRIPTION OF MERU DISTRICT

2.1 General

Meru District is located in the Eastern Province. It covers an area of 9,922 km^2 and it is bounded by the parallels 0° 30'S and 0° 45'N and the longitudes 37°E and 38° 30'E.

The District contains contrasting geographical features, from the height of the Mount Kenya massif and the Nyambeni range to the lowlands in the east and north. The tremendous range of altitude gives the District a diverse climate as well as a wide range of agro-ecological zones.

Administratively, the District is divided into 9 Divisions (Figure 2). The Divisions are further divided into 48 locations and 145 sub-locations. The District has four major local authorities: Meru County Council, Meru Municipal Council, Chuka Town Council, and Maua Town Council.

Urban and rural centres are relatively small in Meru District. The largest centre is Meru Town, the District headquarters. Other urban centres are Chuka, Chogoria, Nkubu and Maua.

Most of the roads converge on Meru Town. However only three roads are tarmac: Embu - Meru, Nanyuki - Isiolo - Meru and Meru - Maua. The upgrading of roads currently receives much attention from the District authorities and this may have a stimulating effect in future on the growth of the centres.

Electricity is supplied to the main urban centres, to the high potential areas and some rural centres, such as Mitunguu, Tunyai, Lare, Mutuati, etc. Currently electricity lines are being extended into Ntonyiri and plans exist to supply Mikinduri and Igembe Division south of Maua. Of all Divisions only Tharaka Division is largely without electricity.

2.2 Physiography and Hydrogeography

Four main physiographic units can be distinguished:

1. Mount Kenya
2. The Nyambeni Range
3. The Volcanic Plains
4. The Basement System Area

Mount Kenya can be further subdivided into (i) the Upper, (ii) the Middle and (iii) the Lower Volcanic Slopes.

The *Upper Volcanic Slopes of Mount Kenya* (5,199 m) are situated above approximately 3,500 m. This zone coincides rather well with the former glaciation. At present it comprises a glacial-naval subzone, an afro-alpine subzone and a moorland subzone. Several glaciers drain to the Ewaso Ngiro and Tana catchment, but contrary to popular belief, total discharge from this area is small. The area is mainly a recharge area with

a deep groundwater table, though locally shallow groundwater and moorlands occur which are associated with perched aquifers.

The *Middle Volcanic Slopes of Mount Kenya* extend from around 2,400 m to 3,500 m. They are covered with forest which tend to thin out to the north-eastern leeward side of the mountain where little true forest is left. These areas enjoy the highest rainfall and supply a substantial part of the perennial runoff. The terrain is often rugged and the rivers are deeply incised. It is a groundwater recharge and transmission area. At lower elevations many springs occur.

The *Lower Volcanic Slopes of Mount Kenya* are used for rainfed agriculture. They are among the best lands in the country. The terrain is hilly to rolling although steep sloping, rugged parts also exist. Stream incision generally decreases in a downstream direction as does rainfall. The landscape has a humid appearance in the upper part of the zone and a semi-arid character in the lower parts. The groundwater table is predominantly shallow at the transition zone between the Upper and Middle Volcanic Slopes, but falls gradually to greater depth in downstream directions. Few springs occur on the leeward side of the mountain, but many in the transition zone on the eastern side of the mountain where rainfall is higher. This area is mainly a groundwater transfer zone although some recharge might occur in the upper, humid parts.

The *Nyambeni Volcanic Range* (2,514 m) is elongated in a north-east to south-west direction rising from the foothills of Mount Kenya and shows superficially a lot of similarity with the Lower Volcanic Slopes of Mount Kenya. The soils are among the best in the country and are used for rainfed agriculture. The terrain is generally steep although flat or hilly parts also occur, notably near the summit. The landscape has a humid appearance in the upper and middle parts and a semi-arid in the lower parts. The groundwater table is predominantly shallow but can be deep at the top of the range. Many springs are found on the windward side of the range and less so on the leeward side. The springs in the Nyambeni Range are less in number but carry much more discharge than those at Mount Kenya. Recharge takes place in the rainy upper parts of the range while most discharge occurs through many large springs on the contact between different lava flows and the underlying Basement.

The *Volcanic Plains* lie roughly between 600 and 1,500 metres contour lines. The climate is semi-arid. They are formed by lavas which have been extruded from the Nyambeni Range, and to a lesser extent from Mount Kenya. The topography is mostly flat to gently undulating with rivers flowing through narrow valleys.

The *Basement System Area* is considered as a separate unit. The appearance of the rocks and the terrain is very different from that of the volcanic areas as are the groundwater, surface water and climatic conditions. The Basement Area can be characterised as a dusty arid flat, dotted with inselbergs and bare rugged mountains.

The present landsurface in the Basement country has been lowered well below the sub-Miocene peneplain which is a sub-volcanic floor, only preserved intact below protective lava layers or as degraded remnants of resistant metamorphic rocks. This surface occurs between 1,200 and 1,350 metres at the eastern and south-eastern margins of Mount Kenya. The second peneplain, the end-Tertiary or mid-Pliocene peneplain is much more important. It occurs at elevations usually between 1,000 and 1,200 metres. According to Baker (1967) volcanicity of Mount Kenya began just before the maturation of this peneplain. The mature peneplain is the floor on which the Nyambeni volcanic pile was built up.

2.3 Land Use and Land Holding

According to the District Development Plan, Meru District has 651,000 ha of agricultural land broken down as shown in Table 1. High potential areas grow mainly tea, coffee, potatoes and maize while cotton, tobacco, sunflower, sorghum and millet are for medium and marginal zones.

Apart from the agricultural land, the remaining part of the district consists of forest reserves and the parks. Meru National Park (870 km^2) and Mount Kenya National Park (380 km^2) represent together 12.6% of the district's total area.

Table 1 Land Classification of Meru District

Category	Area (ha)
High Potential	241,000
Medium Potential	95,000
Low Potential	315,000
Forests	139,700
National Parks	125,000
Other	76,500
Total	992,200

Source: Meru District Development Plan 1989/93

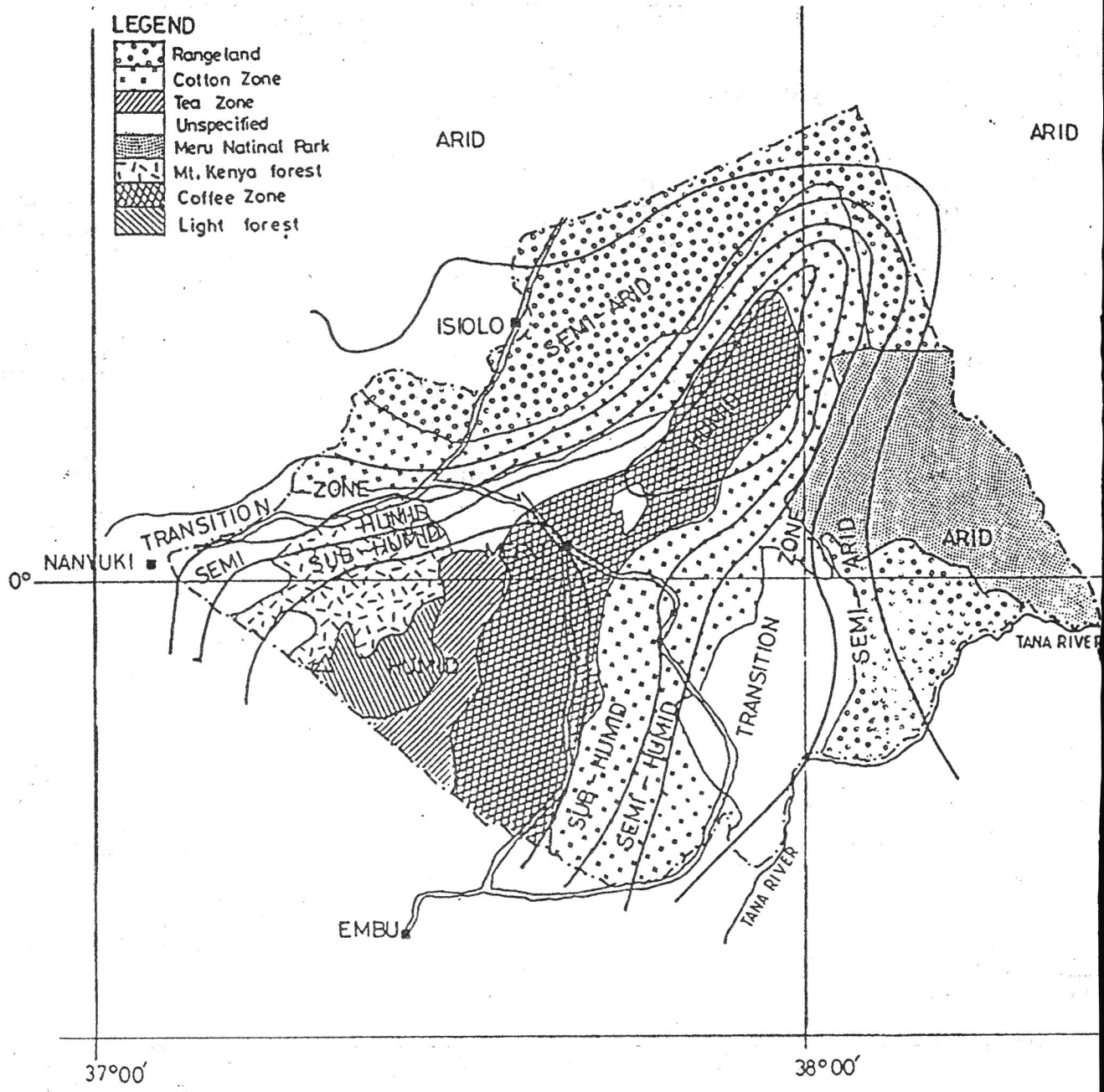
Figure 3 depicts the relationship between moisture availability zones and agro-zones as shown in the Meru District Development Plan.

Land in Meru is held under three headings: clan land; individual small-scale land holdings; and large-scale farms.

Clan land has not been gazetted as adjudication areas. These areas are mainly in Igembe, Ntonyiri, Tigania and Tharaka Divisions. In many of these areas, the ownership of the land is vested in the clan (Mwiriga) and the clan distributes the land to its individual male members. It is not likely that a lot of land is communally owned by the end of this development plan period.

Most of the land in Meru is now owned by small scale farmers who work on the farms as household property. It is cultivated by the farmer and his family for both subsistence and cash crop farming. The size of these holdings range from 0.2 ha to 12 ha.

A large-scale farm is defined as that which used to be included in the former scheduled areas (white highlands); these were mainly in Timau Division of Meru District. The average size was about 700 ha. Very few large farms still exist due to migration into the Division and purchase of these farms by groups of people for sub-division to the members.



Name	Mean Annual Rainfall (mm)	Rainfall/Potential Evaporanspiration (%)	Main Cash Crops	Main Food Crops	Yields
Humid	1100 - 2700	>80	Tea, Coffee	Wheat, Maize	High
Sub-Humid	1000 - 1600	65 - 80	Coffee, Cotton	Beans	High
Semi-Humid	800 - 1400	50 - 65	Cotton	Potatoes	Moderate
Transition-Zone	600 - 1100	40 - 50	Cotton	Bananas	Low
Semi-Arid	450 - 900	25 - 40	-	Almost no	
Arid	300 - 550	15 - 25	-	Crops	

Figure 3 Land Use, Main Crops and Agro-Climatic Zones

2.4 Population

In 1969, Meru District had a population of 596,506 and in 1979 a population of 830,179. The intercensal population growth rate from 1969 to 1979 was 3.4%. The Central Bureau of Statistics estimates the Meru District's annual population growth rate from 1980 to 1988 at 3.9%. Using this estimate, the projected population on divisional level in Meru District is given in Table 2.

Table 2 Population Projections 1979 - 1988

DIVISION	1979	1988	Residential Area (Km^2)	Population Density 1988
North Imenti	107,396	153,198	460	333
Timau	23,389	33,783	790	43
South Imenti	103,543	149,569	392	382
Nithi	142,288	205,528	640	321
Tigania	140,651	203,155	652	312
Tharaka	50,277	72,618	1,496	49
Igembe	90,807	130,592	535	244
Ntonyiri	80,790	116,692	1,167	100
Central Imenti	91,038	134,015	458	293
District Total	830,179	1,199,150	6,590	182

Sources: 1. Central Bureau of Statistics, Kenya Population Census 1979, Volume 1, June 1981 and updated by WRAP to include the new administrative boundaries since then.
2. Central Bureau of Statistics, Population Projections 1980-2000, March 1983
3. Meru District Development Plan 1989-1993

The average population density for 1979 was 84 persons per km^2 given an area of 9,922 km^2. However, excluding non-residential areas like forest and parks, the remaining residential area is 6,590 km^2. This implies a population density of 126 in 1979, 147 in 1983 and 182 in 1988.

2.5 Agriculture and Irrigation

In Meru District crop production is wholly by smallholder farmers except for wheat and barley where there are some large-scale farmers growing the two crops in Timau Division. Crop production estimates for 1987 indicating hectarage, overall production and also yields per hectare for the major crops grown in the district are shown in the Table 3.

Coffee is the major cash crop in the District, but there is no expansion of the area due to low prices. Tea is the second most important cash crop and the hectarage of this crop has increased in recent years. Cotton is the major cash crop in the lower areas, but the area is declining.

Maize is the major food crop in the District. The area under this crop is more or less constant, yields are low due to poor husbandry. Sorghum and millet are the major cereals in the lower areas. Potatoes are grown mainly in the Kibirichia area. Bananas and citrus are the major fruit crops.

Table 3 Crop Production: 1987

Crop	Ha	Prod. (Tons)	Yields (Tons/Ha)	Crop	Ha	Prod. (Tons)	Yields (Tons/Ha)
Cash Crops:				**Food Crops:**			
Coffee (Cherry)	34,502	73,823	2.28	Maize	72,296	60,801	0.84
Tea (green Leaf)	7,021	32,235	4.59	Wheat	6,500	10,395	1.6
Cotton	8,278	5,700	0.69	Sorghum/Millet	13,225	11,691	0.88
Pyrethrum	292	67	0.23	Beans	32,700	10,193	0.31
Tobacco	1,214	1,321	1.09	Cow Peas	4,948	4,927	1.0
Sunflower	10,500	6,510	0.62	Njahi	2,412	2,689	1.1
Barley	1,500	3,790	2.52	Green Grams	4,080	3,771	0.92
				Pigeon Peas	2,825	2,754	0.97
				Irish Potatoes	10,120	65,140	6.44
				Bananas	15,242	132,710	8.71
				Citrus	3,100	18,250	5.89
				Cabbages/Kales	1,212	5,720	4.72
				Cassava	1,052	4,635	4.40

Source: District Development Plan 1989 - 1993

Table 4 Irrigation Schemes in Meru District

Name of Scheme	Division	Area (ha)	Crops	Description
Kanjoo	Igembe	100	Vegetables	Furrow, Plan International is introducing sprinklers
Katheri	C. Imenti	?	Vegetables	Initiated by farmers (1 acre/farmer)
Kiorimba	Tigania	200	Fod/veg/Tob.	Furrow, initiated by farmers, poor design
Kiguru	Timau	60	Fodder/veg	Pipe + canal, pressure problems
Materi	Tharaka	20	Fodder/veg	
Mitunguu	S. Imenti	400	Vegetables	Overhead sprinkler, operational 1985
Mutunyi	Timau	100	Fodder/veg	Furrow, scheme started by settlers
Ng'urwe Gakirwe	Tharaka	150	Fodder/veg	Phase I and II completed, Diocese supporting
Ngare Ndare	Timau	60	Vegetables	Furrow, needs rehabilitation
Tharaka Secondary	Tharaka	20	Vegetables	Diesel pump, started 1972
Proposed Schemes				
Nkondi	Tharaka	100-500	-	Area will depend on water availability
Kamuu	Nithi	-	-	Furrow, mainly domestic, minor irrigation
Muthuani	Nithi	150	-	Overhead sprinkler, gravity system
Kunati	Tigania	20-50	-	Furrow
Ruungu	Tigania	50-100	-	-
Kibuga	Tharaka	-	-	-
Gikui Mweru	S. Imenti	-	-	Furrow, sprinklers, domestic & minor irrigation
Akothima	Tigania	20-50	-	-
Gatunga	Tharaka	20-50	-	-
Kindani	Igembe	20-50	-	-
Kithinu	Tharaka	20-50	-	-
Thiiti	Tigania	20-50	-	-
Thanantu	Tigania	20-50	-	-
Ura West	Tharaka	20-50	-	-

Source: 1. Atlas of Irrigation and Drainage in Kenya, MoA, 1990
2. Information from MoA, Meru

The potential irrigation area in the District according to the DDP is estimated at over 10,000 ha. Currently only about 1,100 ha is under irrigation, mainly by group - based small holder schemes. Most of the schemes are furrow systems and need some sort of rehabilitation. Maintenance of furrow systems is simple and therefore easy to organise. But many schemes are experiencing problems of water shortage and change to sprinkler systems seems the only possible solution in the long run.

The viability of irrigation schemes in the District depends mainly on the marketing of the produce. Some problems have been encountered in marketing at the Mitunguu Irrigation Scheme, therefore improvements in the marketing infrastructure still seem to be needed.

2.6 Livestock

Although there has not been a recent livestock census, estimates of livestock numbers by the Ministry of Livestock Development are available based on their dipping and vaccination statistics. The latest data on livestock production date back to 1986-1987.

WRAP carried out a livestock census in collaboration with the local administration and Divisional livestock offices to obtain livestock numbers for all sub-locations in the District. The data are summarized in Table 5.

Grade cows do well in high to medium potential areas while marginal and range areas tend to support only native cattle.

Table 5 Livestock in Meru District

TYPE	1982	1984	1986	1988
Grade Cattle	94,917	46,589	66,982	214,709
Beef Cattle	261,018	200,984	224,590	151,987
Sheep	312,525	}	}	}
Goats	322,854	}525,000	}555,552	} 482,613
Pigs	5,066	} -	} -	} -
Poultry	932,883	73,000	842,041	-
Donkeys	19,653	-	-	4,621
Bee Hives	76,527	-	-	-

Source: Meru District Development Plan 1984/88 and 1989/93

2.7 Health, Education and Social Services

Meru district has a total of 104 health facilities including 7 hospitals and 8 health centres. The rest are dispensaries, and 2 nursing homes.

A large number of schools (secondary and primary) take care of the school age population numbering 399,970 in 1988. The district has a total of 822 primary and 131 secondary schools.

The Ministry of Culture and Social Services is charged with the responsibility of mobilizing and motivating people through the formation of self-help development groups which encourage self-reliance through both individual and collective action. This is done by creating awareness among the people of the conditions around them and making them realise they are responsible for bringing about positive changes to improve those conditions. Existing social structures such as schools, age groups, churches, chiefs meetings etc. are used to reach the people. There are Social Development Assistants in every location who work closely with the community to understand the social organisation of each society and their leadership. It is on the basis of this that people are encouraged to start development projects and groups according to their felt needs.

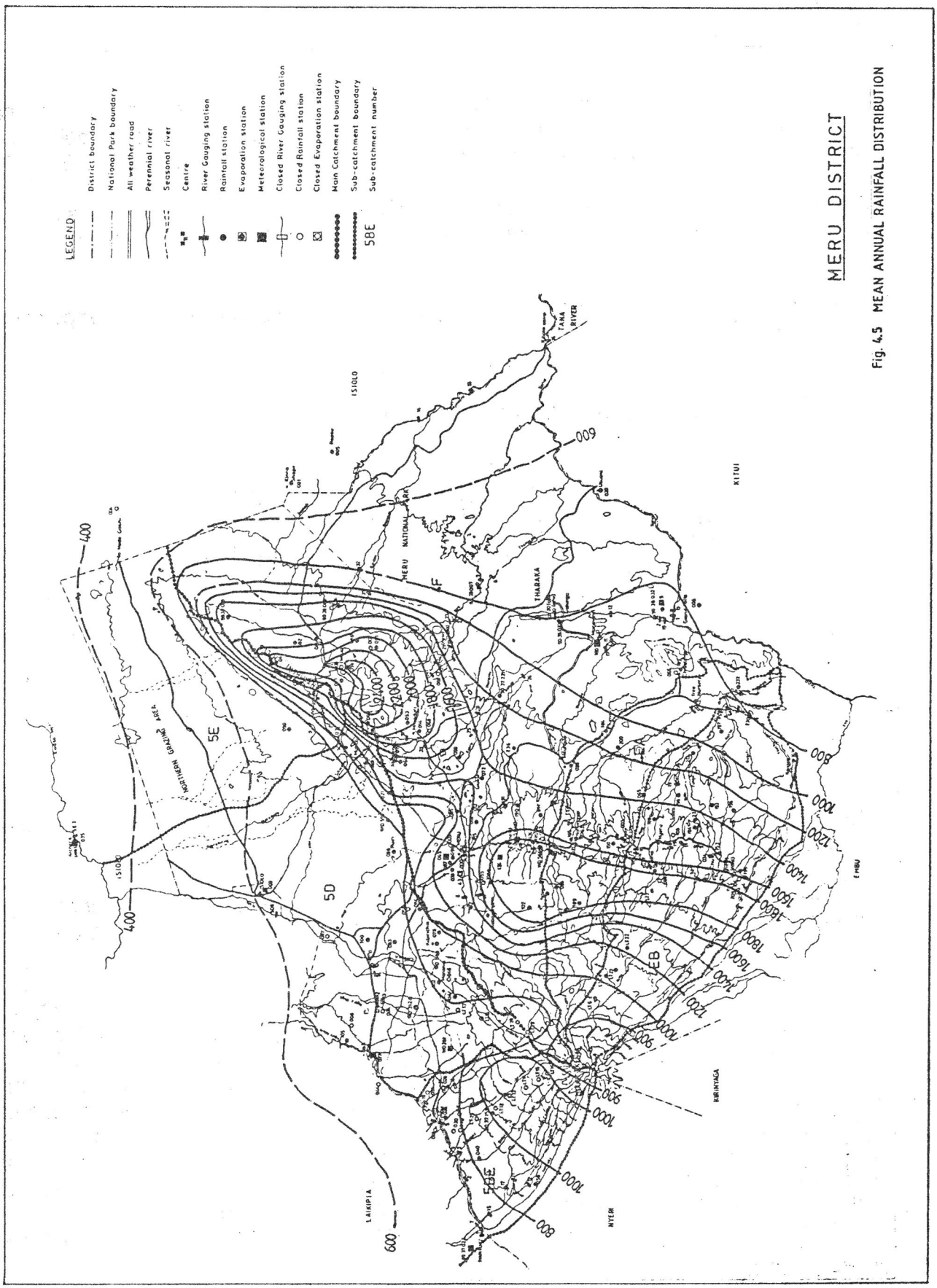


Fig. 4.5 MEAN ANNUAL RAINFALL DISTRIBUTION

Figure 4 Mean Annual Rainfall Distribution

3. WATER RESOURCES

3.1 Surface Water

The surface water drainage system is determined chiefly by three factors:

- the direction of the slope of Mount Kenya and the Nyambeni Range
- the slope of the end - Tertiary Peneplain
- the Basement System structure

Radial and near - radial drainage patterns predominate on the slopes of Mount Kenya and the Nyambeni Range. Most of the tributaries rising on the Upper and Middle Volcanic Slopes are perennial while the majority of the streams rising on the Lower Slopes, the Volcanic Lowlands and the Basement System are ephemeral. The drainage in the Basement System areas is generally controlled by the strike and dip joints of the rocks.

The south-eastern slopes of Mount Kenya and the Nyambeni Range receive 1,250 to 1,500 mm of rainfall annually. This is in strong contrast with the rainfall on the leeward sides of the mountains and the lowlands of the District: 400 to 1000 mm annually. The rainfall pattern is bi-modal with the long rains from mid-March to May and the short rains from October to December.

The higher parts (above 1500 m) of Mt Kenya and the Nyambeni Range are the most productive areas for streamflow generation, mainly because of the high rainfall. In addition, rainfall is rather evenly distributed over the seasons, infiltration conditions are favourable and aquifer transmissibilities high. Groundwater emerges in numerous springs and seepages (the spring inventory identified around 560 springs, but there are more in the unsurveyed areas), often discharging in riverbeds. As a result, most of the streams sustain high, steady baseflows.

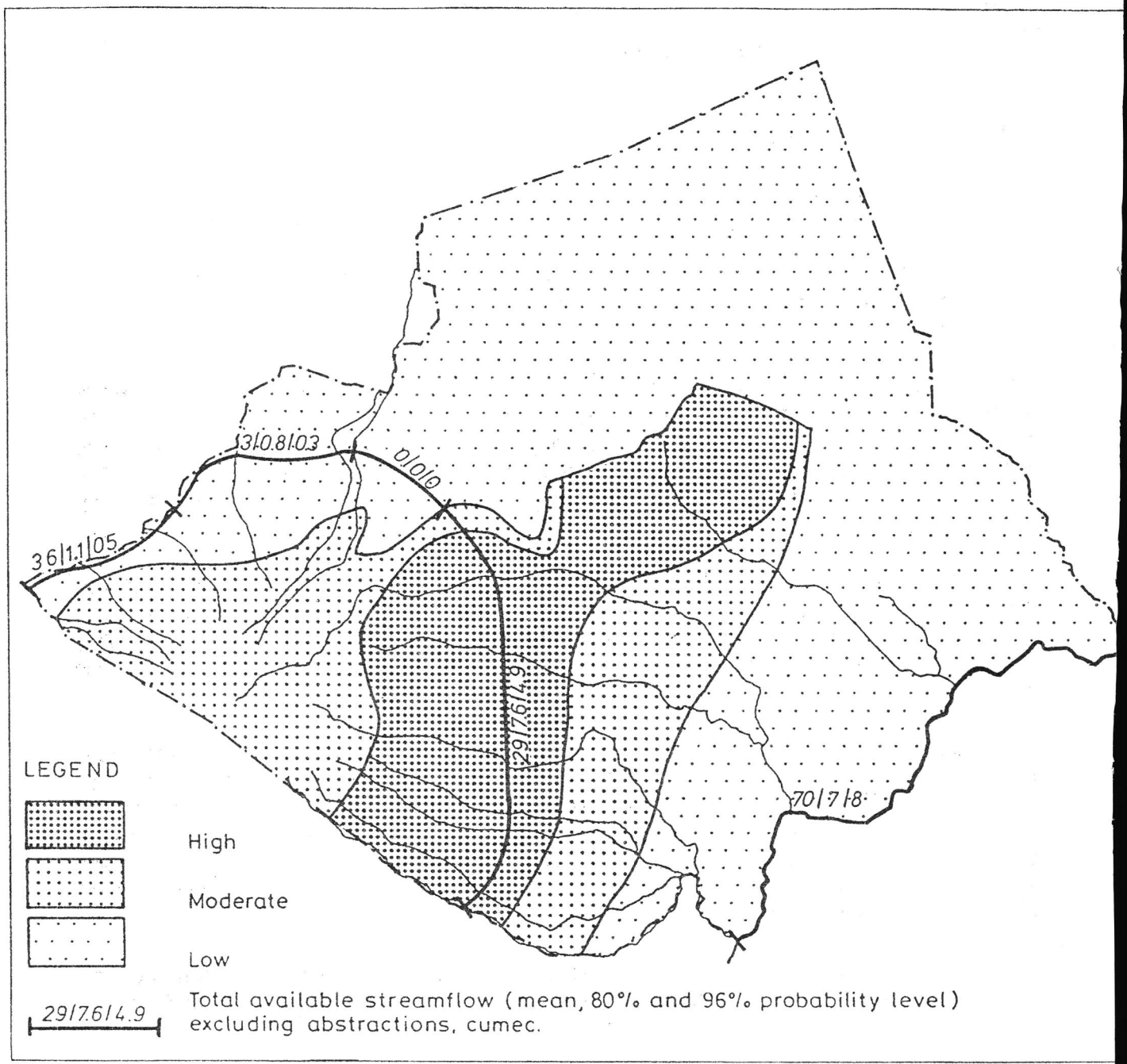
There are however two areas situated above 1500 m without surface water: i.e. the Kirua-Kibirichia and the Lare area. There are no springs in these areas to feed the rivers during dry periods. Rivers therefore are ephemeral.

Elsewhere in the district streamflow production is largely confined to the rainy seasons.

The available streamflow data from 26 hydrometric stations in Meru District were used to estimate the total streamflow generated in Meru District and the total surface flow from Mt Kenya in Meru District along the Chuka-Meru-Nanyuki road. The results are given in Table 6.

The expected overall domestic demand for the year 2013 of 2.4 cumec (see chapter 4) can easily be accommodated by the streamflow available at a 96% probability level. Nevertheless, there are areas in Meru District, like the Northern Grazing Area, without permanent rivers. In these areas groundwater is the only viable alternative.

The chemical quality of surface water is good for domestic use, cattle watering and irrigation.



HIGH	High Rainfall: >	1400 mm/y in areas lower than 1500 m +MSL
	>	1200 mm/y in areas higher than 1500 m +MSL
		Major Streams with minimum flow > 100 l/s
MODERATE	Intermediate Rainfall	800-1200 mm/yr in areas lower than 1500 m +MSL
		1000-1400 mm/yr in areas higher than 1500 m +MSL
		Major Streams permanent
LOW	Low Rainfall <	1000 mm/year in areas lower than 1500 m +MSL
	<	800 mm/year in areas higher than 1500 m +MSL
		Major Streams Ephemeral
		(streams are only permanent if they rise in other zones)

Figure 5 Surface Water Availability

Table 6 Summary of Streamflow in Meru District

		mean	80%	96%	
Streamflow into the Tana River		70	17	8	cumec
Streamflow into the Ewaso Ngiro Basin		10	3	2	cumec
Total Streamflow generated in Meru District		80	20	10	cumec
Streamflow along the Chuka-Nanyuki Rd	Mt Kenya, windward side 4E	29	7.6	4.9	cumec
	Mt Kenya, leeward side 5BE	3.6	1.1	0.5	cumec
	Mt Kenya, Timau-Isiolo side 5D	3.0	0.8	0.3	cumec
Total streamflow passing the Chuka-Meru-Nanyuki road		36	10	5.7	cumec

Note: there are no reliable measurements available for the estimate on the Timau-Isiolo side

3.2 Groundwater

The subsoil of Meru consists of two major units: the Basement System and the Tertiary Volcanics. Groundwater is found in both units and in the shallow alluvial sediments on top of these units. The Basement System is characterized by the presence of local aquifers: this means that there are many small, isolated groundwater pockets in this unit that usually coincide with fractured and/or weathered zones. Borehole siting is therefore critical in the Basement Rocks.

In contrary, the Tertiary Volcanics form a predominantly regional aquifer. The parts above the 1500 m contour are characterized by systems of cascading perched aquifers: infiltrating groundwater flows downward to the main aquifer. On its way, it encounters impervious layers (e.g. lava flows or dikes). Groundwater tends to accumulate on top of such layers giving way to the formation of perched aquifers. Springs can be expected where these aquifers come close to the ground surface. Borehole yields of such small, local systems tend to be low. Borehole siting is critical and should be done by an experienced hydrogeologist as there are no geophysical methods to find such perched aquifers.

Perched aquifers are missing in the two zones with recent parasitic volcanic activity: the Lare and Kibirichia-Kirua areas. Here, infiltrating groundwater percolates downward unhindered by impervious layers. It is highly likely that these zones are underlain by very productive aquifers at greater depth.

Below the 1500 m contour, there is a continuous aquifer in most of this unit: it is likely that a major part of the water discharged by the springs near the Ewaso Ngiro comes from the higher parts of Mt Kenya or the Nyambeni's.

Baseflow analysis indicates that the average baseflow generated during a normal dry season of 3 months amounts to about 45 mm. For a wet season the baseflow may be at least 50% higher. The annual baseflow for these areas should, therefore, be in the order of 225 mm or more.

The baseflow generating area roughly encompasses the volcanic area minus the semi-arid volcanic plains. This area of about 4800 km^2 produces a total calculated baseflow of 1,082 million m^3 per year or 34.3 cumec. The results correspond well with those obtained from the groundwater flow calculations.

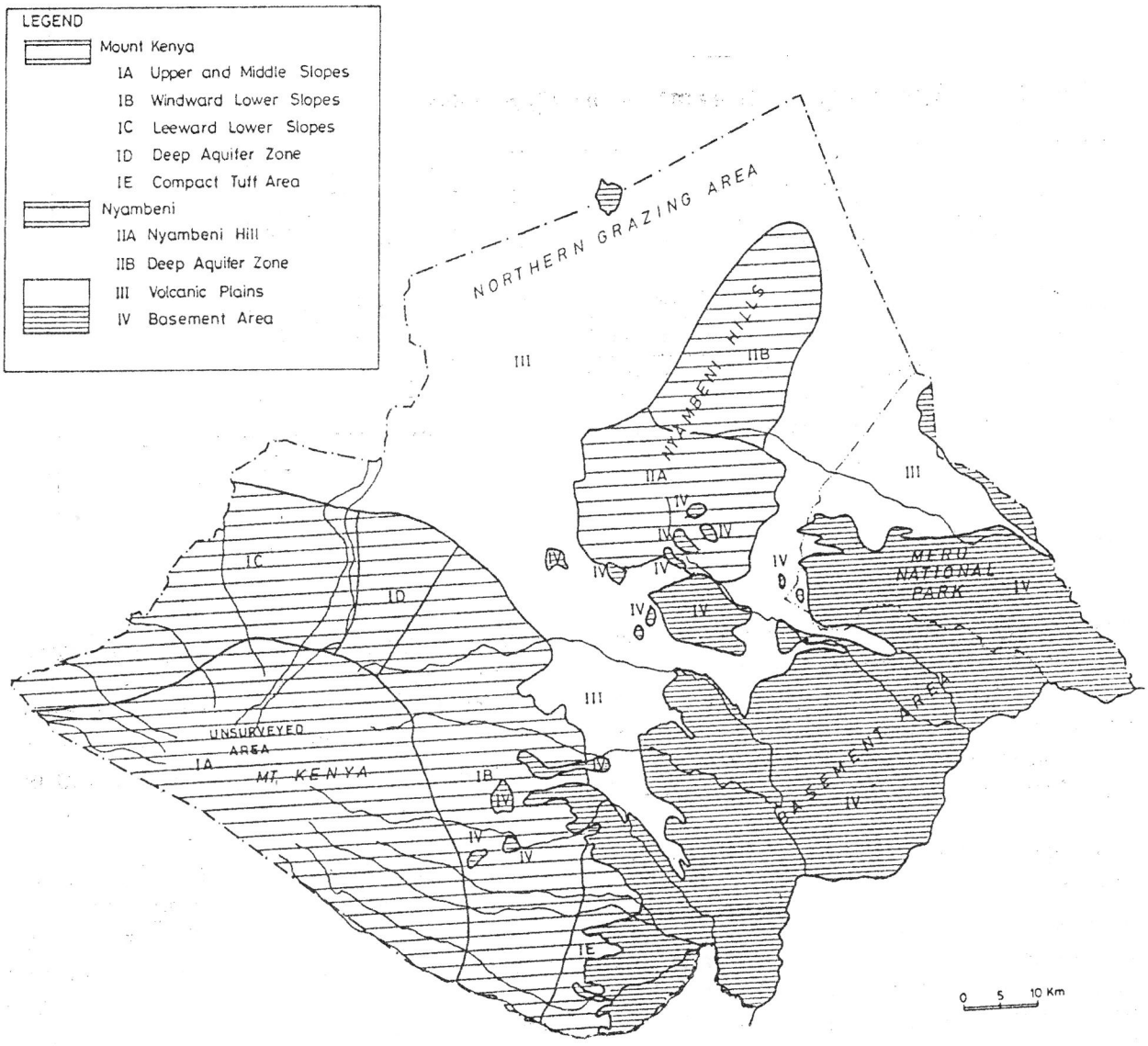


Table 5.2 Summary of Groundwater Sub-zones

SUBZONE	AREA	LITHOLOGY	AQUIFERS	SPRINGS No	SPRINGS Discharge mean max. l/sec	SPRINGS (80% level) total l/sec	SPRINGS specific mm/yr	BOREHOLES No	BOREHOLES Success rate	BOREHOLES Yield mean max m3/h	BOREHOLES Struck lvl mean range m	BOREHOLES Rest lvl mean range m	BOREHOLES Depth mean range m	General water quality
	km2													
IA Mt Kenya: Upper and Middle Slopes	1246	Phonolites, trachytes Kenyte lavas,agglomerates	regional: cinderlayers old land surfaces	many	high	high	high	no boreholes						very good
IB Mt Kenya: Windward Lower Slopes	987	Phonolites, Kenyte lavas tuffs, agglomerates	regional: cinderlayers old land surfaces	307	7.4 113	2263	72	11	100%	9.6 70	53 12-170	53 8.5-150	129 21-201	very good
IC Mt Kenya: Leeward Lower Slopes	651	Trachytes, tuffs agglomerates	regional: cinderlayers old land surfaces	24	5.6	134	6.5	12	82%	4.6 14	76 34-157	60 16-151	93 50-157	very good
ID Mt Kenya Deep Aquifer Zone	200	Coarse pyroclasts	very good extensive aquifers at greater depth	6	0.19	1.2	0.2	4	25%	0.1	82	no rest level	190 136-239	no data, but probably good
IE Mt Kenya: Compact Tuff Area	137	Compact tuffs	very poor aquifers	0	0	0	0.0	no boreholes, but success rate and yield are expected to be very low						no data
IIA Nyambeni Hills	457	Phonolites, tephrites	regional: cinderlayers old land surfaces	125	11.3	1408	97	13	69%	5.1 10	40 4.5-116	30 1.6-101	55 18-120	very good
IIB Nyambeni Deep Aquifer Zone	394	Coarse pyroclasts, tuffs, basaltic lavas, phonolites	very good extensive aquifers at greater depth	2	5	10	0.8	13	15%	2.7	45 28-76	61 39-84	78 49-104	no data, but probably good
III Volcanic Plains	2565	Basalts, pyroclasts	regional: pyroclasts, old land surfaces	45	9.4 45	421	5.2	75	85%	11 100	40 5-115	30 0-100	66 11-213	good
IV Basement Area	2546	Metamorphic rocks, alluvium, colluvium	local: weathered zones, faults,fractures,alluvium	0	0	0	0	33	55%	3.1 10	13.8 2.0-40	6.1 1.5-24	29.1 9.0-57	Poor to fair: overall success rate is only 30%

Figure 6 Groundwater Availability

For a first phase of groundwater development a groundwater abstraction of 30% of the estimated groundwater recharge can be taken as a safe yield. As it may be assumed that the average groundwater recharge equals the total of discharge components (including baseflow and evapotranspiration) it is safe to take 30% of the baseflow as a basis for groundwater development.

This amount of groundwater available for a first phase of development would be sufficient to sustain more than 3000 boreholes of 10 m^3/hour.

A borehole inventory carried out by WRAP identified 163 boreholes. Only 64 were operational (Figure 8). These boreholes are concentrated in Igembe, Ntonyiri and Tharaka.

Groundwater availability can be subdivided into five zones with respectively: (i) Very High, (ii) High, (iii) Medium, (iv) Low and (v) Uncertain Groundwater Availability. The characteristics of the zones regarding groundwater availability are summarized in Figure 6, and described here:

Areas of Very High Groundwater Availability

The aquifers are continuous in this area. Yields of properly constructed boreholes, like the ones drilled by WRAP, will be very high, possibly around 50 m3/h, or even substantially higher with 20 or 30 inch diameter holes. Using such boreholes, irrigation with groundwater is feasible.

Volcanic Plains: The recharge potential is very good; most recharge comes from the higher parts of the Nyambeni, and to a lesser extent Mt Kenya. Average yield of existing boreholes is high. Groundwater struck levels are rather shallow as are groundwater rest levels and borehole depths. Groundwater quality in these volcanic rocks is usually very good.

There are only 56 permanent springs in this area but their average discharge is high.

Areas of High Groundwater Availability

These areas are endowed with numerous springs of good quality water. Often, aquifers are perched; the most productive aquifers are found in cinderlayers. Recharge potential is very good. Aquifers are continuous and hydraulically interconnected by fissures

Windward Mount Kenya Slopes (Meru-Chuka Area): There are only 11 boreholes in this area, mainly because of the large number of springs. Borehole yields are rather high as is the success rate. The average groundwater struck levels is 53 m. Groundwater quality in these volcanic rocks is usually good and suitable for domestic use and irrigation. During the spring survey, 360 permanent springs were found.The average spring discharge is high while the chemical quality is excellent.

Nyambeni Hills: There are only 13 boreholes in this area but a large number (117) of permanent springs. The average spring discharge is high while the chemical quality is excellent.

Areas of Medium Groundwater Availability

Leeward Mount Kenya Slopes (Nanyuki-Timau Area): There are only 37 springs with good quality water: the spring density is much less than in the rainier windward side but the yields are high. The use of springs instead of boreholes should be preferred.

There are 11 boreholes in this area but only eight are successful. Groundwater rest levels are rather deep and borehole yields are medium. As almost everywhere else in the volcanics, siting is not critical while the most productive aquifers are found in cinderlayers. The recharge potential is good and aquifers are continuous and hydraulically interconnected by fissures.

Groundwater quality in these volcanic rocks is good, suitable for both domestic use and irrigation.

Areas of Low Groundwater Availability

Compact Tuff Area: Groundwater in this area occurs mainly in fine volcanic tuffs, lahars and lava flows.

There are no permanent springs. Borehole yields are very small, only sufficient for handpumps and borehole siting is not critical. Groundwater struck and rest levels are near the ground surface. Water quality is expected to be generally good enough for domestic use.

Basement Area: Groundwater occurs mainly in fractures, faults and in weathered zones forming small, isolated water bearing cells of low permeability: groundwater quantities are usually small. Borehole siting therefore is critical: proper application and interpretation of geophysics could improve the success rate of boreholes. Boreholes should be near rivers or laggas so as to facilitate recharge. Borehole yields are low (<3.0 m3/h) but water struck and rest levels are shallow.

Groundwater quality is not good: usually mildly saline to very saline, and hard to very hard. Fluoride levels often exceed the standard of 2.5 mg/l.

The overall success rate of boreholes is about 30% taking into account sufficient discharge for a handpump and the permissable chemical concentrations.

There are no permanent springs.

Areas of Uncertain Groundwater Availability

Kibirichia & Lare Area: Groundwater probably occurs in large amounts at greater depth (>200 m), but how deep is not known. Perched aquifers with sufficient yield for handpumps do occur sometimes at shallower depth: in the Lare area, only two out of a total of 13 boreholes have a discharge which is sufficient for handpumps. There are very few permanent springs. Borehole siting is not critical; striking a perched aquifer seems to be a matter of luck.

Water quality is expected to be generally good enough for domestic use but there are no data.

3.3 Water Resources Development Potential

3.3.1 Surface Water Development Potential

There is ample potential left in Meru District for development of surface water, for domestic use and even for development of low flows for irrigation. Valid surface water permits are issued for around 1,700 different abstraction points along rivers endorsing a total dry season abstraction of 8.4 cumec before the rivers leave the District or join the Tana River.

The available low flow with a probability level of 80% (design flow for irrigation projects) of 20 cumec (equals around 630 million m^3/year) is sufficient to irrigate an area of about 200 km2 given an irrigation requirement of about 10 mm/day. This acreage could be substantially increased with construction of proper storage facilities (dams) along the main rivers.

In some of the semi-arid areas of Tharaka where the distance to the nearest perennial stream is too large, sub-surface dams and sand-filled dams in the beds of seasonal rivers may provide reliable water points, particularly for cattle watering. Roof catchments can be an important supplementary source of drinking water provided that the storage tank is properly constructed.

However, the chemical and biological quality of the streams is in danger as more than 100 coffee factories dispose their effluent without proper treatment into the rivers. Unfortunately, peak coffee production coincides with the onset of low flows when dilution is not as strong as during the rainy season. So, the poisonous coffee effluent is discharged into the streams in a time when about 70% of the population depends

on river flow for their drinking water. Only strict law enforcement by curbing illegal waste water disposal could alleviate this situation.

3.3.2 Groundwater Development Potential

Large parts of Meru District have more than sufficient surface water to satisfy present and future demands. Baseflow in many of these areas originates from spring water which ensures a permanent supply throughout the dry season. Groundwater supply from boreholes is then an expensive alternative which may not be economically feasible for many types of use. However, where the quality of surface water is unsuitable for domestic use during a large part of the year, groundwater supply from springs, boreholes or dug wells should be considered. The benefits in the form of reduced incidence of illnesses may outweigh the high costs of construction or treatment.

In the eastern slopes of Mount Kenya and the western part of the Nyambeni Uplands springs are almost everywhere and as such their development is preferred.

In the leeward slopes of Mount Kenya and the Volcanic Plains (including the Northern Grazing Area) where springs are few or non-existent, water supply from boreholes is considered generally feasible for domestic use.

Only the Kibericha-Kirua and the Lare Areas lack surface water. Groundwater is extremely deep and development is considered highly questionable.

In the Tharaka Basement Area the only option for groundwater supply is drilling of boreholes. There are many local aquifers with limited supply capacity and water of acceptable quality, but their siting requires hydrogeological and geophysical surveys.

Figure 7 **Projected Domestic and Livestock Water Demand in Meru District**

4. WATER DEMAND

4.1 Projection of Water Demand

Water Demand was calculated for each Sub-location within the District. This demand was divided into four major categories:

- human domestic demands, further subdivided into demands derived from urban and rural populations
- livestock demand, calculated for each of the major types of animal
- demand from institutions, mainly schools and health centres, and
- other demand from (small scale) industries.

The demand for irrigation was not estimated independently, but the water available for irrigation was estimated by comparing the total water resources with the water demand from the above named uses (see Section 4.3).

Water Demand was calculated for 1988 and projected for 1993, 2003 and 2013.

Demand projections were based on two Scenarios. These scenarios were in turn based on the projections of District population and economic growth. The Scenarios were intended to represent the minimum and maximum growth rates which may occur in the District. Brief descriptions of the scenarios are as follows:

* Scenario 1 - minimum growth scenario considering current assessment of possible limitations set by the physical environment.
* Scenario 2 - maximum growth scenario based on the growth rates adopted at national and district level.

Table 7 summarises the growth rates used in the Scenarios.

Table 7 Annual Growth Rates 1988-2013

	Scenario 1	Scenario 2
Applied Population Growth Rates		
Major Urban Areas: Meru	4.2 %	5.0 %
Minor Urban Areas: Chuka, Nkubu	7.2 %	8.0 %
Chogoria, Maua		
Rural Areas : High Potential	4.0 %	4.5 %
: Medium Potential	3.5 %	4.0 %
: Low Potential	2.5 %	3.0 %
Resulting District Population Growth Rates	3.1 %	4.1 %
Applied Livestock Growth Rates: High pot.	2 %	4 %
Medium pot.	2 %	5 %
Low pot.	2 %	6 %
Applied School Growth Rates	8 %	10 %
Applied Health (No. of Beds) Growth Rates	4 %	6 %
Applied Commercial/Administr. Growth Rates	7 %	8 %

Figure 7 summarises the demand projections by Scenario showing domestic water demand (including also demand from schools, health facilities, offices, shops, hotels and bars) and demand for livestock watering.

4.2 Water Resources Availability Compared to Water Demand

Water Resources were divided into two main categories:

- surface water obtained from rivers and springs, and
- groundwater obtained from boreholes or dug wells.

The availability and quality of these resources was assessed from available data, from additional observations of surface run-off, from an inventory of springs and boreholes and from exploratory boreholes in combination with geophysical surveys undertaken by WRAP.

The analysis of water availability for water supplies was carried out for each Location in the District. The approach followed assumes full use of surfacewater and springs, but use of groundwater only where shortages exist. This implies that in Locations with good groundwater potential, the actual availability is higher.

The procedure followed was directed at an equal distribution of the water resources between the Locations. This distribution was undertaken per Division. A summary of the water availability per Division is presented in Table 8.

Table 8 Water Resources Availability and Water Use in 2013 - Scenario 2 (m^3/day)

Division	Water Resources Available				Total Water Use			
	Surface Water	Springs	Ground Water	Total	Domestic Livestock	Irrigation Industries	Baseflow	Total
C. IMENTI	136,076	52,253	4,705	193,035	24,870	143,750	24,415	193,035
IGEMBE	23,833	69,984	9,882	103,699	21,073	73,700	8,867	103,640
N. IMENTI	100,510	15,501	6,162	122,173	34,534	77,050	10,178	121,762
NITHI	497,003	40,871	0	537,874	46,794	406,700	83,901	537,395
NTONYIRI	20,500	86	23,693	44,279	16,782	16,750	0	33,532
S. IMENTI	244,074	81,173	1,014	326,261	32,286	252,000	41,975	326,261
THARAKA	337,933		2,005	339,938	8,714	331,200	0	339,914
TIGANIA	133,341	78,835	9,934	222,110	33,739	162,400	25,788	221,927
TIMAU	65,069	11,403	2,088	78,560	7,090	59,700	11,814	78,604
MERU DISTR.	1,558,339	50,106	59,484	1,967,928	225,882	1,523,250	206,937	1,956,069

Future water demand must be compared with the available resources to determine the level of development of water supplies. This comparison was executed for each Location in the District and is summarised per Division in Table 8.

Table 8 shows the quantity of water available as well as the allocation of this quantity for the different water uses. This allocation was based on proposed priorities for water use as described in section 4.1. The water use was estimated:

- for domestic and livestock from the maximum water demand calculated for the 20 year planning period (year 2013, scenario 2)

- for baseflow from 20 % of the surface run-off entering the Division (rivers sometimes cross several Locations, therefore total baseflow per Division is less than 20% of the run-off)

- for irrigation and industries from the quantity remaining after subtracting water use for domestic, livestock and baseflow from the total water available.

The following conclusions can be drawn:

- The demand for domestic and livestock use can be easily satisfied in most of the Divisions, although in two Divisions demand needs to be covered with surface water from other Divisions, i.e. in North Imenti from Central Imenti and in Ntonyiri from Igembe.

- The required quantity from groundwater is limited, but if needed more groundwater is available in some of the Divisions; the indicated quantity in Table 8 is not the total available groundwater quantity, but only represents the quantity required to supplement surface water and spring resources.

- The water quality of surface water is expected to deteriorate with an increased water use and supplies will require treatment facilities to ensure safe water.

5 EXISTING SUPPLY, TECHNOLOGY OPTIONS AND COST

5.1 Existing Water Supply

Water supplies in the District can be divided into two categories:

- protected supplies, which are relatively safe from contamination and should be suitable for drinking, and
- unprotected supplies, the quality of which cannot be assured.

Assessment of existing supplies found that about 70% of the District population relies on unprotected supplies from surfacewater or groundwater. The reliability and quality of these sources is generally not satisfactory. To improve this situation it is of high priority to increase the number and coverage of protected supplies and to rehabilitate existing supplies by relocating intakes, replacing leaking pipes, protecting storage reservoirs and including some form of treatment, like filtration, chlorination or other.

The use of unprotected sources is largest in the dry areas of the District (88% of the population) and generally smaller in the areas with more rainfall (to a minimum of about 10% in the tea zone). The type of water sources used is shown in figure 8, indicating that the majority of the population uses surface water. This information is based on a household survey carried out by WRAP.

About 45% of the total population is covered by the existing supplies, with the MoWD supplying 12%. The number of people covered by proposed or not working supplies is about 11%. Therefore 44% of the population is not benefitting from any form of water supply, either existing or planned. This information is based on an inventory of all existing supplies (Appendix 1).

The major water supplies in the district have been located on topographical maps and the outline of the served areas and the intakes are shown on Plate 1.

Table 9 Inventory of the Existing Water Supplies

Owner/Operator	Total No. of Schemes	Operating Schemes Only						
		No. of Schemes	Beneficiaries		Working Condition			
			Number	% of total	Good	Fair	Poor	Not Known
MoWD {- Urban	4	4	39,269	3	2	1	1	-
{- Rural	7	7	105,178	9	3	3	1	-
Diocese of Meru	7	6	120,850	10	3	-	-	3
GOK/MoA/MoE	3	2	2,610	-	1	-	-	1
Self Help/Plan I.	21	14	32,440	3	13	1	-	-
Self Help	142	97	139,966	12	35	30	32	-
Other	2	2	1,180	-	1	-	-	1
Sub-Total	186	132	441,493	37	58	35	34	5
Groundwater Supplies			8,000	1				
Supplies not in inventory			90,124	7				
Supplies not working/proposed			135,000	11				
Population not served			524,533	44				
Total			1,199,150	100				

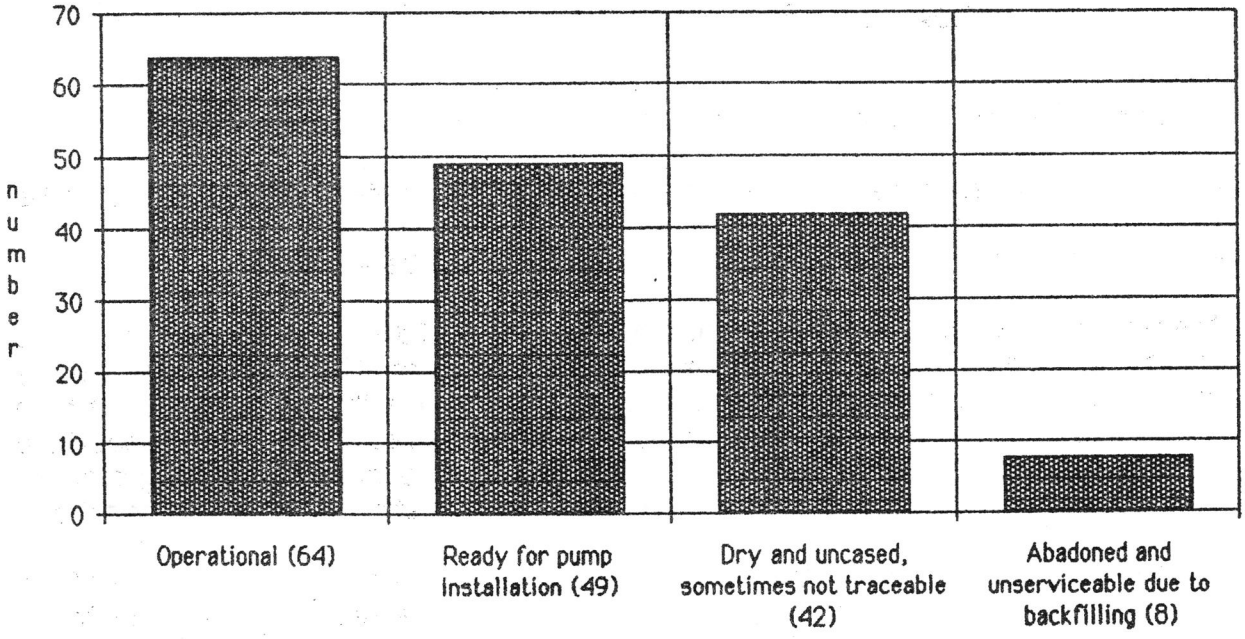


Figure 8 Condition of Boreholes

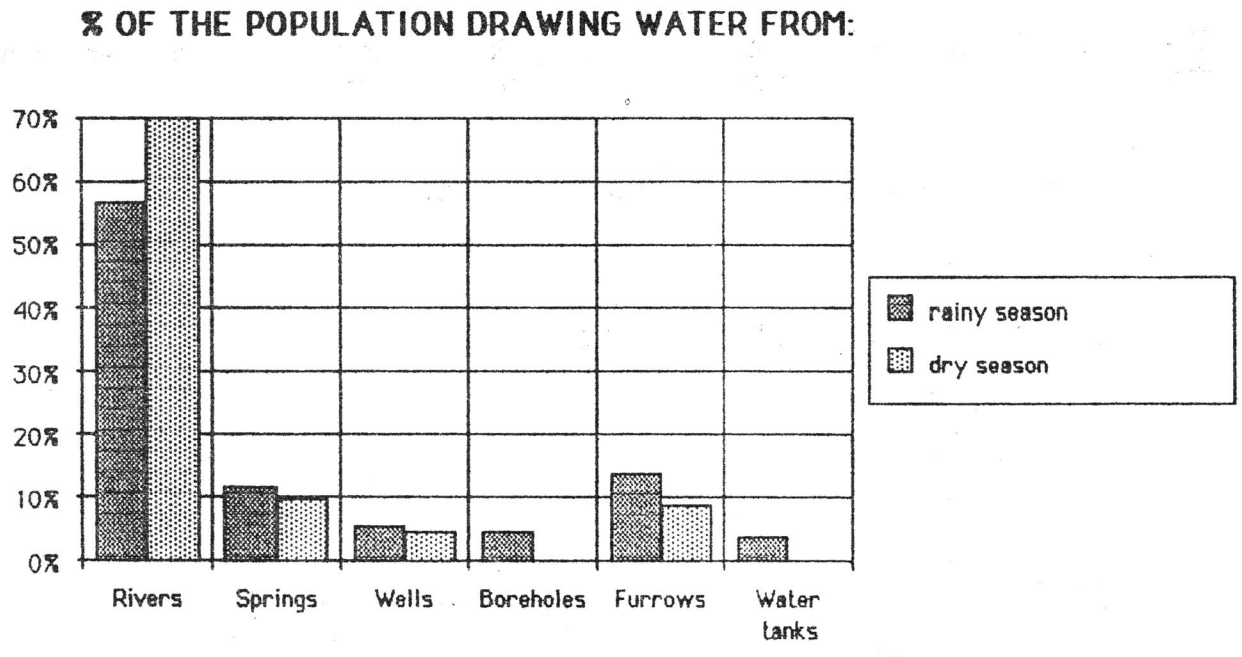


Figure 9 Water Sources in Meru District

Other results from the inventory of existing supplies are:

- a total production capacity of 57,716 m^3/hr meets 94% of the 1988 water demand, although efficiency of supply will have to improve greatly to achieve full coverage and minimum service levels
- the production per beneficiary varies considerably, but is on average 100 lpcd.
- the majority of the schemes have individual connections, with about 10 beneficiaries per connection
- many schemes are not completed, mainly due to financial constraints
- financial information is not available and otherwise often incomplete for most of the self-help supplies; the average revenue of the MoWD supplies collected as a percentage of operation and maintenance costs is 46% for urban systems (excl. Meru water supply) and 30% for rural systems
- the production costs per m^3 are around 2-4 Shs. and per beneficiary about 50 Shs. per year
- availability of accurate and reliable data on technical, operational and organisational aspects of supplies is insufficient to allow detailed analysis.

The conclusion from the inventory is that existing supplies require significant improvement in virtually all areas of operation in order to meet the future water demand. The organisation of the O&M is generally poor, except in some NGO assisted water supplies. A major problem in O&M is lack of funds; therefore, the collection of revenues is a crucial factor.

In many parts of the District small supplies have been organised by self-help groups. These water supplies are often inefficient and of poor technology. To improve the service level such self-help groups will have to combine to larger supplies with an improved organisational structure. However this may not be achieved without assistance from NGO's and/or the MoWD.

5.2 Water Supply Development Technologies and Cost

Choice of the technology appropriate to the need depends on several considerations. The most important among them are:

- the type of area in which it will be used which determines the environmental context, quantities required, the availability of maintenance support, and
- the resources available.

Table 10 summarises the technologies considered by the study, and their feasibility, by area of use.

Given that government policy on cost sharing is to be implemented, the costs of supply technologies are of prime importance in choosing a technology option. In order to include this issue in the study, a cost effectiveness analysis was undertaken, the results of which are presented in Table 11.

Detailed cost estimates of water supply technologies are included in Appendix 2.

Table 10 Recommended Technologies for Various Types of Users

Supply Area	Source Development	Water Supply Development	Feasibility	
			Urban	Rural
Domestic	Surface Water Intake	Treatment + storage + distribution	++	++
	Spring protection	Storage + distribution	+	++
	Drilled wells	Motorpump + storage + distribution	++	++/+
	Dug/Drilled wells	Hand pumps (small units)	n.a.	+
	Dug/Drilled wells	Windmill + storage (large unit)	n.a.	+
	Sub-surface Dam	Dug Well + Handpump or Windmill	n.a.	+
	Roof Catchment	Gutters + storage (individual)	+	++
	Rock Catchment	Storage	n.a.	+
Livestock in ASAL Areas 1)	Surface Water Intake	Storage + distribution	n.a.	++
	Dug/Drilled well	Windmill, storage, trough	n.a.	++
	Dug/Drilled wells	Hand pumps	n.a.	+
	Dug/Drilled well	Motorpump + storage	n.a.	+
	Spring protection	Storage + distribution	n.a.	+
	Dam construction	Fencing, trough	n.a.	+
	Rock Catchment	Storage	n.a.	+
Irrigation	Surface Water Intake	Storage + distribution	n.a.	++
Industry	Surface Water Intake	Treatment + Storage + distribution	++	++
	Drilled well	Motorpump + storage	++	++
	Spring protection	Storage + distribution	+	+

1) Supply may be used also in combination with supply to rural population, provided measures are taken to ensure adequate water quality.
2) ++ high feasibility, + medium feasibility, n.a. not applicable

The conclusions of the cost effectiveness analysis are:

- The most cost effective systems are generally spring supplies with or without gravity distribution, however springs are feasible in part of the District only.
- The next most cost effective supplies differ per supply area: boreholes have preference for urban areas (but only if borehole depths are smaller than about 40 m. and if yields are good); surfacewater supplies have preference for rural centres.
- The most cost effective supply technology for boreholes is motorpumps, partly because solar pumps or windmills can not operate during some periods of the year.

5.3 Proposed Water Supply Development

Based on the information on water availability (section 4.3) and existing water supplies (section 5.1) a proposal for the water supply development in Meru District has been outlined, to cover the water demand in the ultimate year 2013 of the planning period for the maximum growth scenario.

The required development of domestic water supply is 168,842 m^3/day of which 70% will be covered by new supplies, 21% by rehabilitated existing supplies and 9% by existing supplies.

Table 11 Results of Cost Effectiveness Analysis

Ranking Number	Technology	Total Yield (m^3/day)	Total Capital Costs (Shs)	O & M Costs per year (Shs)
	Urban Area			
5	Spring, Gravity Distribution, 200 m^3 St.	200	4,987,500	304,750
6	Spring, Gravity Distribution, 100 m^3 St.	100	2,562,500	159,750
7	2 Boreholes, Motorpump, Distribution	600	12,662,500	1,419,625
8	2 Boreholes, Motorpump, Distribution	200	5,037,500	524,375
10	2 Boreholes, Motorpump, Distribution	100	2,643,750	262,688
13	2 Boreholes (100m), Motorpump, Distrib.	200	5,637,500	633,375
15	Surface Water, Weir, Distribution	200	5,937,500	723,375
16	2 Boreholes, Solar pump, Distribution	100 (2)	3,812,500	172,625
20	Surface Water, Weir, Pump, Distribution	200	7,562,500	885,625
22	Surface Water, Dam, Pump, Distribution	200	13,187,500	941,875
	Rural Centre			
4	Spring, 40 m^3 Storage	40	925,000	54,500
11	Surface Water, Chamber, Gravity Distr.	40	1,387,500	66,875
12	Surface Water, Weir, Gravity Distr.	40	1,425,000	67,250
14	Surface Water, Chamber, Hydram, Distr.	40	1,612,500	84,125
17	2 Boreholes, Motorpump, Limited Distr.	40	1,787,500	106,875
19	2 Boreholes with Windmill	40 (2)	2,150,000	34,750
21	2 Boreholes, Solar pump, Limited Distr.	40 (2)	2,432,500	49,525
	Rural Area			
1	Spring	10	37,500	500
2	Dug Well with Handpump	10	187,500	500
3	Borehole with Handpump	10	262,500	1,875
9	Surface Water, Chamber, Gravity Supply	10	431,250	15,313
18	Dug well with Windmill	20 (2)	1,012,500	17,063

Notes (1) - Total Capital Costs include investment + replacement costs for a period of 20 years.
(2) - Supply per year during 300 days only.
(3) - Roof and rock catchments and sub-surface dams were not included in the analysis, because more detailed study is needed on their feasibility and because available cost estimates are not sufficiently accurate.

The proposed domestic water supply development with additional livestock supply is presented in Table 12. The table indicates an additional livestock supply of 40,000 m^3/day, which will have to come in total from new supplies. The total costs involved are presented in Table 15.

The proposed domestic and livestock water supply development is also presented on Plate 2, where for each Location the contribution of new, existing and rehabilitated supplies to the supply capacity is indicated in a pie diagram.

The quantity of water available for the development of irrigation and industries was derived by subtracting from the total water resources available the amounts of water allocated for domestic and livestock use and the amount of water reserved for environmental purposes (maintenance of baseflow, see also section 6.1). Using an estimate for the water requirement per hectare, the total area was estimated which can be irrigated in each Location (Table 13 and Plate 3).

Table 12 Proposed Domestic and Livestock Water Supply Development

DIVISION	1988 - Existing Situation					2013 - Scenario 2		REQUIRED DEVELOPMENT OF SUPPLIES		
	Total Population	Population Covered		Existing Capacity		Total Population	Required Capacity	Additional Population Covered	Capacity Development	
		Total	%	Good (m^3/day)	To Rehab. (m^3/day)		(m^3/day)		New (m^3/day)	Rehabilitate (m^3/day)
C. IMENTI	134,014	43,480	32	743	7,090	385,578	24,870	342,098	17,037	7,090
IGEMBE	130,592	46,820	36	4,377	990	379,952	21,072	333,132	15,705	990
N. IMENTI	153,197	73,190	48	293	7,000	442,800	34,535	369,610	27,242	7,000
NITHI	205,527	59,514	29	4,350	9,597	606,436	46,792	546,922	32,845	9,597
NTONYIRI	116,692	85,500	73	300	1,410	285,892	16,783	200,392	15,073	1,410
S. IMENTI	149,568	54,675	37	590	6,149	452,844	32,286	398,169	25,547	6,149
THARAKA	72,618	13,750	19	300	0	166,715	8,713	152,965	8,413	0
TIGANIA	203,155	68,100	34	4,044	1,500	534,503	33,739	466,403	28,195	1,500
TIMAU	33,783	7,683	23	416	1,582	89,067	7,090	81,384	5,092	1,582
MERU TOTAL	1,199,146	452,712	38	15,413	35,318	3,343,787	225,880	2,891,075	175,149	35,318

Notes: 1. Existing capacity is not known accurately and also known for only part of the supplies.

It must be understood that this estimate is based on water availability only and not on land suitability. Planning of irrigation projects involves studies beyond the scope of WRAP, therefore further analysis of irrigation potential and cost estimates have not been embarked on in this study.

Table 13 Irrigable Area Based on Water Availability

LOCATION	Total Area of Division (km^2)	Available Water for Irrigation (m^3/day)	Coverage in % of Area	Coverage in hectares
CENTRAL IMENTI	475	143,750	5.7	2,688
IGEMBE	634	73,755	1.3	827
NORTH IMENTI	511	77,050	2.5	1,276
NITHI	689	406,700	10.2	7,043
NTONYIRI	1,325	16,750	0.1	174
SOUTH IMENTI	405	252,000	12.7	5,149
THARAKA	1,403	331,200	2.4	3,413
TIGANIA	660	162,400	3.3	2,195
TIMAU	761	59,700	1.3	1,009
MERU TOTAL	6,863	1,523,250	3.5	23,775

Note: Coverage in hectares based on irrigation water requirement in a dry year in m3/ha/year (60% irrigation efficiency) from MoWD Design Manual

6 GUIDELINES AND RECOMMENDATIONS FOR INVESTMENT PACKAGES

6.1 Design of Investment Packages

Investment Packages are assumed to comprise one or more investment project(s). Each project must be designed to suit its circumstances.

Four factors were identified as central to the design of successful investment projects. These were:

- Appropriate technical choice
  in terms of its ability to produce the required quantity and quality, and to avoid adverse impact on the environment; the latter is particularly sensitive as there is insufficient data on the direct and indirect impact of water schemes on the environment.
- The socio-economic base
  which determines the attitude to participation in the project; this involves consideration of the different priorities for availability/quality/use by different social groups.
- The institutional base
  for execution of planning, design, construction and operation of the investment project, including community consultation and involvement during all of these phases.
- The financial base of the project
  including the policy framework, particularly on cost sharing and on district financial autonomy, and the financial systems used.

Each of these considerations effect the economic demand of the people for water on the one hand, and the ability of the MoWD and other bodies to supply it on the other.

The major conclusions from consideration of the above factors are:

- A policy framework must be developed to allocate resources. WRAP suggests allocation according to the following priorities:
  1. domestic water supplies (including livestock at homesteads)
  2. protection of environment: part of the surface water baseflow should be reserved to prevent dry riverbeds and to retain a minimum inflow into the Tana and Ewaso Nyiro rivers
  3. livestock water supply in ASAL (low potential) areas
  4. irrigation water supply in ASAL (low potential) areas
  5. industrial water supply (mainly coffee factories and agro-industries)
  6. other uses, eg. irrigation in high potential areas, non agro-industries, etc.

- cost sharing policies with respect to government/donor schemes may need to be flexible depending on the community served; full cost sharing (Capital and O&M costs) may be feasible in urban schemes, but for rural schemes cost sharing may have to be limited to recovery of O&M costs (at least initially)

- even with these limited objectives, the choice of technology must be appropriate to the communities ability and willingness to pay, in particular rural schemes must have minimum O&M costs if they are to be borne by the community

- in order to implement the District Focus policy which gives the District Water Office responsibility for co-ordinating the provision of water to the Meru communities, several facets of the operation of the MoWD at Central and District level should change. The most important are set out in section 64 below.

6.2 Appraisal of Packages

Based on the above considerations, specific criteria were developed for use in the appraisal of investment projects. These criteria were incorporated in a simple checklist, a version of which, after modification by the District authorities, should be included in the DWDP. Such a checklist will enable a quick assessment of the impact and viability of a proposed project.

The checklist covers the following topics:
- water resources
- land use planning/ environmental impact
- social impact
- institutional/ community participation
- economics
- affordability
- finance.

An example of the full checklist is given in Appendix 3 of this summary.

The result of the assessment in each of these areas (except finance) will indicate, either qualitatively or quantitatively, whether the proposed project is viable. It is suggested that priority for implementation should be given to projects according to their performance against financial cost recovery criteria. Projects which are self-sustaining (that is, recover both capital and O&M costs) will be highest priority.

6.3 Cost Estimates of Water Development

The study sets out a methodology to design investment packages, suitable for establishing the broad outline of donor funded projects. This methodology requires that specific assumptions be made as to the growth scenario and cost sharing policy (and consequent choice of technology). Using the maximum growth scenario the upper limit of the investments required for domestic and for livestock water supplies may be provided (Tables 13 and 14 and Appendix 4).

The total capital costs required to obtain a full coverage of domestic water demand will increase from 529 million Shs. in 1993, to 1,280 million Shs. in 2003 and to about 3,149 million Shs. in 2013. These are large amounts of money, which are based on the assumption that coverage by protected water supplies is raised from the current 30% to 100% in a few years.

However, implementation of projects will probably be planned in phases. This planning is not included in this study, because phasing of investments and prioritisation of projects is the responsibility of the District. It is proposed that this planning will be included in the DWDP on the basis of decisions made by the DDC.

Table 14 Preliminary Cost Estimate of Domestic Water Supply Development

DIVISION	Year 1993 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)	Year 2003 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)	Year 2013 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)
C. IMENTI	121,970	63,616,000	522	208,946	155,319,000	743	342,098	382,406,000	1,118
IGEMBE	114,396	25,360,000	222	199,863	93,343,000	467	333,132	313,086,000	940
N. IMENTI	113,684	125,058,000	1,100	214,096	268,440,000	1,254	369,610	584,408,000	1,581
IITHI	195,069	66,205,000	339	332,378	208,114,000	626	546,922	577,839,000	1,057
ITONYIRI	53,848	47,244,000	877	113,673	98,396,000	866	200,392	201,200,000	1,004
S. IMENTI	131,351	100,137,000	762	234,479	220,638,000	941	398,169	531,377,000	1,335
HARAKA	71,909	27,082,000	377	105,620	50,006,000	473	152,965	93,940,000	614
IGANIA	177,981	65,588,100	369	293,944	162,592,000	553	466,403	402,606,000	863
IMAU	33,255	8,728,000	262	52,588	23,878,000	454	81,384	62,265,000	765
ERU TOTAL	1,013,463	529,018,100	522	1,755,587	1,280,726,000	730	2,891,075	3,149,127,000	1,089

The total costs per beneficiary will amount to 522 Shs. in 1993 and about 1,100 Shs. in 2013. These costs increase because the demand calculation assumes improved service levels and therefore higher water consumption per beneficiary in the future.

The costs per beneficiary may be compared with the contributions to water supply projects from households, which may be obtained from the household survey carried out by WRAP. The household survey asked people how much they had contributed to water supply projects in the past and how much they are willing to contribute to water supply projects in the future. On average people expressed that they are willing to contribute 100 Shs. per person for standpipes and 180 Shs. per person for individual connections. Actual contributions in the past were 400 Shs. per person for the tea zone, 220 Shs. per person for the coffee zone and 50 Shs. per person for the cotton zone.

The results from the household survey indicate that the required contributions from the beneficiaries are above their present level of contributions. However it must be understood that the presented cost estimates are related to water supplies with very

Table 15 Preliminary Cost Estimate of Domestic and Livestock Water Supply Development

VISION	Year 1993 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)	Year 2003 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)	Year 2013 Additional Population Covered	TOTAL COSTS (Ksh.)	TOTAL COSTS PER BENEFIC. (Ksh.)
IMENTI	121,970	99,238,000	814	208,946	211,880,000	1,014	342,098	481,164,000	1,407
EMBE	114,396	30,976,000	271	199,863	123,792,000	619	333,132	364,610,000	1,094
IMENTI	113,684	171,960,000	1,513	214,096	346,786,000	1,620	369,610	706,024,000	1,910
THI	195,069	160,528,000	823	332,378	383,031,000	1,152	546,922	866,545,000	1,584
ONYIRI	53,848	99,344,000	1,845	113,673	189,960,000	1,671	200,392	361,256,000	1,803
IMENTI	131,351	148,363,000	1,130	234,479	298,820,000	1,274	398,169	654,269,000	1,643
ARAKA	71,909	57,992,000	806	105,620	103,818,000	983	152,965	185,086,000	1,210
GANIA	177,981	132,763,100	746	293,944	301,026,000	1,024	466,403	646,190,000	1,385
MAU	33,255	26,954,000	811	52,588	62,384,000	1,186	81,384	135,754,000	1,668
RU TOTAL	1,013,463	928,118,100	916	1,755,587	2,021,497,000	1,151	2,891,075	4,400,898,000	1,522

good supply reliability, much better than most of the existing water projects in the area. Once this is realised then people may be willing to contribute more than what was indicated in the household survey.

The present study does not attempt to provide cost estimates per project. These should be based on feasibility studies, which will follow the preparation of the DWDP. The cost estimates given must therefore be considered as preliminary.

6.4 Institutional Requirements

In order to implement the DWDP in the context of the District Focus policy several institutional strengthening measures are required. These measures will reinforce the actions already undertaken by the MoWD. The two objectives of these measures are:

1) To provide the District Water Office with the means and resources for their co-ordinating tasks in the provision of water to communities, and
2) To strengthen the Central MoWD in its supporting role towards the districts and in its role of formulating and implementing the national policies and guidelines regarding water distribution, provision and conservation.

The most important measures required to achieve the first objective are:

- Strengthening of assessment and planning capacity at district level. This in turn requires provision of equipment and of training in these subjects
- Strengthening administrative and financial systems along lines already under discussion within the MoWD. Specifically the following measures are suggested.
  - District Water Offices should be enabled to retain revenues collected, as an incentive for better collection and to ease cash flow problems. In the interim, the "appropriations in aid" policy with respect to funding of recurrent expenditure should be reassessed so as to ensure that it will not disadvantage high cost schemes and that it will provide a real incentive to efficient management.
  - Financial systems should be revised to enable effective management and implementation of District Focus and Cost Sharing policies, in particular, full costs and revenues should be brought together in one set of accounts
  - Flexibility in pricing policy, reflecting the different operating costs of water schemes, will be required also to effectively implement the national cost sharing policy.

  Additional equipment and training are required to implement these measures.
- District office staff also require training/support in O&M activity and in catalysing community participation.

The most important measures required to achieve the second objective are:

- Central office staff, in their role of supporting the Districts, require better training in higher level skills in the areas of training, water resources planning, O&M, financial systems, community mobilisation, technical design, environmental management and project appraisal, and
- MoWD in general, should put more effort in strengthening the links to other agencies and organisations, both public and private, involved in provision of water supplies.

7 MAJOR ISSUES RAISED BY THE STUDY

The major issues raised by the study are:

- Can the District Water Office achieve the organisational and financial autonomy it requires to effectively implement the District Focus Policy? And will it have the capacity to do so?

- Can the necessary infra-structure be implemented to improve the collection of revenues on water use, to achieve the aim of self sufficiency of water supplies in at least operation and maintenance?

- Will the policy of cost sharing and community participation achieve the expected improvement in water supply conditions?

- Does the District have sufficient capacity to formulate and implement a comprehensive District Water Development Plan, using the present studies prepared by WRAP? And will it be able to update such a Plan in the future?

- How reliable is the projection of water demand as the basis for the planning of water development in respect of the incompleteness and general inaccuracy of basic data?

- Can the District, the Central MoWD and the District Water Office be organised to acquire and co-ordinate external assistance from bi-lateral, multi-lateral and NGO donors for water supply projects?

- Can an administrative framework for co-ordination of water resource management be achieved, encompassing MoWD and other organisations such as the Ministries of ASAL, Health, Social Services, Agriculture and Livestock?

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Survey of Water Use and Needs in Meru District
Water Resources Assessment and Planning Project

Appendix 1

Existing Water Supplies in Meru District

Appendix 1

Existing Water Supplies in Meru District

- Technical Data

- Operational Data

Existing Water Supplies in Meru District: Technical Data

Nr.	NAME OF SUPPLY	SUB-LOCATION OR LOCATION	SOURCE	OWNER/ ASSIST. AGENCY	YEAR COMM	PUMP PLANT	DISTRIB. CAPACITY (M3/DAY)	STORAGE (M3)	PIPES (KM)	QUAL. SOURCE	TREAT-MENT	1988 POPUL. SERVED	METER CONNC.	NON-METERED CONNC.	KIOSKS	CWP	AREA (KM2)	CATTLE TROUGH /DIP	WORK COND.
	MoWD/Urban Supplies																		
3.1	Maua	Maua	River	MoWD	1957	Gr	169	45	4	OP	Full	3,500	242	0	0	0	3	1	3
4.1	Meru	Ntima	River	MoWD-MC	1970	Gr	7,000	1600	-	OP	F,Cl	26,790	2,925	30	0	0	25	-	1
6.1	Nkubu	Nkuene	River	MoWD	1972	EP	314	125	10	OP	Full	3,665	215	0	0	0	2	0	2
7.1	Chuka	Karingani	River	MoWD	1977	Gr	415	700	-	OK	Cl	5,314	350	0	0	0	4	-	1
	MoWD/Rural Supplies																		
1.1	Timau	Kirimara	SP	MoWD	1978	Gr	130	500	41.5	OK	0	2,878	311	4	0	0	9	0	2
2.1	Tigania	Tigania Div.	SP	MoWD/SIDA	1977	Gr	2,004	324	51	OK	Cl	38,600	329	135	0	42	60	2	1
4.2	Nkabune	Nyaki	River	MoWD/SIDA	1978	Gr	293	100	8	OP	Full	10,000	304	0	20	0	10	2	1
6.2	Mwimbi	Igoji	River	MoWD	1978	Gr	4,290	325	(65)	OK	Cl	32,000	327	1,189	0	-	60	-	2
6.3	Kanyakine	Kanyakine	River	MoWD	1974	Gr/DP	270	260	32	OP	Full	4,200	437	0	0	0	15	0	3
6.4	Mitunguu	Mitunguu/ S. Tharaka	River	MoWD/SIDA	1976	Gr	624	250	18	OP	Full	5,100	394	0	3	9	45	2	1
7.2	Karingani	Karingani	River	MoWD	1970	Gr	5,900	-	-	OK	Cl	12,400	732	2,240	-	-	23	-	2
	Other Supplies																		
2.8	Kamberia	Akithii/Mituntu	SP	Miss/SH	1987	Gr	1,090	100	19.0	OK	0	12,100	-	-	-	15	60	3	1
2.9	Mbaranga	Muthara	River	Miss	1982	Gr	190	50	7.0	OK	0	3,600	0	0	0	10	5	3	1
2.10	Lailuba	Athwana	River	Miss	1983	Gr	240	10	7.0	OP	0	1,000	0	0	0	9	3	1	1
2.11	Mikinduri Girls	Mikinduri	River	Miss	1987	Gr	-	90	4.6	(OK)	0	750	0	20	0	4	2	0	1
2.12	Lanyiro	Muthara	River	Meth	-	Gr	-	14	8	OK	0	1,150	0	0	0	-	5	-	1
2.14	Tigania M. Hosp.	Muthara/Akithii	SP	Miss/SH	1967	Gr	520	60	9	OK	0	2,500	20	3	0	12	4	0	1
3.2	Tuuru	Ithima/Mutuati	SP	Miss/SH	1969	Gr	1,700	4,000	190	OK	0	100,000	490	0	86	-	550	5	2
6.	Mitunguu Irriga.	Mitunguu	River	MoA/GTZ	1985	Gr	34,560	64.4	81.0	OP	0	1,860	0	310	0	0	-	1	1
6.	Muguru Coffee Fact.	Ngonyi	River	FCU	1982	Gr	-	23	1.26	OP	0	30	0	4	0	0	-	0	1
7.14	Kathwana Pre.site	Kanjuki	River	GOK	-	Gr	150	-	-	OP	0	1,000	-	-	-	-	5	-	6
8.1	Ng'uru Gakirwe	S. Tharaka	River	Miss/SH	1989	Gr	6,000	25	29.5	OP	0	1,650	0	260	0	0	20	0	1
	Self Help Supplies																		
1.3	Mukuria	Ontulili	River	SH	UC	Gr	380	135	-	OK	0	400	-	-	-	-	5	-	1
1.4	Katheri Ontulili	Ontulili	River	SH	UC	Gr	270	-	-	OK	-	450	-	-	-	-	6	-	5
1.8	Muguna Timau	Kithithina	River	SH/RDF	UC	Gr	-	-	-	OK	(0)	300	-	-	-	-	6	-	4
1.9	Kiguru	Ngushishi	River	SH/MoWD	UC	Gr	36	135	-	OP	-	200	-	-	-	-	3	-	1
1.13	Muthatene	Buuri	SP	SH	-	Gr	-	150	-	OK	0	140	-	-	-	-	3	-	3
1.14	Marania Ntirimiti	Buuri	River	SH	-	Gr	1,500	-	-	(OK)	0	600	-	-	-	-	25	-	5
1.15	Ndurumuru	Buuri	SP	SH	UC	Gr	864	-	-	OK	-	200	-	-	-	-	5	-	5
2.4	K.K. Mwethe	Mikinduri	River	SH/RDF	1983	Gr	1,500	135	3	OK	0	4,200	-	-	-	-	8	-	2

BH = Borehole
SP = Spring
EP = Electrical Pump
DP = Diesel Pump
S = Solar Pump
HD = Hydram
Gr = Gravity
WM = Windmill
MC = Municipal Council
Plan = Plan International

Miss = Diocese of Meru
SH = Self Help
MoLD = Min. of Livestock Dev.
MoA = Min. of Agriculture
MoWD = Min. of Water Development
FCU = Farmers' Co-operative Union
EEC = European Economic Community
GOK = Government of Kenya
GTZ = German Technical Aid
Meth = Methodist Church
CHF = Canadian Hunger Foundation

CWP = Communual Water Points
OP = Organic Pollution
OK = Good Water Quality
NOK = Not Good Quality
Cl = Chlorination
F = Filtration
IP = Industrial Pollution
UC = Uncommissioned

- = No data available
0 = nil
( ) = Data not accurate

WORKING CONDITION

1 = Good
2 = Fair
3 = Poor
4 = Not Working
5 = Not Completed
6 = Not Started / Proposed

(Cont.) Existing Water Supplies in Meru District: Technical Data

Nr.	NAME OF SUPPLY	SUB-LOCATION OR LOCATION	SOURCE	OWNER/ ASSIST. AGENCY	YEAR COMM	PUMP PLANT	DISTRIB. CAPACITY (M3/DAY)	STORAGE (M3)	PIPES (KM)	QUAL. SOURCE	TREAT-MENT	1988 POPUL. SERVED	METER CONNC.	NON-METERED CONNC.	KIOSKS	CWP	AREA (KM2)	CATTLE TROUGH /DIP	WORK COND.
3.3	Kaweru	Njoune, Kanjoo Athiru Ruujine	SP	SH/PLAN	1986	Gr	1,470	415	31	OP	0	6,500	0	(400)	0	28	50	29	1
3.8	Akachiu	Amungenti	SP	SH/PLAN	1986	Gr	500	150	(30)	OK	0	2,200	0	(100)	0	11	10	1	1
3.9	Amwamba	Auki	River	SH/PLAN	1987	Gr	199	125	20	OK	0	6,800	0	196	-	5	8	1	1
3.10	Athi	Kirindine	SP	SH/PLAN	1987	Gr	271	95	14.7	OK	0	1,600	0	60	0	8	10	1	2
3.11	Mukine	Kiegoi/Amwathi	River	SH/PLAN	1988	Gr	220	75	9	OP/IP	0	700	0	(200)	0	0	2	0	1
3.12	Kanjara/ Muthathene	Kiegoi	River	SH/PLAN	1989	Gr	108	75	6	OK	0	400	0	(70)	0	0	2	0	1
3.13	Ntingirai	Kiegoi	River	SH/PLAN	1990	Gr	450	130	18.5	OK	0	2,500	0	200	0	0	7	1	1
3.14	Gitwe	Burieruri	SP	SH/PLAN	1987	Gr	260	50	3.6	OK	0	3,000	0	30	0	4	4	1	1
3.15	Murimi	Antubetwe Njoune	SP	SH/PLAN	1989	Gr	294	50	8	OP	0	2,500	0	0	0	5	5	6	1
3.16	Gitura 4K Club	Amwathi	SP	SH/PLAN	1987	Gr	130	100	1.0	OK	0	2,200	0	1	0	1	-	1	1
3.17	Ngongone	Athiru Gaiti	SP	SH/PLAN	1990	Gr	260	25	4.8	OK	0	900	0	3	0	3	5	0	1
3.18	Bwathu	Athiru Gaiti	SP	SH/PLAN	1990	Gr	354	0	5	OK	0	950	0	0	0	0	5	0	1
3.19	Nthambiro	Kanjoo	SP	SH/PLAN	1988	Gr	260	0	5	OK	0	-	0	0	0	5	-	3	3
3.20	Rwaene	Amwathi	SP	SH/PLAN	1989	Gr	-	75	4.65	OK	0	-	0	(80)	0	0	-	1	1
3.21	MathaWe	Auki	SP	SH/PLAN	1990	Gr	432	20	5	OK	0	2,190	0	0	0	0	2	1	1
3.22	Muhorone	Kiegoi	SP	SH/PLAN	UC	Gr	-	-	-	OK	0	1,890	-	-	-	-	2	-	6
3.23	K.K. Karui	Kiegoi	SP	SH/PLAN	UC	Gr	-	-	-	OK	-	710	-	-	-	-	-	-	5
3.24	Kimuthi	Kangeta	SP	SH/PLAN	UC	-	-	-	-	OK	-	-	-	-	-	-	-	-	5
4.4	Naari Kirua	Kirua	River	SH/MoWD	UC	Gr	-	-	-	OK	0	9,200	-	-	-	-	44	-	2,5
4.11	Ndekero	Nyaki	SP	SH/CARE	UC	Gr	-	-	-	OK	0	300	-	-	-	-	1	-	1
4.14	Mbuta	Mwanganthia	River	SH	-	Gr	-	-	-	OP	0	1,000	-	-	-	-	2	-	2
4.16	Nyonta	Nyaki	River	SH	-	Gr	-	-	-	OP	0	2,500	-	-	-	-	8	-	2
4.19	Muguna `B'	Nyaki	River	SH	UC	Gr	-	-	-	OK	0	2,500		-	-	-	6	-	2,5
4.	Karai Kanani	Nyaki	River	SH	-	Gr	-	-	-	-	0	282	-	-	-	-	-	-	2
5.1	Katheri Nthimbiri	Abothuguchi	River	SH	1982	Gr	270	500	-	OK	0	5,800	-	-	-	-	5	-	3,5
5.3	Kibaranyeki	Abothuguchi	SP	SH	UC	Gr	1,200	130	-	OK	0	1,800	-	-	-	-	5	-	3
5.4	Magundu	Ntima	River	SH	-	Gr	-	-	-	OP	0	2,000	-	-	-	-	2	-	3
5.5	Ntumburi	Ntumburi	SP	SH/EEC	1987	Gr	743	225	55	OK	0	5,000	0	0	0	50	40	3	1
5.12	Kariene Baragu	Gatimbi	River	SH	-	Gr	-	-	-	OP	0	1,000	-	-	-	-	2	-	2
5.14	Gaitu Gaguma	Mwanganthia	River	SH	UC	Gr	1,000	135	-	OP	0	6,000	-	-	-	-	3	-	3
5.15	Ciontare	Mwanganthia	River	SH	-	Gr	1,000	-	-	OP	0	1,450	-	-	-	-	4	-	2
5.18	Mujwa Mututa	Mwanganthia	River	SH	-	Gr	2,000	-	-	OP	0	3,200	-	-	-	-	9	-	3
5.19	C.Abothuguchi	Gatimbi	River	SH	1985	Gr	1,620	300	-	OP	0	7,500	-	-	-	-	16	-	2
5.20	Kanja Women Group	Mwanganthia	River	SH/RDF	UC	Gr	-	-	-	OP	0	2,000	-	-	-	-	7	-	5
5.22	Njuthine	Mwangathia	River	SH	UC	Gr	-	-	-	OP	0	230	-	-	-	-	2	-	5
5.31	Kirie	Ngonyi	River	SH	1987	Gr	226	0	34.7	OP	0	-	0	0	0	0	-	0	2
6.5	Taita/Muguru	Nkuene	River	SH	1974	Gr	90	0	16	OP	0	(910)	0	160	0	0	4	0	2
6.6	Kithinu/Mari	Kothine	River	SH	1979	Gr	430	318	19	OP	0	3,180	0	536	0	0	4	1	2
6.7	Lower Kithangani	Kanyekine	River	SH	-	Gr	1,216	135	-	OP	-	6,000	-	-	-	-	24	-	3
6.10	Mwirangara I	Nkuene	SP	SH	1976	Gr	-	96	56	OP	0	1,000	0	500	-	-	2	1	2
6.13	Maigene	Igoki	River	SH	1976	Gr	113	136	10.8	OP	0	1,500	0	80	0	0	2	0	2
6.14	Igandene	U. Kiungone	SP	SH	-	Gr	-	-	-	OK	0	200	-	-	-	-	1	-	6
6.15	Kirugakwi	Uruku	River	SH	U.C	Gr	-	-	-	OP	0	720	0	-	0	0	1	1	5

(Cont.) Existing Water Supplies in Meru District: Technical Data

Nr.	NAME OF SUPPLY	SUB-LOCATION OR LOCATION	SOURCE	OWNER/ ASSIST. AGENCY	YEAR COMM	PUMP PLANT	DISTRIB. CAPACITY (M3/DAY)	STORAGE (M3)	PIPES (KM)	QUAL. SOURCE	TREAT-MENT	1988 POPUL. SERVED	METER CONNC.	NON-METERED CONNC.	KIOSKS	CWP	AREA (KM2)	CATTLE TROUGH /DIP	WORK COND.
6.	Igoji	Igoji	River	SH	1985	Gr	1,210	-	-	-	-	6,000	-	-	-	-	-	-	-
6.	Munyaka Gitiri	Ngonyi	River	SH	1976	Gr	-	0	7.29	OP	0	(208)	0	26	0	0	-	0	1
6.	Konjunguru	Kigane	River	SH	1988	Gr	-	0	14	OP	0	1,000	0	-	-	-	-	1	1
6.	Cypriano Kimathi	Kathera	River	SH	1971	Gr	1.75	0	0.060	OP	0	15	0	1	0	0	-	1	1
6.	Gatuirura	Kathera	SP	SH	1978	Gr	-	-	1.4	OP	0	30	0	5	0	0	-	0	2
6.	Kathiano	Kathera	River	SH	1977	Gr	-	0	3.1	OP	0	250	0	31	0	0	-	0	1
6.	Mirugi/Gakuri /Nugu	Kigane	River	SH	1977	Gr	-	23	6.0	OP	0	540	0	67	0	0	-	0	1
6.	Kiruma	Kathera	River	SH	1977	Gr	-	0	3.5	OP	0	210	0	35	0	0	-	0	1
6.	Kirima	Uruku	River	SH	1977	Gr	-	0	7.2	OP	0	280	0	40	0	0	-	0	1
6.	Kanyoo	Kathera	River	SH	1984	Gr	-	0	4.4	OP	0	100	0	14	0	0	-	0	2
6.	Uruku U/Thingithu	Uruku	River	SH	1980	Gr	216	0	32	OK	0	510	0	84	0	0	-	0	1
6.	Kathima	Uruku	River	SH	1979	Gr	-	0	2.4	OP	0	65	0	13	0	0	-	0	3
6.	Marimba Ngweti	Uruku	River	SH	1987	Gr	-	0	14	OP	0	350	0	50	0	0	-	0	1
6.	Karindwa	Kathera	River	SH	1979	Gr	-	0	9.35	OP	0	260	0	26	0	0	-	0	2
6.	Nguru	Kigane	River	SH	1979	Gr	-	0	5.3	OP	0	260	0	26	0	0	-	0	1
6.	Muroe	Uruku	River	SH	1979	Gr	-	0	5	OP	0	400	0	42	0	0	-	0	3
6.	Nkui	Kirendene	River	SH	1975	Gr	-	0	13.0	OP	0	300	0	43	0	0	-	0	2
6.	Mamuru	Kirendene	River	SH	1967	Gr	-	0	8.0	OP	0	1,000	0	150	0	0	-	0	2
6.	Kithunguri/Mutheri	Ngonyi	River	SH	1974	Gr	-	0	8.85	IP	0	300	0	61	0	0	-	0	2
6.	Kithinu Green	Ngonyi	River	SH	U.C	Gr	-	0	-	OP	-	1,800	-	-	-	-	-	0	5
6.	Kinoru	Ngonyi	River	SH	1974	Gr	-	0	10.57	OP	0	500	0	70	0	0	-	0	1
6.	Kathiari	Ngonyi	River	SH	1976	Gr	-	0	1.1	OP	0	27	0	3	0	0	-	0	3
6.	Thingithu/ Kithunguri/Nkumari	Ngonyi	River	SH	UC	Gr	-	315	(20)	OP	0	2,000	0	0	0	0	-	0	5
6.	Ekumbo/Rwitu /Ndamene	Ngonyi	River	SH	1977	Gr	-	0	8.4	OP	0	525	0	35	0	0	-	1	2
6.	Kaurone	Kirendene	River	SH	1987	Gr	-	0	4.98	OP	0	200	0	25	0	0	-	0	1
6.	Ntitune Spring	Kirendene	SP	SH	UC	Gr	-	0	22.4	OK	0	500	0	81	0	0	-	0	5
6.	Pius M'Arunga	Ngonyi	BH	SH	1957	MP	-	0	0	OK	0	46	0	0	0	1	-	0	1
7.3	Murugi Mugumango	Chogoria/Kiera	River	SH/CHF	1983	Gr	1,690	-	(92)	OK	0	14,700	1,187	0	-	-	35	-	1
7.4	Gantaraki	Muthambi/Chog.	River	SH	-	Gr	(2,245)	135	-	OK	0	5,000	-	-	-	-	12	-	1
7.5	Mutindwa E.West	Chogoria	River	SH	-	Gr	-	-	-	OK	0	400	-	-	-	-	1	-	1
7.7	Magumoni	Magumoni	River	SH/MoWD /EEC	1987	Gr	2,333	500	-	OK	0	19,000	-	-	-	-	45	-	5
7.13	Gatua/Karimba /Muguna	Muthambi/ Karingani	River	SH/GOK	-	Gr	(564)	-	-	OK	0	13,700	-	-	-	-	35	-	5
7.	Mara-Kiangua Ker.	Kiera	River	SH	1987	Gr	-	-	-	OP	0	-	-	-	-	-	-	-	2
8.2	Kathita Gatunga	N. Tharaka	River	SH/Miss	-	Gr	11	-	-	OP	-	(3,000)	0	0	-	-	20	-	5
8.4	Gachiongo	N. Tharaka	River	SH	-	Gr	-	-	-	(NOK)	-	(3,000)	-	-	-	-	-	-	2
8.7	Mitunguu/Tunyai Furrow	Tunyai	River	SH	1928	Gr	-	0	(29) (furrow)	OP	0	6,500	0	0	0	0	(20)	0	3
8.9	Nkondi Solar	Nkondi	BH	SH/MoWD	1991	S	50	45	-	OK	0	2,000	-	-	-	-	-	-	5

Existing Water Supplies in Meru District: Operational Data

Nr.	Name of Supply	Location	Maintenance Agency	Utilization			Average Walking Distance (Km)	Rates F/M	Water Produced (M3/Y)	Water Sold (M3/Y)	Revenue Billed (Year)	Revenue Collected (Year)	Operation & Maintenance (Kshs/Year)	Source of Information
				Households	Livestock (LU)	Irrigation								
	MoWD/Urban Supplies													
3.1	Maua	Maua	MoWD	350	583	-	-	M	62,700	56,422	75,525	26,663	101,280	3
4.1	Meru	Ntima	MoWD-MC	2,679	4,981	-	-	M	1,703,750	1,703,750	1,718,736	11,711	-	3
6.1	Nkubu	Nkuene	MoWD	366	611	-	-	M	110,175	100,471	193,447	151,318	288,000	3
7.1	Chuka	Karingani	MoWD	531	-	-	-	M	135,050	130,915	218,782	219,111	-	1
	MoWD/Rural Supplies													
1.1	Timau	Kirimara	MoWD	287	480	-	-	M	44,139	41,106	100,247	67,343	-	3
2.1	Tigania	Tigania Div.	MoWD	3,860	-	-	-	M	945,345	818,863	134,073	60,677	228,240	2
4.2	Nkabune	Nyaki	MoWD	1,000	(1,000)	-	-	M	71,199	61,680	71,036	78,901	-	3
6.2	Mwimbi	Igoji	MoWD	3,200	(4,981)	-	-	M	1,785,070	1,263,879	366,283	288,032	-	1
6.3	Kanyakine	Kanyakine	MoWD	420	(700)	-	-	M	85,462	48,421	62,921	60,869	218,595	3
6.4	Mitunguu	Mitunguu/S. Th	MoWD	510	1,247	-	-	M	193,919	121,647	170,550	160,187	503,760	3
7.2	Karingani	Karingani	MoWD	1,240	(4,000)	-	-	M	1,173,840	1,105,779	407,961	252,188	-	1
	Other Supplies													
3.2	Tuuru	Ithima/Mutuati	SH/Miss	10,000	-	-	-	F	-	272,000	-	768,069	1,168,000	3
6.	Mitunguu Irrigation	Mitunguu	MoA	186	830	Large	-	F	12,614,400	0	(150,000)	110,000	36,600	3
6.	Muguru Coffee Fact.	Mitunguu	FCU	3	6	-	-	F	-	0	0	0	0	3
7.14	Kathwana P. Site	Kanjuki	MoWD/SH	100	-	-	-	F	-	-	-	-	-	2
8.1	Ng'uru Gakirwe	South Tharaka	Miss	165	350	Large	-	F	-	2,190,000	-	52,000	350,000	3
	Self Help Supplies													
1.3	Mukuria	Ontulili	SH	40	500	-	-	F	-	-	-	-	-	3
1.4	Katheri Ontulili	Ontulili	SH	45	583	-	-	F	-	-	-	-	-	3
1.8	Muguna Timau	Kirimara	SH	30	417	-	-	F	-	-	-	-	-	3
1.9	Kiguru	Kirimara	SH	20	100	-	-	F	-	-	-	-	-	3
1.13	Muthatene	Kisima	SH	14	300	-	-	F	-	-	-	-	-	3
1.14	Marania Ntirimiti	Kisima	SH	60	833	-	-	F	-	-	-	-	-	3
1.15	Ndurumuru	Kisima	SH	20	300	-	-	F	-	-	-	-	-	3
2.4	K.K. Mwethe	Mikinduri	SH	420	5,000	-	-	F	-	-	-	-	-	3

MoWD = Ministry of Water Development
SH = Self Help
MC = Municipal Council
MoA = Ministry of Agriculture
Miss = Diocese of Meru
MoLD = Ministry of Livestock Development
FCU = Farmers' Co-operative Union

\- = No data available
( ) = Data not accurate
F = Fixed Rates
M = Metered

Source of Information:

1. Data from Operational Chart or from monthly O & M Report.
2. Data from Inventory Ministry of Planning & National Dev.
3. Data Collected from Fieldvisit
4. Data Collected from PLAN International

(Cont.) Existing Water Supplies in Meru District: Operational Data

Nr.	Name of Supply	Location	Maintenance Agency	Utilization			Average Walking Distance (Km)	Rates F/M	Water Produced (M3/Y)	Water Sold (M3/Y)	Revenue Billed (Year)	Revenue Collected (Year)	Operation & Maintenance (Kshs/Year)	Source of Information
				Households	Livestock (LU)	Irrigation								
3.3	Kaweru	Maua & Athiru Ruujine	SH	650	(12,000)	-	-	F	528,520	-	-	123,000-150,000	90-100,000	1,4
3.8	Akachiu	Akachiu	SH	220	(3,000)	-	-	F				-		
3.9	Amwamba	Akachiu	SH	680	620	-	-	F		-	-	3,000	-	4
3.10	Athi	Akachiu	SH	160	300	-	-	F		-	-	5,880	6,000	4
3.11	Mukine	Maua/Kiegoi	SH	70	(6,000)	-	-	F		-	-	2,000	-	4
3.12	Kanjara Muthathene	Kiegoi	SH	40	270	-	-	F		-	-	-	-	4
3.13	Ndingirai	Kiegoi	SH	250	1,350	-	-	F		-	-	21,120	0	4
3.14	Gitwe	Njia	SH	300	50	-	-	F		-	-	-	-	4
3.15	Murimi	Maua	SH	250	220	-	-	F		-	-	-	-	4
3.16	Gitura 4K Club	Akachiu	SH	220	270	-	-	F		-	-	-	-	4
3.17	Ngongone	Akachiu	SH	90	182	-	-	F		-	-	-	-	4
3.18	Bwathu	Akachiu	SH	95	750	-	-	F		-	-	-	0	4
3.19	Nthambiro	Maua	SH	-	-	-	-	F		-	-	-	0	4
3.20	Rwaene	Maua	SH	-	-	-	-	F		-	-	-	-	4
3.21	Mathawe	Akachiu	SH	219	660	-	-	F		-	-	-	-	4
3.22	Muhorone	Kiegoi/Akachiu	SH	189	570	-	-	F		-	-	-	-	4
4.4	Naari-Kirua	Kirua	SH	920	(3,330)	-	-	F	-	-	-	-	-	2
4.11	Ndekero	Nyaki	SH	30	67	-	-	F	-	-	-	-	-	2
4.14	Mbuta	Mwanganthia	SH	100	458	-	-	F	-	-	-	-	-	2
4.16	Nyonta	Nyaki	SH	250	670	-	-	F	(98,550)	-	-	-	-	2
4.19	Muguna `B'	Nyaki	SH	250	2,670	-	-	F	-	-	-	-	-	2
4.	Karai Kanani	Nyaki	SH	28	47	-	-	F	-	-	-	-	-	2
5.1	Katheri Nthimbiri	Abothuguchi	SH	580	2,900	Small	-	F	-	-	-	-	-	2
5.3	Kibaranyeki	Abothuguchi	SH	180	167	-	-	F	-	-	-	-	-	2
5.4	Magundu	Ntima	SH	200	-	-	-	F	-	-	-	-	-	2
5.5	Ntumburi	Kibirichia	SH/MoWD	500	5,330	-	-	F	-	-	-	-	-	2
5.12	Kariene Baragu	Gatimbi	SH	100	667	-	-	F	-	0	0	-	48,000	3
5.14	Gaitu Gaguna	Mwanganthia	SH	600	11,670	-	-	F	-	-	-	-	-	2
5.15	Ciontare	Mwanganthia	SH	145	833	-	-	F	-	-	-	-	-	2
5.18	Mujwa Mututa	Mwanganthia	SH	320	1,083	-	-	F	-	-	-	-	-	2
5.19	Central Abothuguchi	Gatimbi	SH	750	2,667	-	-	F	-	-	-	-	-	2
5.20	Kanja Women Group	Mwanganthia	SH	200	450	-	-	F	591,300	-	-	-	-	2
5.22	Njuthine	Mwangathia	SH	230	(670)	-	-	F	-	-	-	-	-	2
5.31	Kirie	Mitunguu	SH	-	1,730	-	-	F	-	-	-	-	-	2
6.5	Taita/Muguru	Nkuene	SH	91	(700)	-	-	F	-	0	0	0	-	3
6.6	Kithinu/Mari	Igoki	SH	318	2,475	-	-	F	-	0	0	0	-	3
6.7	Lower Kithangari	Kanyekine	SH	600	1,000	-	-	F	-	0	0	-	4,300	3
6.10	Mwirangara I	Nkuene	SH	100	1,750	-	-	F	-	-	-	-	-	2
6.13	Maigene	Nkuene/Igoki	SH	150	400	-	-	F	-	0	0	0	-	3
6.14	Igandene	Abogeta	SH	20	(2,525)	-	-	F	-	0	0	-	2,400	3
6.15	Kirugakwi	Nkuene	SH	72	280	-	-	F/M	-	-	-	-	-	2
								F	-	0	0	0	-	3

(Cont.) Existing Water Supplies in Meru District: Operational Data

Nr.	Name of Supply	Location	Main-tenance Agency	Utilization			Average Walking Distance (Km)	Rates F/M	Water Produced (M3/Y)	Water Sold (M3/Y)	Revenue Billed (Year)	Revenue Collected (Year)	Operation & Maintenance (Kshs/Year)	Source of Inform-ation
				Households	Livestock (LU)	Irrigation								
6.	Igoji	Igoji	SH	600	-	-	-	M	-	-	-	-	-	2
6.	Munyaka Gitiri	Mitunguu	SH	20	78	-	-	F	-	0	0	0	0	3
6.	Konjuguru	Nkuene	SH	100	750	-	-	F	-	0	0	0	-	3
6.	Cypriano Kimathi	Nkuene	SH	1	17	-	-	F	-	0	0	0	9,600	3
6.	Gatuirura	Nkuene	SH	3	15	-	-	F	-	0	0	0	-	3
6.	Kathiano	Nkuene	SH	25	115	-	-	F	-	0	0	0	-	3
6.	Mirugi/Gakuri/Nugu	Nkuene	SH	54	158	-	-	F	-	0	0	0	-	3
6.	Kiruma	Nkuene	SH	21	93	-	-	F	-	0	0	0	-	3
6.	Kirima	Nkuene	SH	28	120	-	-	F	-	0	0	0	-	3
6.	Kanyoo	Nkuene	SH	10	80	-	-	F	-	0	0	0	-	3
6.	Uruku U/Thingithu	Nkuene	SH	51	310	-	-	F	-	0	0	0	-	3
6.	Kathima	Nkuene	SH	6	34	-	-	F	-	0	0	0	-	3
6.	Marimba Ngweti	Nkuene	SH	35	200	-	-	F	-	0	0	0	-	3
6.	Karindwa	Nkuene	SH	26	110	-	-	F	-	0	0	0	-	3
6.	Nguru	Nkuene	SH	26	80	-	-	F	-	0	0	0	-	3
6.	Muroe	Nkuene	SH	40	105	-	-	F	-	0	0	0	-	3
6.	Nkui	Mitunguu	SH	30	720	-	-	F	-	0	0	0	0	3
6.	Mamuru	Mitunguu	SH	100	1,250	-	-	F	-	0	0	0	0	3
6.	Kithunguri Mutheri	Mitunguu	SH	30	140	-	-	F	-	0	0	0	0	3
6.	Kithinu Green	Mitunguu	SH	180	916	-	-	F	-	0	0	0	0	3
6.	Kinoru	Mitunguu	SH	50	290	-	-	F	-	0	0	0	0	3
6.	Kathiari	Mitunguu	SH	3	7	-	-	F	-	0	0	0	0	3
6.	Thingithu/Kithung. Nkumari	Mitunguu	SH	200	520	-	-	F	-	0	0	0	0	3
6.	Ekumbo/Rwitu/Ndam.	Mitunguu	SH	52	207	-	-	F	-	0	0	0	0	3
6.	Kaurone	Mitunguu	SH	20	103	-	-	F	-	0	0	0	0	3
6.	Ntitune Spring	Mitunguu	SH	50	322	-	-	F	0	0	0	0	0	3
6.	Pius M'Arunga	Mitunguu	SH	5	11	-	-	F	-	0	0	0	4,020	3
7.3	Murugi Mugumango	Chogoria/Kiera	SH	1,470	4,670	Small	-	F	-	-	-	420,000	-	2
7.4	Gantaraki	Muthambi/Chog.	SH	500	667	-	-	F	-	-	-	-	-	2
7.5	Mutindwa East/West	Chogoria	SH	40	10,830	-	-	F	-	-	-	-	-	2
7.7	Magumoni	Magumoni	SH	1,900	5,689	-	-	F	851,545	-	-	-	-	2
7.1	Gatua/Muguna/Karimba	Muthambi	SH	1,370	-	-	-	F	-	-	-	-	-	2
7.	Mara-Kiangua Keria	Kiera	SH	-	-	-	-	F	-	-	-	-	-	2
8.2	Kathita Gatunga	N. Tharaka	SH	300	116	-	-	F	-	-	-	-	-	3
8.4	Gachiongo	N. Tharaka	SH	300	500	-	-	F	-	-	-	-	-	3
8.7	Mitunguu/Tunyai/ Muthangacwe Furrow	Mitunguu/ Tharaka	SH	650	9,006	Small	-	N/A	-	0	0	0	0	3

Appendix 2

Development Costs of Domestic Water Supply

Development Costs of Domestic Water Supply

Supply Area	Source Development	Water Supply Development	Initial Capital Cost (Shs) 1)			Annual O&M Cost (Shs)	Capital Cost/ Capita (Shs)	Annual Cost/ Capita (Shs)	Capital Cost/ m^3/day (Shs)	Annual Cost/ m^3/day (Shs)
			Source Develop.	Supply Develop.	Total Cost					
Urban Area 5,000 pop. **(200 m^3/day)**	Boreholes (2, 40 m)	Electr. subm. pump, storage, chlorination, distribution	625,000	4,112,500	4,737,500	524,375	940	105	23,700	2,600
	Boreholes (2, 100 m)	Electr. subm. pump, storage, chlorination, distribution	1,125,000	4,112,500	5,237,500	633,375	1,048	127	26,200	3,170
	Spring protection	Storage, chlorination, gravity distribution	500,000	4,487,500	4,987,500	304,750	998	60	24,950	1,525
	Surface Water Intake (weir)	Transmission, treatment, storage, distribution	250,000	5,687,500	5,937,500	723,375	1,188	145	29,700	3,600
	Surface Water Intake (Dam)	Transmission, treatment, storage, pump, distribution	6,250,000	5,937,500	12,187,500	941,875	2,438	188	60,950	4,700
Rural Centre 1000 pop. **(40 m^3/day)**	Boreholes (2, 40 m)	Windmill, storage, 6 cwp.	837,500	1,312,500	2,150,000	34,750	2,150	35	53,750	870
	Boreholes (2, 40 m)	Solar pump, storage, 6 cwp.	1,000,000	1,312,500	2,312,500	49,525	2,312	50	57,800	1,240
	Boreholes (2, 40 m)	Electr. subm. pump, storage, 6 cwp.	375,000	1,312,500	1,687,500	106,875	1,690	107	42,200	2,670
	Spring protection	Grav. supply, storage, 6 cwp	125,000	800,000	925,000	54,500	925	55	23,125	1,360
	Surface Water Intake (weir)	Gravity supply, storage, filtr. & chlor., 6 cwp.	125,000	1,300,000	1,425,000	67,250	1,425	67	35,625	1,680
	Surface Water Intake (intake chamber)	Hydram, storage, filtr. & chlor., 6 cwp.	212,500	1,300,000	1,512,500	84,125	1,512	84	37,800	2,100
Rural Institution or Rural Area 200 pop. **(10 m^3/day)**	Dug Well (10 m)	Handpump	37,500	75,000	112,500	500	565	2.5	11,250	50
	Borehole (40 m)	Handpump	125,000	62,500	187,500	1,875	940	9.4	18,750	188
	Spring protection	Storage, one outlet	37,500	-	37,500	500	188	2.5	3,750	50
	Surface Water Intake (intake chamber)	Gravity supply, storage, 1 cwp	62,500	268,750	331,250	15,313	1,660	77	33,125	1,530
	Roof Catchment	Gutters, storage	-	200,000	200,000	2,000	1,000	10	20,000	200
	Rock Catchment 2)	Storage	50,000	100,000	150,000	1,500	750	7.5	15,000	150

Price level: 1988

Notes: 1) For detailed estimates of capital costs, see Appendix 5.
2) Indicative cost estimate, because this depends very much on local conditions.

Appendix 3

Example of Checklist for Assessment of Impact and Viability of Proposed Projects

EXAMPLE OF CHECKLIST FOR ASSESSMENT OF IMPACT AND VIABILITY OF PROPOSED PROJECTS

a) Water Resources

The basis for these criteria is the Water Resources Assessment Study by WRAP. This study contains all the existing basic data on the availability and quality of both surfacewater and groundwater. The basic questions to be answered are:

Can the required present and future water supply be met from the indicated water source throughout the year?

e.g if a surfacewater reservoir is proposed, how will siltation affects its capacity?
or if a groundwater source is proposed, how will groundwater levels develop in future.

In ASAL areas can the required water supply be maintained during drought periods?

Does the proposed technology make optimum use of the available water source?

e.g if a groundwater source is proposed, does the pump capacity match the well yield?

Is there an alternative water source and has it been considered? Maybe to serve as alternative if the first source is out of order?

i.e a system using two different sources is more reliable

Is the quality of the water suitable for its intended use?

e.g for livestock water supply quality criteria are less than for domestic water supply

b) Land Use/Environmental Impact

The basis for these criteria are the District Development Plan and documents on land resources. The basic questions to be answered are:

Does the project supply water to activities consistent with the District Development Plan?

e.g is water provided for expansion of irrigation?

Are the facilities/plant of the project consistent with the existing and future usage?

e.g. can the water sources supply the quantities required by the present and projected land use
e.g. is wastewater treatment upstream capable of coping with increased loads or does the water supply treatment have to be designed for future upgrading?

Are the facilities/plant of the project consistent with plans for urban/rural development?

e.g is there sufficient capacity for likely increases in production of the local crops
e.g will the proposed siting of the reservoir will not sterilise mineral deposits, or block the most appropriate route for an upgraded access road?

Will the facilities/plant of the project, or their construction, have an adverse environmental impact?

The major forms of impact to be considered in the Meru District are:

- *pollution from processing plants, especially coffee plants*
- *pollution from urban areas especially stormwater runnoff and sewerage*
- *the degradation of vegetation cover and soils from erosion*
- *the impact of dams which intercept surface water causing downstream wet lands to dry up - this may have a significant impact on some wildlife*
- *heavy pumping of ground water may cause springs to dry up, affecting animals and sometimes people.*
- *possible pollution of water sources from agricultural inputs and farm waste*

c) Social Impact

It is difficult to discuss appropriate criteria for social assessment in the absence of a socio-economic study of the district which is designed to develop such criteria. However, some significant issues have been raised in consultation with local people. These are:

Where traditional groups are affected by the scheme, does the proposed scheme work within the cultural context of those groups?

> *This issue should be balanced against development goals in so far as sub-groups, such as women, within these groups should be given the opportunity to develop their talents*

Does the proposed scheme improve the welfare of the people of the district, particularly lower income groups and/or women?

> *i.e. does it provide employment, or does it provide opportunities for people to earn income from conditions created by the scheme?*

d) Institutional/Community Participation Issues

- **Institutions**

The major tasks which must be addressed with respect to institutional issues are design, construction and operation/maintenance of the systems. The organisation, or grouping of organisations must be able to carry out these tasks effectively. One organisation should be in charge of co-ordinating these tasks, and, preferably, this organisation should be that which will operate and maintain the project. The key issues are thus:

Which organisation is co-ordinating the project?

Does it have a realistic project organisational structure and implementation schedule?

Which organisations have responsibility for design, construction and operation of the schemes?

Are skills and financial resources available for each of these organisations to undertake their tasks?

If not, who is to supply training/funds to achieve the required levels of performance?

Are there written agreements with the co-ordinating organisation to support the above statements?

- **Community Participation**

Community participation can occur in any of the above tasks. In small scale water supply projects, it is likely that it will occur in all of these tasks. The organisation of this participation is thus a key element in the successful implementation of the project. The main issues involved are:

Are the leaders of the community organisation representative of the community?

- *i.e are the ones promising resource inputs capable of organising the delivery of those inputs?*

Can they deliver the promised labour and money inputs to the project on time?

- *i.e does the community have the resources?*

Can the community organisation effectively carry out the liaison activities that are required to implement the project?

- *e.g with government, contractors etc.*

Is the organisation recognised by the local government agencies and will/can they provide the organisational and logistic support required?

e) Economic Issues

The methodology required to undertake an economic assessment of the project is set out in the main report. For small scale projects which are to be implemented and paid for by the community, it may be assumed that the economic benefit is proven by the level of commitment shown. Where substantial levels of government or donor funds are to be used, a feasibility study of the project should include an assessment of economic viability, and the average/indicative values used in the main report should be replaced with those applicable to the specific project.

f) Affordability Issues

Based on the above analysis, the issue of affordability can be addressed. The Household survey indicates the levels of affordability which the respondants found to be acceptable. These levels cannot be regarded as definitive, but can be taken as a guide. The issues of affordability and willingness to pay are complex, and bound up with slowly changing traditional beliefs and priorities.

If the community is to implement and pay for the water scheme, there is little need to assess willingness to pay. Only confirmation of this must be obtained in feasibility studies. Where government and/or donor involvement is envisaged, the feasibility studies must address this issue in some detail.

In the latter case, the main consideration is the level of cost sharing required by the government or donor agency. This will determine the fee or tariff set in the scheme. General guidelines which are likely to be adopted require full cost recovery in urban schemes, and, outside urban areas, recovery of operation and maintenance costs. The basic questions are:

Does the sum involved in cost recovery constitute more than 5% of the income of, say, the poorest 20% of the population?

- *if so, use another technology or review level of cost sharing*

If not, what is the community attitude to paying this amount of money?

- *if negative, as it often is, then additional questions are required*

Is there an acceptable alternative source and what is the cost?

- *if there is no alternative, or if it is more expensive than the proposed scheme, then there is a good prospect of achieving a sufficient level of willingness to pay given adequate institutional systems and political support*

- *if there is an alternative which is acceptable to the people, even if the water is technically inferior, another technology should be considered, or the level of cost recovery should be reviewed.*

g) Financial Issues

The key financial issue is the sustainability of the project. With the above analysis complete, and concurrently with the determination of affordability, it is possible to project likely demand for, and the costs of, the scheme over time. The feasibility study must identify the sources of funds for design, construction and operation/maintenance. The projection of the expenditure of these funds must be realistic. A basic cash flow analysis can then be carried out to identify potential liquidity problems, and measures developed to overcome them. The financial return on the project can also be calculated.

Financial systems for revenue collection and recording financial flows (simple records of costs and receipts) have been developed, and could be applied to even the smallest schemes. For larger schemes, simple procedures for capital budgeting and funding of preventative maintenance schemes could be developed based on experience in some NGO projects. These types of procedures will take some time to establish, however.

The key criteria are thus:

Does the cash flow show that expenditures are covered by revenues through the life of the project?
Are procedures for revenue collection and monitoring of revenues and expenditures described and realistic?

Appendix 4

Cost Estimate

Domestic and Livestock Water Supply

COST ESTIMATE - YEAR 1993
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4

LOCATION	Year 1993 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL COSTS PER BENEFICIARY Ksh.
CENTRAL IMENTI										
BOTHUGUCHI	32,331	725	S	22,000	15,950,000	1,470	15,000	22,050,000	38,000,000	1,175
ATIMBI	35,220	0	S	22,000	0	1,533	15,000	22,995,000	22,995,000	653
WANGANTHIA	32,287	0	S	22,000	0	2,023	15,000	30,345,000	30,345,000	940
IBIRICHIA	22,132	359	S	22,000	7,898,000	0			7,898,000	357
TOTAL	121,970	1,084			23,848,000	5,026		75,390,000	99,238,000	814
GEMBE										
ANGETA	13,523	609	S	22,000	13,398,000	120			13,398,000	991
IEGOI	10,536	0	S	22,000	0	0			0	0
KACHIU	40,700	0	S	22,000	0	0	15,000	0	0	0
AUA	28,994	0	S	22,000	0	0	15,000	0	0	0
IA	20,643	799	S	22,000	17,578,000	170			17,578,000	852
TOTAL	114,396	1,408			30,976,000	290		0	30,976,000	271
NORTH IMENTI										
IRUA	17,387	1,188	S	22,000	26,136,000	0			26,136,000	1,503
IRI	10,353	792	S	22,000	17,424,000	0			17,424,000	1,683
IMA	46,557	0	S	22,000	0	4,828	15,000	72,420,000	72,420,000	1,556
AKI	28,085	685	S	22,000	15,070,000	1,400	15,000	21,000,000	36,070,000	1,284
AKI	11,302	905	S	22,000	19,910,000	0			19,910,000	1,762
TOTAL	113,684	3,570			78,540,000	6,228		93,420,000	171,960,000	1,513
THI										
AGUMONI	30,111	0	S	22,000	0	1,213	15,000	18,195,000	18,195,000	604
JONGE	13,530	776	S	22,000	17,072,000	0			17,072,000	1,262
ARINGANI	45,582	0	S	22,000	0	5,168	15,000	77,520,000	77,520,000	1,701
JTHAMBI	27,555	218	S	22,000	4,796,000	364	15,000	5,460,000	10,256,000	372
HOGORIA	25,763	0	S	22,000	0	563	15,000	8,445,000	8,445,000	328
ERA	37,000	791	S	22,000	17,402,000	0			17,402,000	470
NJUKI	15,528	529	S	22,000	11,638,000	0			11,638,000	749
TOTAL	195,069	2,314			50,908,000	7,308		109,620,000	160,528,000	823
TONYIRI										
THIMA	14,430	1,030	S	22,000	22,660,000	680	15,000	10,200,000	32,860,000	2,277
		1,000	GW	23,700	23,700,000				23,700,000	1,642
JTUATI	12,406	507	S	22,000	11,154,000	530	15,000	7,950,000	19,104,000	1,540
JTUBETWE-K.	9,121	615	S	22,000	13,530,000	150	15,000	2,250,000	15,780,000	1,730
THIRU-RUUJ.	17,891	325	S	22,000	7,150,000	50	15,000	750,000	7,900,000	442
TOTAL	53,848	3,477			78,194,000	1,410		21,150,000	99,344,000	1,845
SOUTH IMENTI										
GOJI	14,142	0	S	22,000	0	1,068	15,000	16,020,000	16,020,000	1,133
TINE	14,899	0	S	22,000	0	1,065	15,000	15,975,000	15,975,000	1,072
BOGETA	20,034	955	S	22,000	21,010,000	0			21,010,000	1,049
GOKI	12,349	730	S	22,000	16,060,000	430	15,000	6,450,000	22,510,000	1,823
KUENE	40,726	1,698	S	22,000	37,356,000	743	15,000	11,145,000	48,501,000	1,191
TUNGUU	13,000	341	S	22,000	7,502,000	0			7,502,000	577
NYAKINE	16,201	0	S	22,000	0	1,123	15,000	16,845,000	16,845,000	1,040
TOTAL	131,351	3,724			81,928,000	4,429		66,435,000	148,363,000	1,130

COST ESTIMATE - YEAR 1993
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4 (Cont.)

LOCATION	Year 1993 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL P BENEFI
THARAKA										
GIKINGO	12,820	295	S	22,000	6,490,000	0			6,490,000	
MARIMANTI	31,705	1,464	S	22,000	32,208,000	0			32,208,000	
N. THARAKA	13,067	622	S	22,000	13,684,000	0			13,684,000	
S. THARAKA	14,317	255	S	22,000	5,610,000	0			5,610,000	
TOTAL	71,909	2,636			57,992,000	0		0	57,992,000	
TIGANIA										
MITUNTU	1,972	0	S	22,000	0	0			0	
URINGU	13,737	0	S	22,000	0	0			0	
		483	Gw	23,700	11,447,100				11,447,100	
MBEU	17,255	644	S	22,000	14,168,000	0			14,168,000	
KIANJAI	16,770	736	S	22,000	16,192,000	0			16,192,000	
AKITHII	22,989	0	S	22,000	0	0			0	
MUTHARA	19,439	1,769	S	22,000	38,918,000	0			38,918,000	
KARAMA	16,375	381	S	22,000	8,382,000	0			8,382,000	
MIKINDURI	37,646	0	S	22,000	0	1,388	15,000	20,820,000	20,820,000	
THANGATHA	31,798	1,038	S	22,000	22,836,000	0			22,836,000	
	177,981	5,051			111,943,100	1,388		20,820,000	132,763,100	
TIMAU										
ONTULILI	12,806	0	S	22,000	0	192	15,000	2,880,000	2,880,000	
KIRIMARA	7,790	242	S	22,000	5,324,000	130	15,000	1,950,000	7,274,000	
KISIMA	12,659	0	S	22,000	0	1,120	15,000	16,800,000	16,800,000	
TOTAL	33,255	242			5,324,000	1,442		21,630,000	26,954,000	
MERU TOTAL	1,013,463	23,506			519,653,100	27,521		408,465,000	928,118,100	

Notes: Gw = Groundwater
S = Surface Water or Spring

COST ESTIMATE - YEAR 2003
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4 (Cont.)

LOCATION	Year 2003 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL COSTS PER BENEFICIARY Ksh.
CENTRAL IMENTI										
BOTHUGUCHI	57,342	2,552	S	22,000	56,144,000	1,470	15,000	22,050,000	78,194,000	1,364
KATIMBI	57,571	1,293	S	22,000	28,446,000	1,620	15,000	24,300,000	52,746,000	916
MWANGANTHIA	56,858	0	S	22,000	0	3,548	15,000	53,220,000	53,220,000	936
NIBIRICHIA	37,175	1,260	S	22,000	27,720,000	0			27,720,000	746
TOTAL	208,946	5,105			112,310,000	6,638		99,570,000	211,880,000	1,014
GEMBE										
KANGETA	21,875	688	S	22,000	15,136,000	120	15,000	1,800,000	16,936,000	774
		500	Gw	23,700	11,850,000				11,850,000	542
NEGOI	17,562	0	S	22,000	0	0			0	0
KIACHIU	67,525	712	S	22,000	15,664,000	271	15,000	4,065,000	19,729,000	292
MAUA	53,655	985	S	22,000	21,670,000	429	15,000	6,435,000	28,105,000	524
NJIA	39,246	951	S	22,000	20,922,000	170	15,000	2,550,000	23,472,000	598
		1,000	Gw	23,700	23,700,000				23,700,000	604
TOTAL	199,863	4,836			108,942,000	990		14,850,000	123,792,000	619
NORTH IMENTI										
MIRUA	30,846	1,670	S	22,000	36,740,000	0			36,740,000	1,191
		500	Gw	23,700	11,850,000				11,850,000	384
MIRI	17,114	823	S	22,000	18,106,000	0			18,106,000	1,058
		500	Gw	23,700	11,850,000				11,850,000	692
NTIMA	89,809	3,246	S	22,000	71,412,000	5,600	15,000	84,000,000	155,412,000	1,730
MAKI	56,774	2,622	S	22,000	57,684,000	1,400	15,000	21,000,000	78,684,000	1,386
MAKI	19,553	1,552	S	22,000	34,144,000	0			34,144,000	1,746
TOTAL	214,096	10,913			241,786,000	7,000		105,000,000	346,786,000	1,620
NITHI										
AGUMONI	45,703	0	S	22,000	0	2,207	15,000	33,105,000	33,105,000	724
MONGE	24,379	1,439	S	22,000	31,658,000	0			31,658,000	1,299
KIRINGANI	80,830	3,002	S	22,000	66,044,000	6,100	15,000	91,500,000	157,544,000	1,949
MUTHAMBI	48,729	1,770	S	22,000	38,940,000	364	15,000	5,460,000	44,400,000	911
MUGORIA	49,057	1,478	S	22,000	32,516,000	800	15,000	12,000,000	44,516,000	907
KIERA	61,797	2,361	S	22,000	51,942,000	0			51,942,000	841
KANJUKI	21,883	903	S	22,000	19,866,000	0			19,866,000	908
TOTAL	332,378	10,953			240,966,000	9,471		142,065,000	383,031,000	1,152
MERU-NYIRI										
KHIMA	37,725	2,679	S	22,000	58,938,000	680	15,000	10,200,000	69,138,000	1,833
		1,500	Gw	23,700	35,550,000				35,550,000	942
KITUATI	31,358	777	S	22,000	17,094,000	530	15,000	7,950,000	25,044,000	799
		500	Gw	23,700	11,850,000				11,850,000	378
KITUBETWE-K.	17,015	647	S	22,000	14,234,000	150	15,000	2,250,000	16,484,000	969
		500	Gw	23,700	11,850,000				11,850,000	696
KHIRU-RUUJ.	27,575	877	S	22,000	19,294,000	50	15,000	750,000	20,044,000	727
		0	Gw	23,700	0				0	0
TOTAL	113,673	7,480			168,810,000	1,410		21,150,000	189,960,000	1,671

COST ESTIMATE - YEAR 2003
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4 (Cont.)

LOCATION	Year 2003 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL BENEF
SOUTH IMENTI										
IGOJI	27,226	536	S	22,000	11,792,000	1,400	15,000	21,000,000	32,792,000	
MITINE	28,995	0	S	22,000	0	1,885	15,000	28,275,000	28,275,000	
ABOGETA	31,112	1,737	S	22,000	38,214,000	0			38,214,000	
IGOKI	20,936	1,541	S	22,000	33,902,000	430	15,000	6,450,000	40,352,000	
NKUENE	73,761	4,257	S	22,000	93,654,000	743	15,000	11,145,000	104,799,000	
MITUNGUU	22,170	896	S	22,000	19,712,000	0			19,712,000	
KANYAKINE	30,279	563	S	22,000	12,386,000	1,486	15,000	22,290,000	34,676,000	
TOTAL	234,479	9,530			209,660,000	5,944		89,160,000	298,820,000	
THARAKA										
GIKINGO	17,403	489	S	22,000	10,758,000	0			10,758,000	
MARIMANTI	45,750	2,523	S	22,000	55,506,000	0			55,506,000	
N. THARAKA	19,182	1,093	S	22,000	24,046,000	0			24,046,000	
S. THARAKA	23,285	614	S	22,000	13,508,000	0			13,508,000	
TOTAL	105,620	4,719			103,818,000	0			103,818,000	
TIGANIA										
MITUNTU	5,760	0	S	22,000	0	0			0	
URINGU	24,831	182	S	22,000	4,004,000	0			4,004,000	
		1,000	Gw	23,700	23,700,000				23,700,000	
MBEU	25,793	1,140	S	22,000	25,080,000	0			25,080,000	
KIANJAI	32,052	1,808	S	22,000	39,776,000	0			39,776,000	
AKITHII	39,687	901	S	22,000	19,822,000	0			19,822,000	
MUTHARA	33,392	3,733	S	22,000	82,126,000	0			82,126,000	
KARAMA	26,442	906	S	22,000	19,932,000	0			19,932,000	
MIKINDURI	58,923	1,042	S	22,000	22,924,000	1,500	15,000	22,500,000	45,424,000	
THANGATHA	47,064	1,871	S	22,000	41,162,000	0			41,162,000	
	293,944	12,583			278,526,000	1,500		22,500,000	301,026,000	
TIMAU										
ONTULILI	20,632	397	S	22,000	8,734,000	270	15,000	4,050,000	12,784,000	
KIRIMARA	13,076	549	S	22,000	12,078,000	130	15,000	1,950,000	14,028,000	
KISIMA	18,880	811	S	22,000	17,842,000	1,182	15,000	17,730,000	35,572,000	
TOTAL	52,588	1,757			38,654,000	1,582		23,730,000	62,384,000	
MERU TOTAL	1,755,587	67,876			1,503,472,000	34,535		518,025,000	2,021,497,000	

Notes: Gw = Groundwater
S = Surface Water or Spring

COST ESTIMATE - YEAR 2013
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4 (Cont.)

LOCATION	Year 2013 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL COSTS PER BENEFICIARY Ksh.
CENTRAL IMENTI										
ABOTHUGUCHI	96,184	6,679	S	22,000	146,938,000	1,470	15,000	22,050,000	168,988,000	1,757
GATIMBI	92,281	4,534	S	22,000	99,748,000	1,620	15,000	24,300,000	124,048,000	1,344
MWANGANTHIA	93,769	2,678	S	22,000	58,916,000	4,000	15,000	60,000,000	118,916,000	1,268
KIBIRICHIA	59,864	3,146	S	22,000	69,212,000	0			69,212,000	1,156
TOTAL	342,098	17,037			374,814,000	7,090		106,350,000	481,164,000	1,407
IGEMBE										
KANGETA	33,995	1,831	S	22,000	40,282,000	120	15,000	1,800,000	42,082,000	1,238
		500	Gw	23,700	11,850,000				11,850,000	349
KIEGOI	28,473	930	S	22,000	20,460,000	0			20,460,000	719
AKACHIU	107,947	3,471	S	22,000	76,362,000	271	15,000	4,065,000	80,427,000	745
MAUA	94,581	4,362	S	22,000	95,964,000	429	15,000	6,435,000	102,399,000	1,083
NJIA	68,136	2,611	S	22,000	57,442,000	170	15,000	2,550,000	59,992,000	880
		2,000	Gw	23,700	47,400,000				47,400,000	696
TOTAL	333,132	15,705			349,760,000	990		14,850,000	364,610,000	1,094
NORTH IMENTI										
KIIRUA	51,198	3,795	S	22,000	83,490,000	0			83,490,000	1,631
		500	Gw	23,700	11,850,000				11,850,000	231
RUIRI	26,734	1,782	S	22,000	39,204,000	0			39,204,000	1,466
		500	Gw	23,700	11,850,000				11,850,000	443
NTIMA	158,488	10,879	S	22,000	239,338,000	5,600	15,000	84,000,000	323,338,000	2,040
NYAKI	101,502	6,957	S	22,000	153,054,000	1,400	15,000	21,000,000	174,054,000	1,715
GIAKI	31,688	2,829	S	22,000	62,238,000	0			62,238,000	1,964
TOTAL	369,610	27,242			601,024,000	7,000		105,000,000	706,024,000	1,910
NITHI										
MAGUMONI	69,462	2,064	S	22,000	45,408,000	2,333	15,000	34,995,000	80,403,000	1,158
MWONGE	41,143	2,950	S	22,000	64,900,000	0			64,900,000	1,577
KARINGANI	137,682	10,000	S	22,000	220,000,000	6,100	15,000	91,500,000	311,500,000	2,262
MUTHAMBI	81,260	5,126	S	22,000	112,772,000	364	15,000	5,460,000	118,232,000	1,455
CHOGORIA	87,013	5,447	S	22,000	119,834,000	800	15,000	12,000,000	131,834,000	1,515
KIERA	99,461	5,681	S	22,000	124,982,000	0			124,982,000	1,257
KANJUKI	30,901	1,577	S	22,000	34,694,000	0			34,694,000	1,123
TOTAL	546,922	32,845			722,590,000	9,597		143,955,000	866,545,000	1,584
NTONYIRI										
ITHIMA	71,762	5,729	S	22,000	126,038,000	680	15,000	10,200,000	136,238,000	1,898
		2,500	Gw	23,700	59,250,000				59,250,000	826
MUTUATI	58,380	1,797	S	22,000	39,534,000	530	15,000	7,950,000	47,484,000	813
		1,000	Gw	23,700	23,700,000				23,700,000	406
ANTUBETWE-K.	28,533	1,364	S	22,000	30,008,000	150	15,000	2,250,000	32,258,000	1,131
		750	Gw	23,700	17,775,000				17,775,000	623
ATHIRU-RUUJ.	41,717	1,183	S	22,000	26,026,000	50	15,000	750,000	26,776,000	642
		750	Gw	23,700	17,775,000				17,775,000	426
TOTAL	200,392	15,073			340,106,000	1,410		21,150,000	361,256,000	1,803

COST ESTIMATE - YEAR 2013
DOMESTIC AND LIVESTOCK WATER SUPPLY

APPENDIX 4 (Cont.)

LOCATION	Year 2013 Total Population Covered	New Water Supplies: Required Capacity m3/day	Water Source	Unit Cost Ksh. per m3/day	Total Cost Ksh.	Rehabilitated Water Supplies: Required Capacity m3/day	Unit Cost Ksh. per m3/day	Total Cost Ksh.	TOTAL COSTS Ksh.	TOTAL CO PER BENEFIC K
SOUTH IMENTI										
IGOJI	47,417	2,454	S	22,000	53,988,000	1,400	15,000	21,000,000	74,988,000	1,
MITINE	49,995	1,572	S	22,000	34,584,000	2,090	15,000	31,350,000	65,934,000	1,
ABOGETA	48,316	3,489	S	22,000	76,758,000	0			76,758,000	1,
IGOKI	34,272	3,202	S	22,000	70,444,000	430	15,000	6,450,000	76,894,000	2,
NKUENE	130,317	10,123	S	22,000	222,706,000	743	15,000	11,145,000	233,851,000	1,
MITUNGUU	35,961	2,056	S	22,000	45,232,000	0			45,232,000	1,
KANYAKINE	51,891	2,651	S	22,000	58,322,000	1,486	15,000	22,290,000	80,612,000	1,
TOTAL	398,169	25,547			562,034,000	6,149		92,235,000	654,269,000	1,
THARAKA										
GIKINGO	23,650	857	S	22,000	18,854,000	0			18,854,000	
MARIMANTI	65,634	4,452	S	22,000	97,944,000	0			97,944,000	1
N. THARAKA	27,687	1,816	S	22,000	39,952,000	0			39,952,000	1
S. THARAKA	35,994	1,288	S	22,000	28,336,000	0			28,336,000	
TOTAL	152,965	8,413			185,086,000	0			185,086,000	1
TIGANIA										
MITUNTU	11,022	75	S	22,000	1,650,000	0			1,650,000	
URINGU	41,990	768	S	22,000	16,896,000	0			16,896,000	
		2,000	Gw	23,700	47,400,000				47,400,000	1
MBEU	38,574	2,165	S	22,000	47,630,000	0			47,630,000	1
KIANJAI	55,480	4,136	S	22,000	90,992,000	0			90,992,000	1
AKITHII	63,190	2,866	S	22,000	63,052,000	0			63,052,000	
MUTHARA	53,880	7,185	S	22,000	158,070,000	0			158,070,000	2
KARAMA	41,822	2,031	S	22,000	44,682,000	0			44,682,000	1
MIKINDURI	90,693	3,466	S	22,000	76,252,000	1,500	15,000	22,500,000	98,752,000	1
THANGATHA	69,752	3,503	S	22,000	77,066,000	0			77,066,000	1
	466,403	28,195			623,690,000	1,500		22,500,000	646,190,000	1
TIMAU										
ONTULILI	32,688	1,457	S	22,000	32,054,000	270	15,000	4,050,000	36,104,000	1
KIRIMARA	20,688	1,149	S	22,000	25,278,000	130	15,000	1,950,000	27,228,000	1
KISIMA	28,008	2,486	S	22,000	54,692,000	1,182	15,000	17,730,000	72,422,000	2
TOTAL	81,384	5,092			112,024,000	1,582		23,730,000	135,754,000	1
MERU TOTAL	2,891,075	175,149			3,871,128,000	35,318		529,770,000	4,400,898,000	1

Notes: Gw = Groundwater
S = Surface Water or Spring