THE APPROACH FOR SUSTAINABLE RURAL WATER SUPPLY IN NYANZA PROVINCE - KENYA

Lake Basin Development Authority - (RDWSSP)
FEBRUARY, 1990

A C K N O W L E D G E M E N T S

We would like to acknowledge the Managing Director of Lake Basin Development Authority who made the presentation of this Paper possible in the African Water and Technology Conference, February 1990 in Nairobi.

We also acknowledge the Programme Co-ordinator of the Rural Domestic Water Supply and Sanitation Programme for his personal comitment and for disposing to us all the necessary facilities and time we required in the preparation and presentation of the paper.

Further, we thank Mrs. Mary Balah who typed the paper and the staff of the Rural Domestic Water Supply and Sanitation Programme for the co-operation which has been freely given , both in the discussions and in the provision of the information and data essential to the production of this Paper.

THE APPROACH FOR SUSTAINABLE RURAL WATER SUPPLY

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A Paper presented at the African Water Technology Conference Nairobi, February 1990.

ABSTRACT

The Rural Domestic Water Supply and Sanitation Programme (RDWSSP), initiated by the Lake Basin Development Authority in 1984 has implemented over 600 water points in Nyanza Province of Kenya. The target for the next 4 years is to construct another 1200 water points.

These water points are based mainly upon the exploitation of ground water resources through the construction of wells fitted with handpumps and protection of springs.

The beneficiary communities own, manage, operate and maintain these water points, an aspect which is considered crucial for the sustainability of the constructed facilities.

Apart from the above, activities of the Programme which are also geared towards achieving long term sustainability include: resources assessment, community education and training, local institution building, choice of technology, local pump and spares manufacturing, maintenance, planning, monitoring and evaluation.

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INTRODUCTION

Nyanza Province is situated in the southwestern part of Kenya bordering Lake Victoria, from which it derives its name (Nyanza = Lake). The estimated population of 3.3 million live mostly in rural areas, and are engaged in agriculture and animal husbandry.

In 1984, only 10% of the rural population in Nyanza Province had access to a properly constructed water supply. The reliability of these water supply systems in most cases was far from satisfactory. The vast majority of the rural population carried water over considerable distances, from natural sources which are often polluted, insufficient or unreliable.

During the past 25 years, numerous Government and Non-Governmental organizations have been involved in rural water supply activities, but despite all their efforts the situation has not noticeably improved. The lack of maintenance of all types of constructed water supplies and the tendency to design mainly large scale supplies which so far have proved to be difficult to manage in the rural areas, has resulted in very little improvement being achieved in the rural water supply sector.

It is against this background that the LBDA initiated the Rural Domestic Water Supply and Sanitation Programme with the primary aim of providing safe water, easily accessible and in adequate quantities at a cost in keeping with the economic level of the communities and through facilities which can be operated and maintained by the beneficiaries themselves.

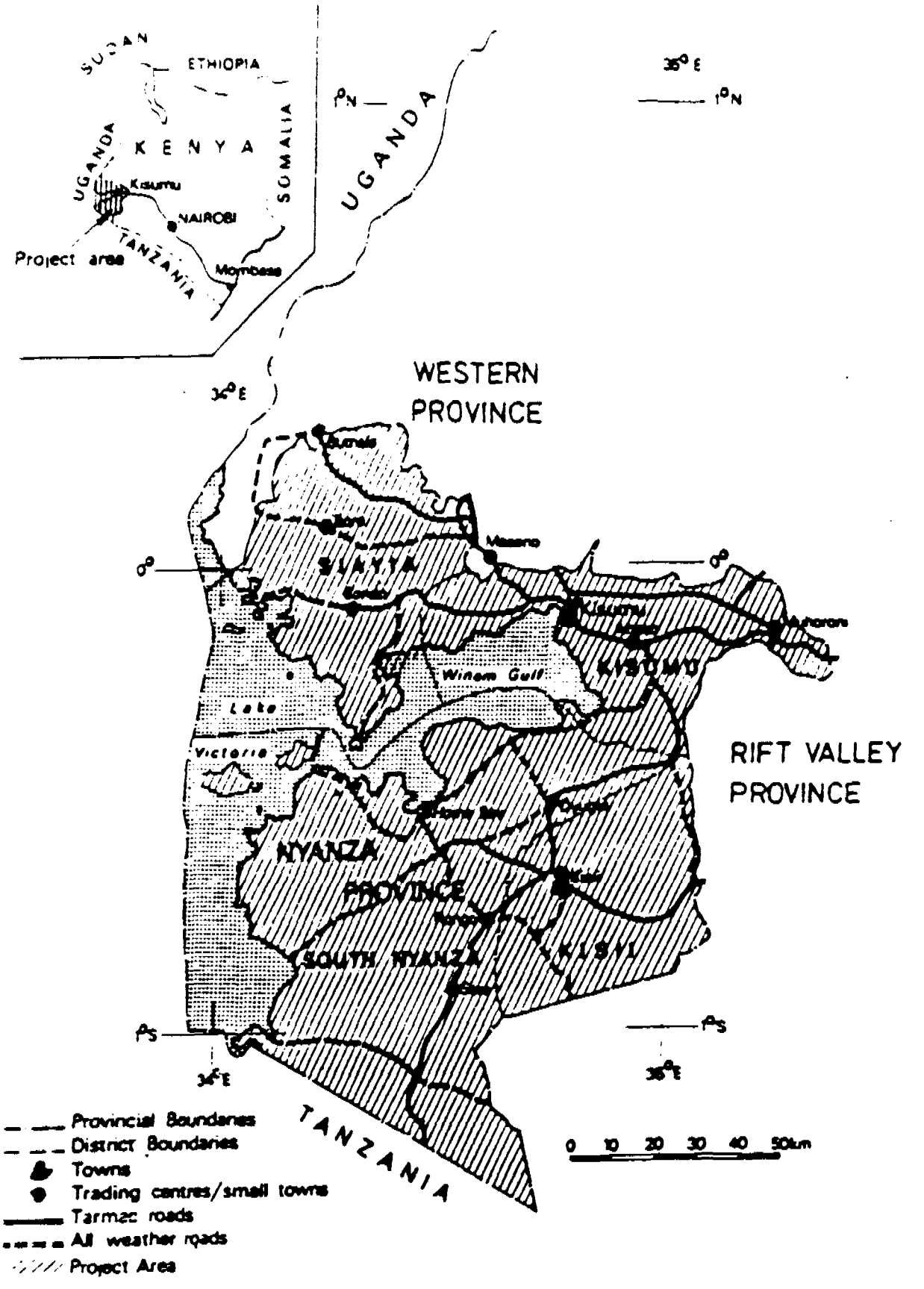


Fig. 1. LOCATION OF NYANZA PROVINCE

RURAL DOMESTIC WATER SUPPLY AND SANITATION PROGRAMME

The Rural Domestic Water Supply and Sanitation Programme (RDWSSP), extends over 26 divisions, together making up South Nyanza, Kisii/Nyamira, Kisumu and Siaya Districts of Nyanza Province (Figure 1).

One of the aims of the Programme was to evolve an implementation approach that would ensure that constructed water points were sustainable on a long term basis.

In order to achieve this aim, the following activities were undertaken by the Programme:

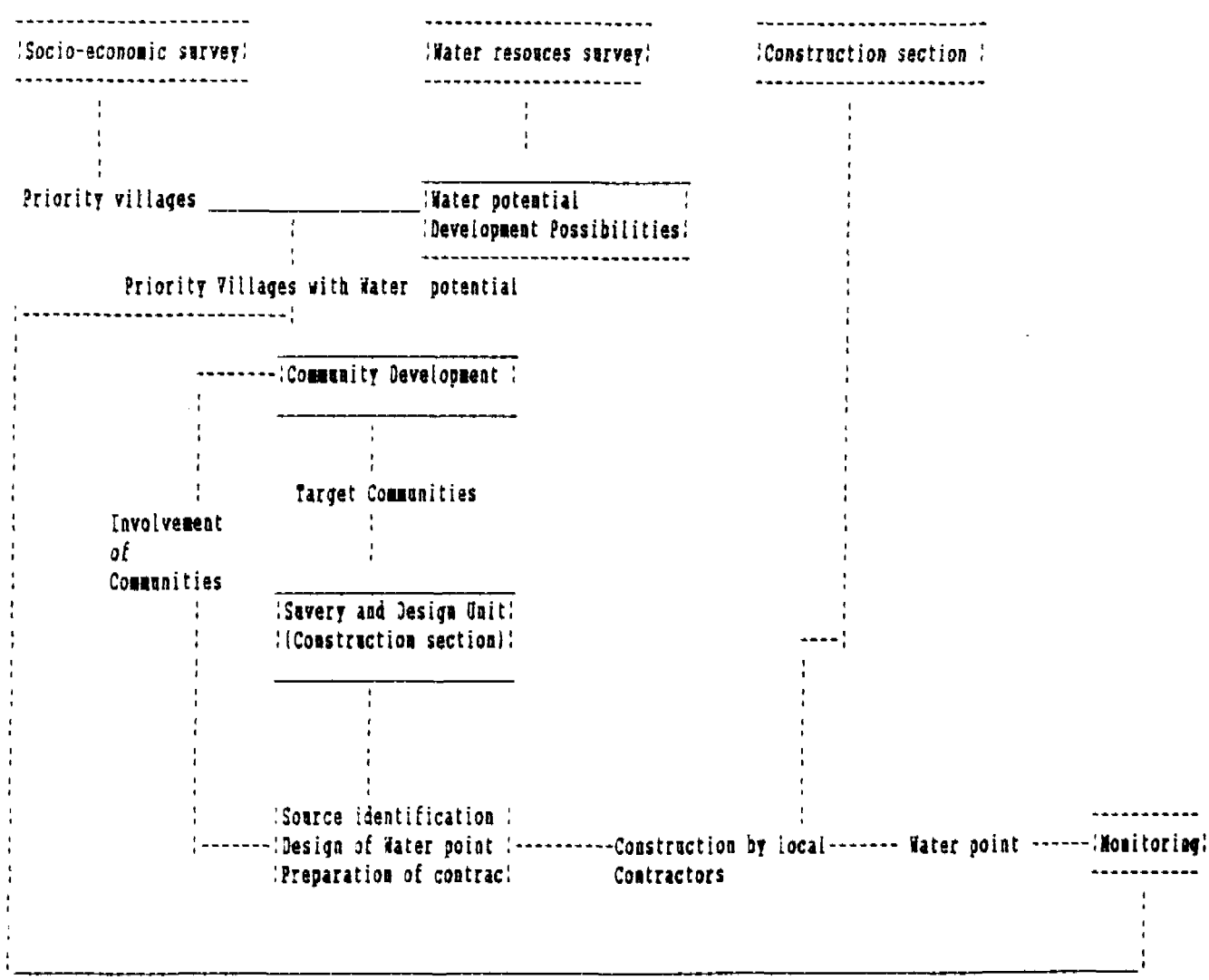
- A systematic and comprehensive water resources assessment to form the technical basis for the implementation programme;
- A socio-economic survey to form the basis for the selection of needy communities;
- A comprehensive community development programme to mobilize and educate communities towards being part and parcel of the implementation process;
- An institution building, training, and manpower development programme, to ensure availability of trained manpower for the operation and maintenance of the water points.
- The establishment of a production line in Kenya, which will manufacture hand pumps (and spare parts) and to develop a distribution network to ensure ready availability of these equipment.
- Monitoring of the functioning of the completed water points to identify areas that require improvement so that the life of the water points can be prolonged.

To carry out the above activities, the Programme adopted a two pronged approach: community development activities to mobilise and train recipient communities to become part and parcel of the implementation process and the technical services to take care of the construction aspects of the Programme.

The interelation of the various Programme activities towards the major target, the water point, is shown in Figures 2

Fig.2.

SIMPLIFIED FLOWSHEET OF ACTIVITIES FOR CONSTRUCTION OF WATER POINTS



As a result of these activities the Lake Basin Development Authority has to-date through the RDWSSP provided over 600 water points, based mainly on ground water resources. The water points are mainly wells, spring improvement and few roof catchments, serving about 200,000 people.

1. Water Resources Assessment and Socio-economic Surveys

Despite the efforts of numerous organizations during the last three decades, the rural water supply situation in Nyanza Province only marginally improved. This state of affairs can be partly ascribed to a lack of data and partly to lack of coherent information which resulted in inconsistent planning and inefficient approach to implementation. Being aware of this, the RDWSSP before embarking on its implementation activities, carried out comprehensive systematic surveys that covered each Division of the Province.

Basically, two different surveys were carried out:

- a Water Resources Assessment study
- a Socio-economic Survey.

Based on the results of the above studies, information on the occurrence, use, exploration and exploitation possibilities and the economic status of the communities were elicited.

In addition, a systematic approach to planning, survey and design of water points was adopted. Lastly, monitoring and evaluation of water yield, quality, technical performance, maintenance of water points, local management, and use of water was introduced to assess the sustainability by the rural communities.

The objective of the Water Resources Assessment was to gather information on the present use, occurrence, exploration and exploitation possibilities of the water resources of the Province. It consisted of two major activities:

- an inventory of all existing water supplies, in which all water sources used for domestic supply were traced, mapped and evaluated on their possibilities for improvement. All data were stored in a specially designed data base system.
- a systematic ground water survey based on remote sensing and geophysical methods (electromagnets and Resistivity).

Since 85% of Nyanza Province is underlain by hard rocks, the ground water survey focused on water bearing faults and fracture zones.

The water resources survey resulted in water supply plans for the 26 divisions and 4 districts of Nyanza Province.

The primary aim of the socio-economic survey was to identify target communities in need an improved water supply and evaluate the ability of the communities to support and maintain these new water supplies in the future.

In addition to this, Socio-economic indicators of the community such as education, employment opportunities, population and income levels were analyzed to give a detailed overall picture. The information was kept in a data base system and used for the formulation of water supply plans.

The results of the two studies, have been used to formulate rural domestic water supply plans at both divisional and District level. The plans aim at identifying possibility of providing a reliable supply of sufficient and good quality drinking water for the entire rural population of Nyanza Province.

The approach is to use ground water based point sources. The improvement of existing water points such as springs and wells is given first priority. The choice for point source water supply is based on the high potential of ground water in most parts of Nyanza Province. Piped water supply and the use of surface water resources is only considered where no opportunities exist for the use of ground water.

The following information is contained in the water supply plans:

- the number of springs and wells to be improved in each area;
- the number of new wells to be constructed;
- the number of piped water supply taps needed in areas with no ground water opportunities.

In addition, an indication is given of the rehabilitation and/or construction costs of the planned works.

The water supply plans have maps showing the location of all existing rural water supplies and the hydrogeology of the Divisions. An example of a plan is given in Annex 1.

This approach ensures that only water sources that are likely to be sustainable are selected for implementation.

2. **Water Point Monitoring**

Monitoring of water points was set up to help gather information on existing water points. The information gathered is used to know the operational condition and ultimate life time of water points. These include: monitoring and evaluation of yield, quality, technical performance, maintenance of water points, local management and general use of water.

The results give information needed for improving the water points so that sustainability of the water points can be assured.

3. **Water Point Management and Institution Building at the local level**

Long term sustainability of community water supplies can be assured only when the beneficiaries take full responsibility for the management of their newly acquired facilities. The recognition of the fact that rural development programmes cannot effectively succeed without full participation of the intended beneficiaries has received attention in a majority of water development programmes in recent years and the LBDA-RDWSSP is not an exception.

Sustainability of community based water supplies calls for the establishment of local systems which will take care of both operation and charging in order to continuously ensure availability of sufficient funds for maintenance.

Community Participation

For the achievement of long term sustainability, the programme has developed a link with the communities through their field extension workers based at grassroot level. The Programme field extension workers have been instrumental in helping to enhance continuous community involvement in planning, design and construction, while at the same time assisting them in the creation of strong and sustainable community institutions.

Before any construction work commences, the field staff creates awareness among the would be beneficiaries regarding their expected roles in the programme. This includes among others acceptance of the total responsibility for ownership of the water points.

Institution building at the local level

Institution building at the local level is given a two pronged approach:

(a) **Institution building at the beneficiary level**

In the first instance, the field workers carry out intensive community mobilization among the beneficiaries to form water committees for the general management of water points. One of the crucial roles of a water committee is to ensure that the beneficiary community raises sufficient funds towards the upkeep of the water point, and that a bank/postal savings account is opened up in the name of the water project for the safe custody of funds.

Additionally, the water committee has to appoint a water point attendant to ensure cleanliness and preventive maintenance of the facility.

Finally women water users are encouraged to start small scale income generating activities around water points, both to boost the maintenance funds and to improve their socio-economic status.

Having formed these institutions at the beneficiary level, the Programme then provides them with relevant intensive training and continuously monitors their performance with a view to improving their skills. Training at this level is given to four categories of community groups namely:

(i) The user community are educated on the usage and benefits accruing from the improved water and sanitation facilities;

(ii) Specialized training is given to water committee officials on:

- preventive maintenance;

- general leadership and management skills.

The detail of this training include record keeping, basic book keeping as well as communication skills.

(iii) Women water users are accorded the same type of training as in (ii) above addition to:

- Project selection

- Project planning and marketing skills.

(iv) Finally, pump caretakers are trained on:

- proper operation, preventive and simple curative maintenance of the hand pump.

b). **Local Manufacture of Pumps and Spare Parts**

An equally vital element for long-term sustainability is the availability of spare parts and technical know-how at the local level. Hence, the second approach to institution building is the creation of a network of well trained and experienced local enterpreneurs.

From the onset of implementation, the programme has used and encouraged the development of local workshops and fundis in all aspects of water point construction and maintenance.

A unique feature of the RDWSSP is the fact that all construction and maintenance works are carried out by private local contractors. The Programme strengthens these institutions by not only awarding them contracts but also loaning them equipment in addition to training their fundis on quality control handpump manufacture and modern construction technology.

A major achievement of the programme to this end has been the establishment of handpump and pump cylinder manufacture in the Project area.

From the foregoing discussion, it becomes crystal clear that utter community participation is a prerequisite for long term sustainability of rural water development Programmes, and this sustainability of rural water development programmes, and this is the path along which the LBDA-RDWSSP in Nyanza Province is trading.

5. **Data Base Management System**

During the initial years of the Programme, the set-up, progress and results of the various implementation activities were worked out, recorded and reported more or less separately thereby using different computer packages and programmes. Due to the increased complexity of the Programme and the large number of water points completed and planned for, the need arose to bring together these separately matured data systems into one, relatively simple to operate data base management system.

The "WADATA" program version 1.0 is a software package, developed for data management of all water point implementation related activities as carried out by the Programme.

WADATA was designed, programmed and tested during 1989. The program will be used from 1990 onward.

CONCLUSIONS

Conclusions and recommendations arising from experiences gained in the Programme are outlined below:

- It is the desire of every rural water and sanitation programme to achieve popular participation of the beneficiaries in the planning, implementation and sustenance of the improved facilities. However, a number of factors impose limits on the ability of the communities to participate effectively in water and sanitation Programme.

- The new rural water supply systems require new structural adjustments in community organization network. Due to cultural lag, the communities adaptive capacity to the required attitudinal and organizational changes is quite slow. This lengthens the community mobilization process. It was found, that the willingness of communities to pay for maintenance is closely related to their socio-economic status. Poor communities need a lot of community mobilization effort to participate effectively in water supply systems. lastly, lack of education and ignorance poses the great difficulty.

- The main physical constraint comes when the water point is of low quality and quantity. This act as a hindrance to popular participation and people's adoption of health education messages.

The major achievement from the above activities is difficult to assess. However, monitoring and evaluation of LBDA-RDWSSP will come out soon with the impact. The only assessment so far, is the returns of the repairs of the pump breakdowns. From these breakdown, records and invoices to communities for repairs and spares, there is evidence to suggest that the communities are responding positively to the maintenance system (See 2a & b.).

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Volume	V	Rongo	Division	1985
Volume	VI	Macalder	Division	1985
Volume	VII	Migori	Division	1985
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ANNEX 1

Water Supply Plan

A INTRODUCTION

This report gives information about the occurrence, use, exploration techniques, water potential and exploitation possibilities of the water resources in Siaya District.
It presents a plan for improvement of rural water supply in the District (Water Supply Plan) as well as recommendations for implementation of this plan.

The report is mainly based on the results of the systematic and detailed water resources assessment studies carried out in the District during 1987 and 1988 as a part of the Lake Basin Development Authority's Rural Domestic Water Supply and Sanitation Programme (RDWSSP), which have subsequently been published in five comprehensive Divisional Reports.

The primary aim of the RDWSSP is to improve the water supply situation in the rural areas of Nyanza Province.

Siaya District is an area with tremendous contrasts in water resources. The western and southern parts are very dry areas with almost no perennial water points, while the northern and eastern parts have abundant surface and ground water resources.

The Water Supply Plan for Siaya District is based on point sources water supply. Only in the western and southern parts of the District piped systems are planned. Piped water supply systems are needed in these areas because of the complete absence of suitable ground water sources. Preconditions for piped water supply are a decentralised operation and maintenance set up, including full responsibility and power for the piped water supply staff, and supply of water at a cost-effective basis.

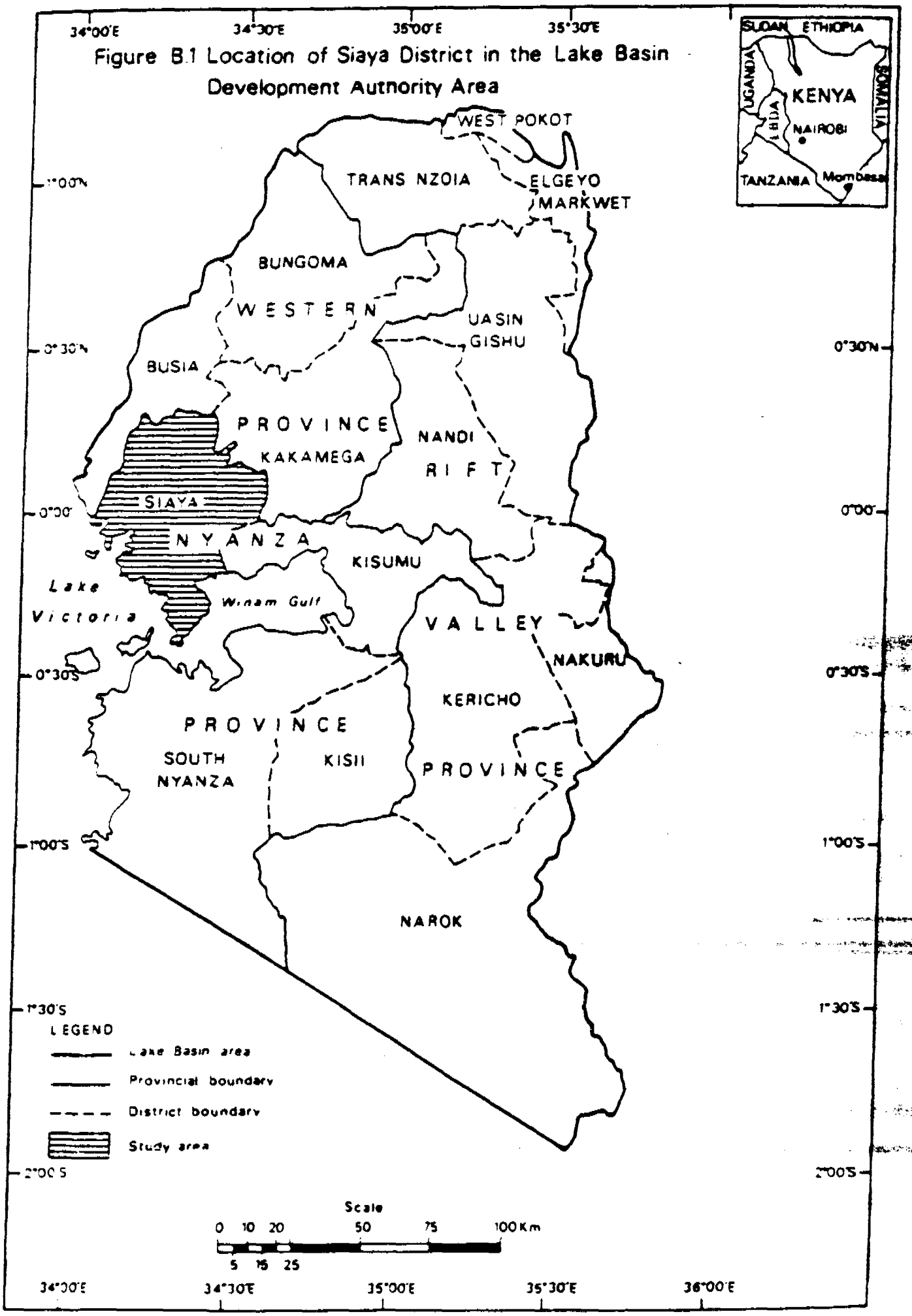


Figure B.1 Location of Siaya District in the Lake Basin Development Authority Area

B GENERAL FEATURES OF SIAYA DISTRICT

Siaya District forms the northern part of Nyanza Province, located in the southwest corner of Kenya. It is bordered by Busia District to the west and north, by Kakamega District to the northeast, Kisumu District to the east and Lake Victoria to the south.

The area is roughly situated between latitudes 00° 25' South and 00° 18' North (UTM-grid: 9955-0035) and longitudes 34° 00' East and 34° 35' East (UTM-grid: 0610-0675).
The total surface area is about 2,500 (km^2), which is 20 % of the total land surface of Nyanza Province (12,500 km^2).

Siaya District is characterized by a smooth gently undulating landscape with altitudes ranging from 1140 (m) along the Lake Victoria shores to about 1500 (m) in the north and northeastern part of the District.

Climatological conditions vary dramatically from the south with a mean annual rainfall of less than 700 (mm) towards the north where the mean annual rainfall exceeds locally 2000 (mm). Evaporation which is very intense in the southern part, over 2000 (mm/year), steadily decreases towards the northeast of the area (1600-1800 (mm/year).

The present total population amounts to about 690,000 resulting in an average population density of around 276 people per (km^2).

Distribution of population per Division and population projections for 1995 and 2005 are given in Table B-1.

TABLE B-1. SUMMARY OF DISTRICT POPULATION PROJECTIONS.

DIVISION NAME	POPULATION		
	1987	1995	2005
BONDO	109,000	138,000	186,000
RARIEDA	109,000	138,000	186,000
BORO	157,000	199,000	267,000
YALA	139,000	176,000	237,000
UKWALA	176,000	223,000	300,000
SIAYA DISTRICT	690,000	874,000	1,176,000

Remarks; 3 % growth rate is assumed based on "Integrated Regional Development Master Plan" JICA, 1987

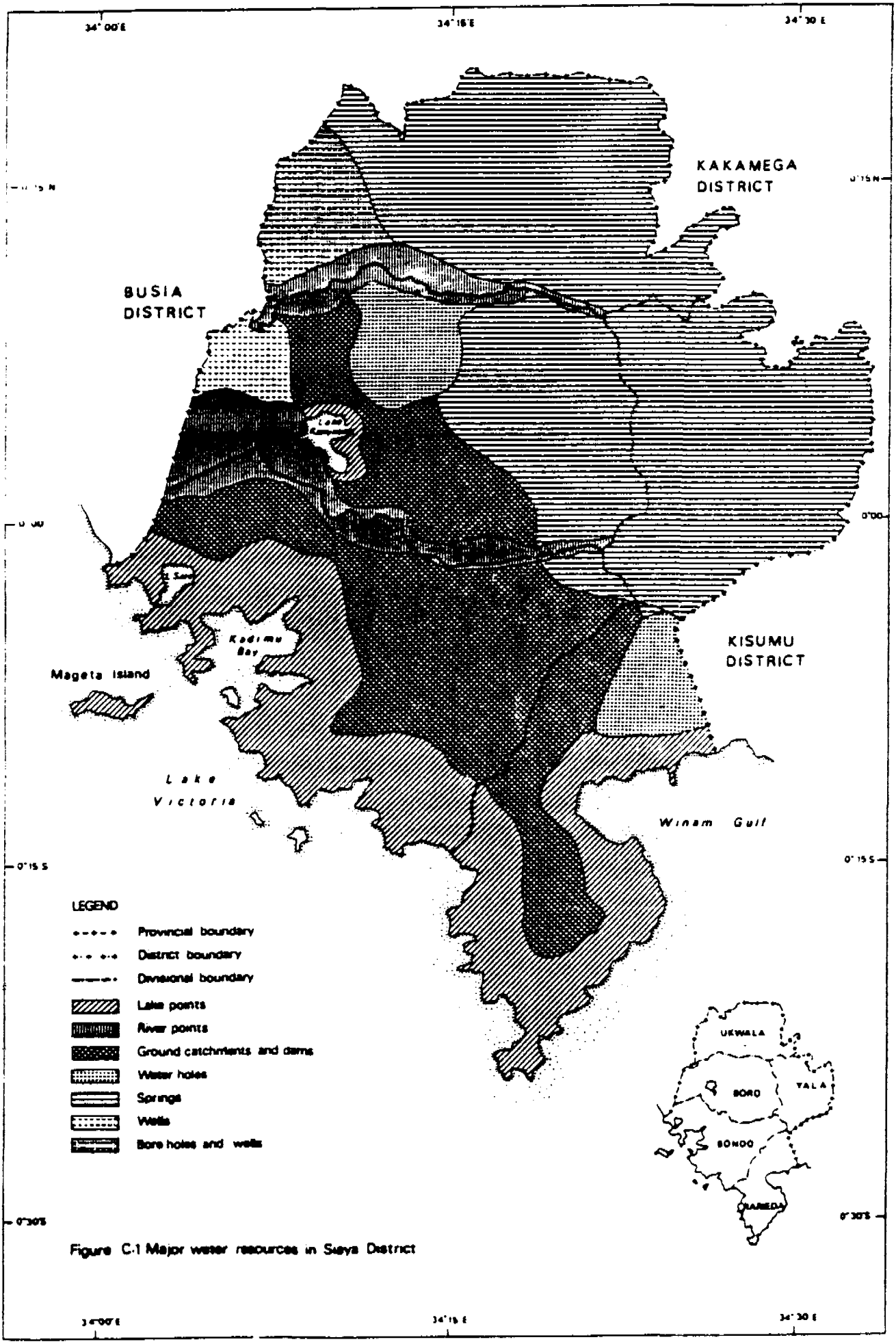


Figure C.1 Major water resources in Siaya District

C EXISTING WATER SUPPLY SITUATION

C-1 *Introduction*

As part of the RDWSSP a comprehensive inventory survey has been carried out, with the aim to assess and evaluate the use and condition of all water sources in the District.

It was found that in total 4,308 different water points are used for domestic water supply, including : springs, river points, lake points, water holes, wells, boreholes, roof catchments, ground catchments and dams. In addition to these point sources, 38 piped water supplies are used on a limited scale.

A summary of existing water sources used for domestic purposes in the District is given in Table C-1.

TABLE C-1. SUMMARY OF EXISTING WATER SOURCES IN SIAYA DISTRICT, USED DURING THE WET AND DRY SEASON.

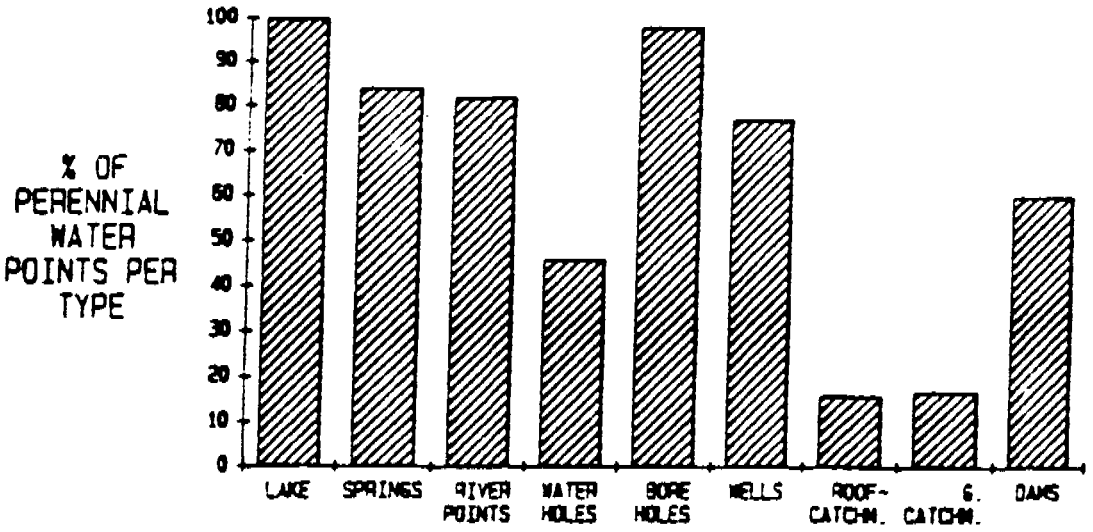
	WET SEASON		DRY SEASON	
TYPE OF WATER SOURCE	NR. OF SOURCES	% OF CONSUMERS	NR. OF SOURCES	% OF CONSUMERS
SPRINGS	1.601	33.8	1,346	33.7
WELLS	492	7.7	379	7.8
BOREHOLES	112	3.6	110	3.7
ROOF CATCHMENTS	525	2.2	82	0.3
RIVERS	622	13.3	507	15.6
LAKE VICTORIA	112	5.8	112	14.5
WATER HOLES	259	5.9	118	4.1
DAMS	109	7.4	65	9.1
GROUND CATCHMENTS	476	16.1	82	6.4
PIPED SUPPLIES		4.2		4.8
TOTAL	4,308	100.0	2,801	100.0

C-2 *Point sources*

The rural population of Siaya District mainly use point sources for their domestic water supply.
On an average about 2 water points per (km^2) exist, but tremendous differences in water point density occurs within the District. The southern part (Bondo and Rarieda Divisions) have less than 1 water point per 2-5 (km^2), while the north, north-eastern part has a water point density of more than 3 per (km^2). Springs are the most widespread type of water point, but occur

The quality of the water collected from most of the point source is very poor. With the exception of boreholes, springs and well (only if they are properly improved or constructed) all existin water points are polluted.
Many springs which essentially supply good water are contaminate due to lack of a proper drainage of the water. Wells without cover, lining and hand pump were all found to be contaminated.

FIG. C 2 PERCENTAGES OF PERENNIAL WATER POINTS PER TYPE



C-3 *Piped water supply systems*

There are 38 piped water supply systems in Siaya District (Fi C-5), of which:

- 21 systems regularly supply water;
- 7 systems are irregularly functioning;
- 7 systems are out of order
- 3 systems are under construction.

Out of the 21 systems which are regularly supplying water, the are 7 from which part of the distribution system is operationa As a result only 14 schemes are effectively used.
In total only a small part of the rural population is present served by the piped water supply systems (4.5 %).

FIG C 3 WATER POINTS USED FOR DRINKING AND WATER POINTS WHICH ARE NOT USED FOR DRINKING

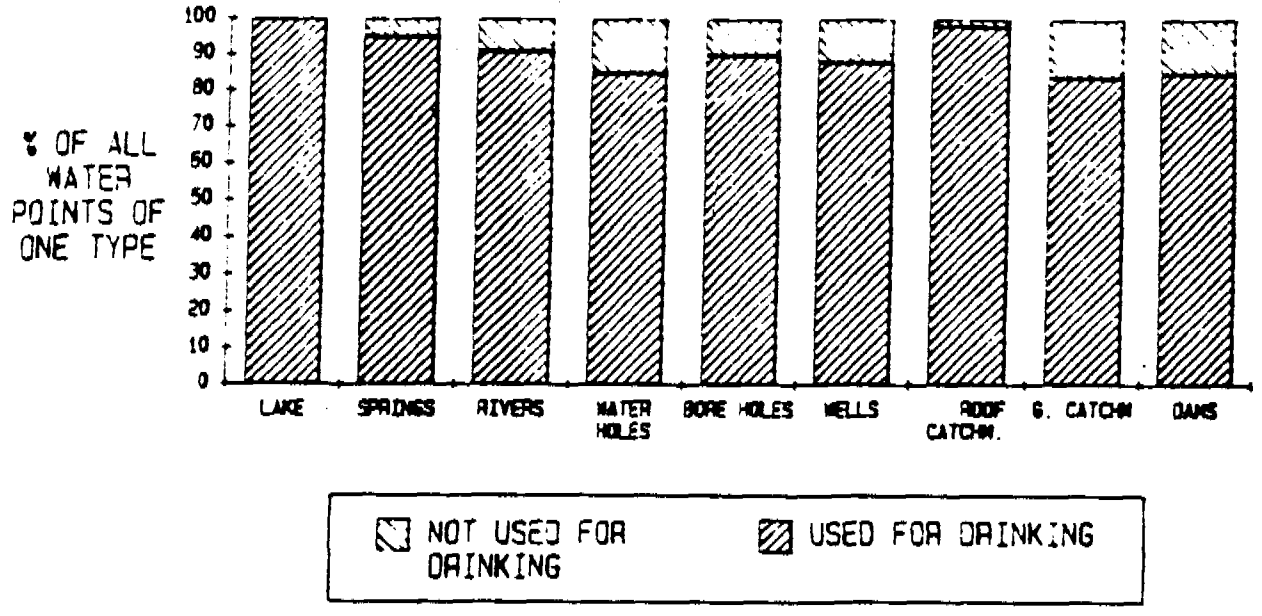
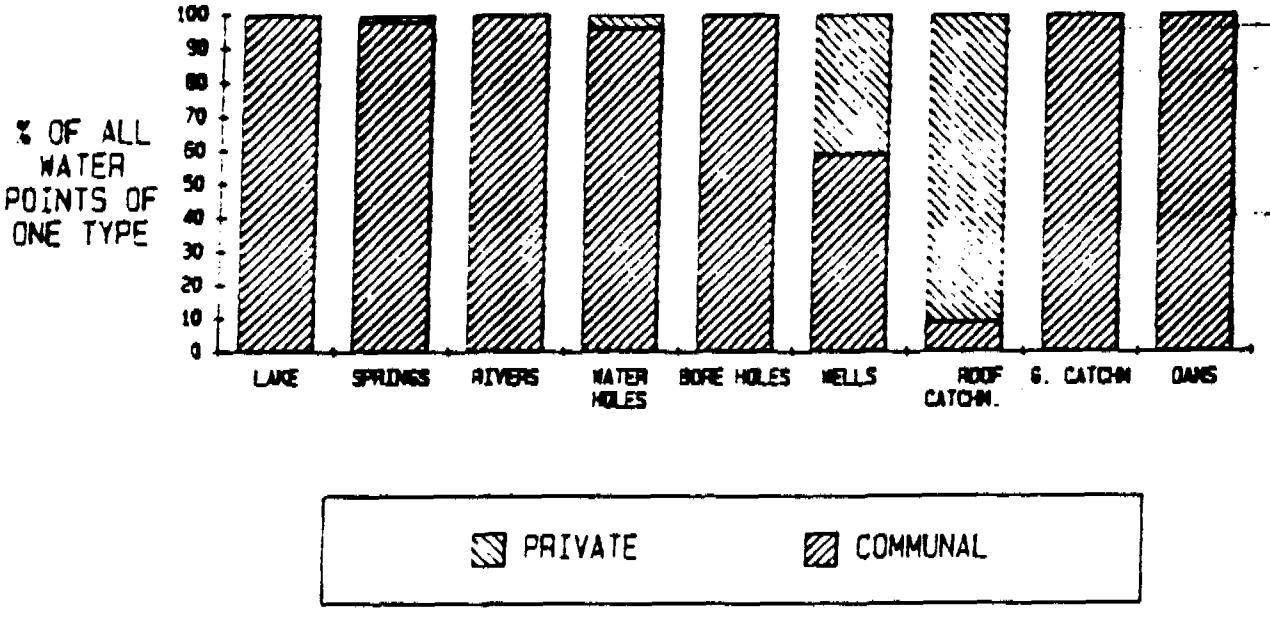


FIG. C.4 PRIVATE AND PUBLIC USE OF WATER POINTS



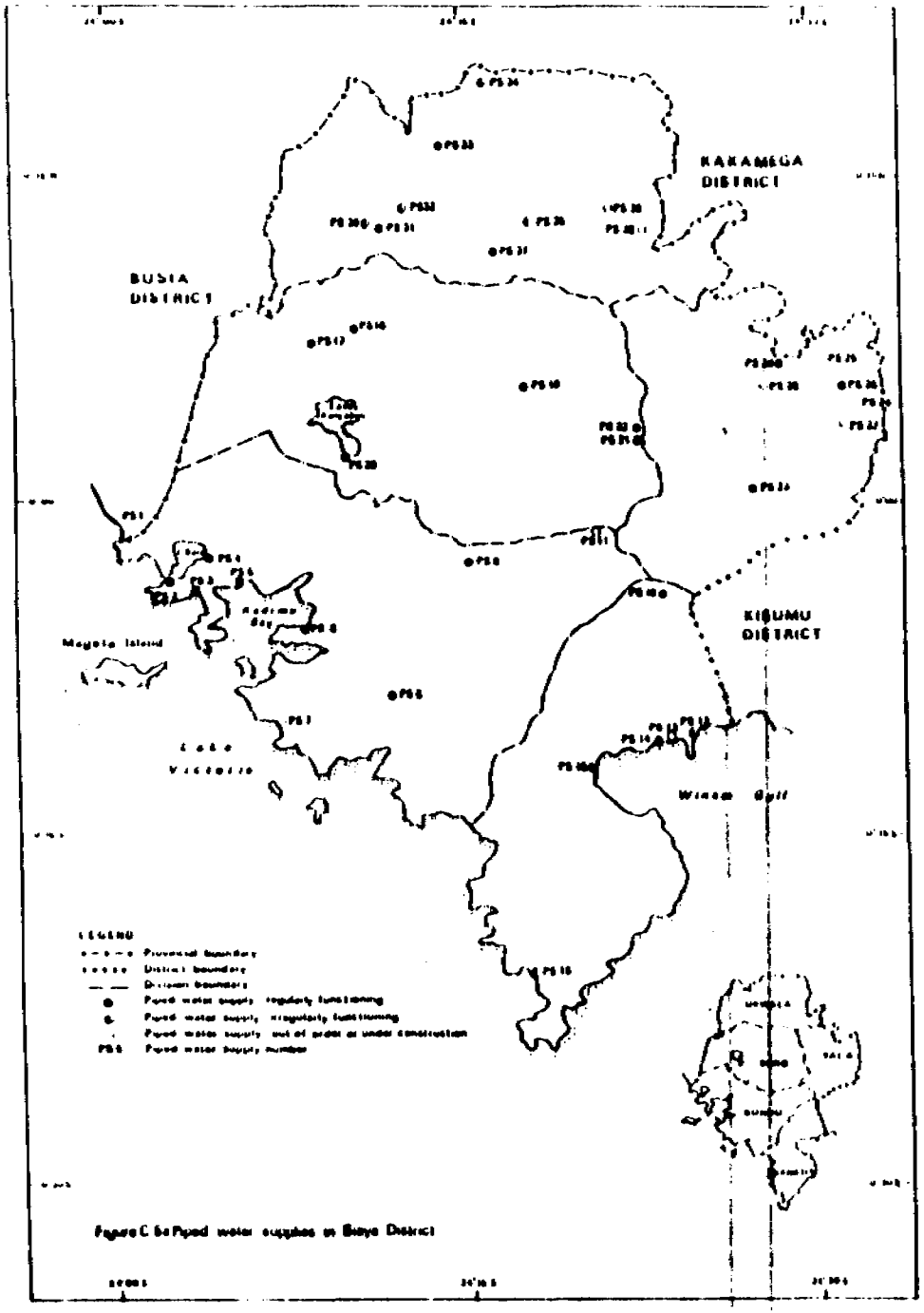


Figure C 6a Piped water supplies in Siaya District

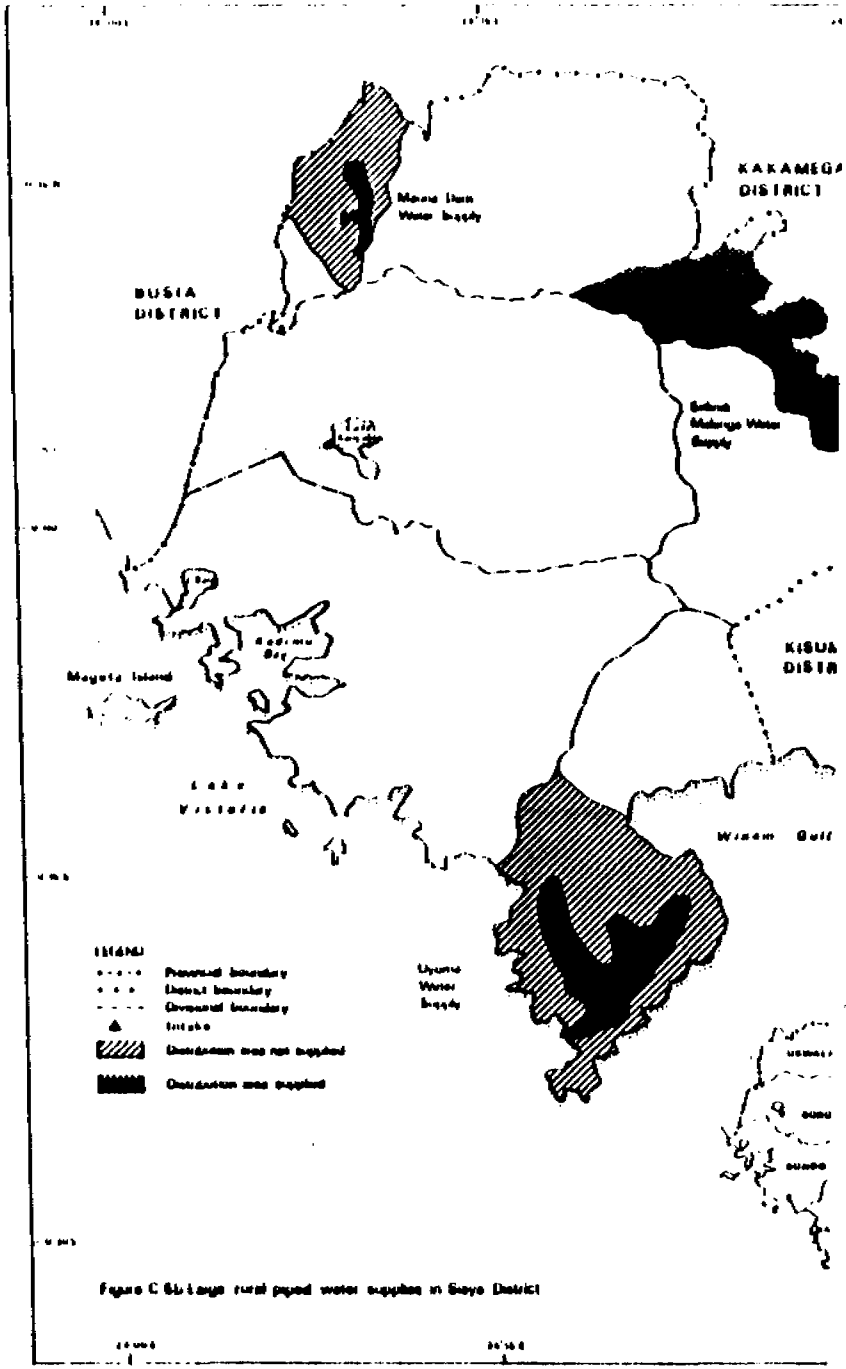


Figure C 6b Siaya rural piped water supplies in Siaya District

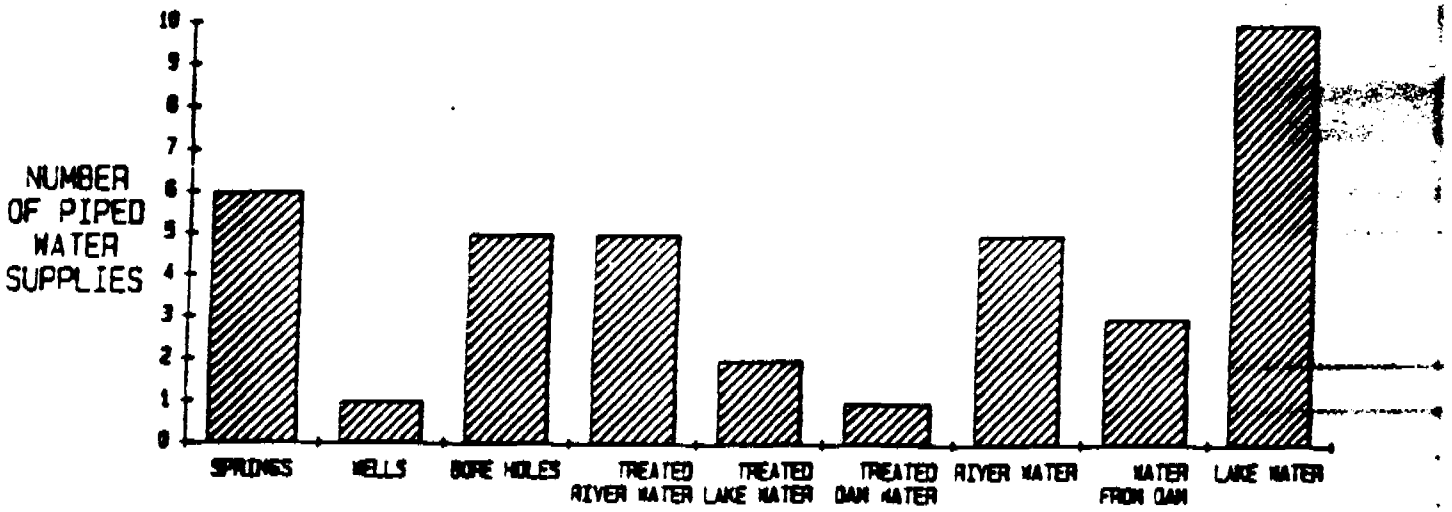
The major sources used for the piped water supply systems are as follows (Fig. C-6):

- 12 schemes use Lake Victoria
- 9 schemes use river water
- 6 schemes use springs
- 5 schemes use dams
- 5 schemes use boreholes
- 1 scheme uses a well.

Most piped water supply systems use diesel driven pumps (33 schemes), while the remaining 5 schemes use electrical driven pumps.

From the 5 schemes with electrical driven pumps, one is out of order, but the remaining 4 regularly supply water.

FIG. C.6 WATER SOURCES OF PIPED WATER SUPPLY: A BREAKDOWN PER NUMBER



Non or irregularly functioning of the piped water supplies mainly occurs on the schemes with diesel driven pumps.
The main reasons for non or irregularly functioning is caused by:

- lack of diesel supply
- removal of (parts of) the diesel engines
- pump breakdowns.

There are 3 large piped water supply systems in Siaya District.

- Uyoma Water Supply
- Mauna Dam Water Supply
- Sidindi-Malanga Water Supply

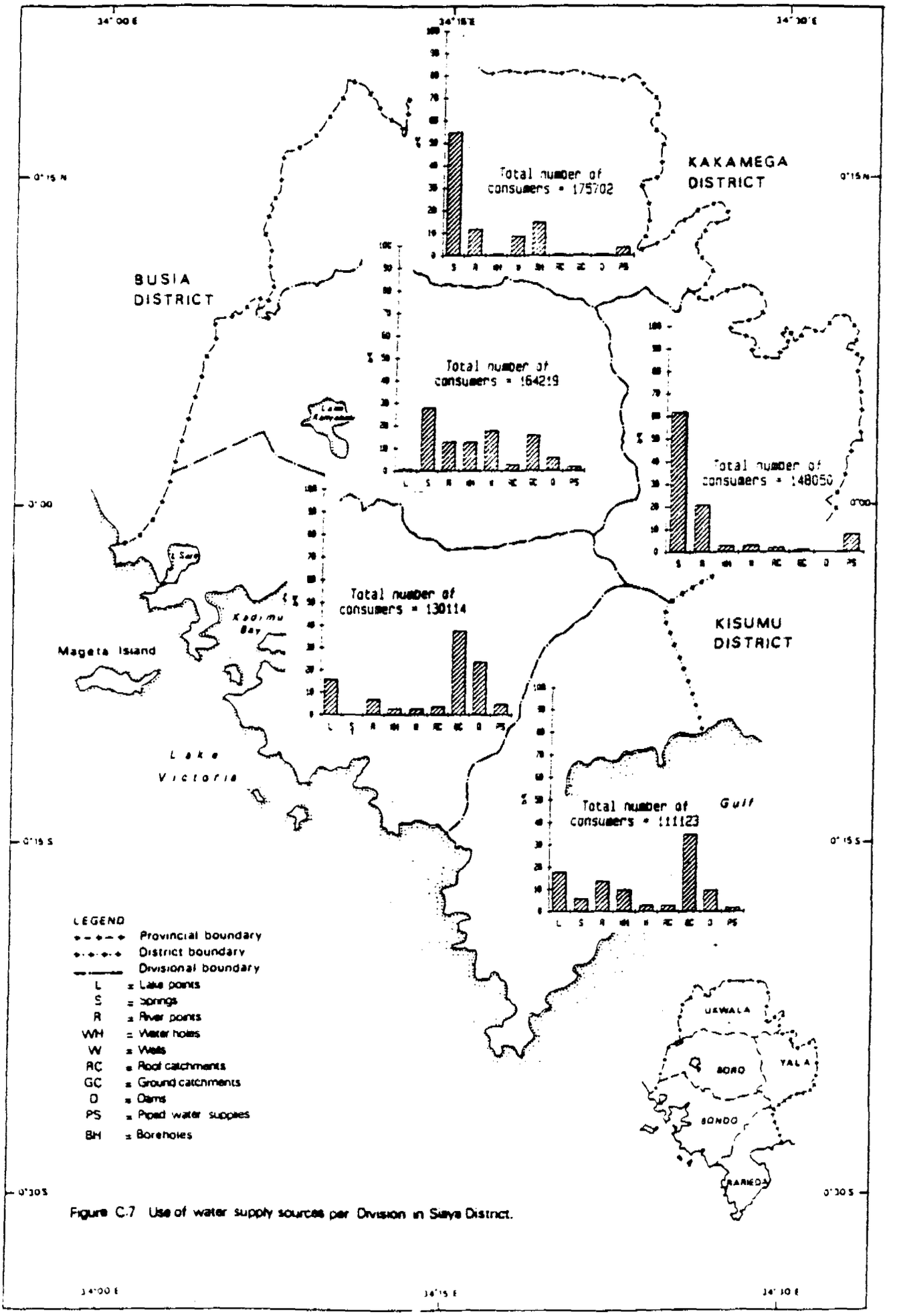


Figure C.7 Use of water supply sources per Division in Siaya District.

C-4 *Use of different water supply resources*

As shown in Table C-1, a large variety of different water points are used in Siaya District. However, the type of water point used by the rural population differs substantially from place to place.
In the southern part, in a wide zone along the Lake Victoria shore, people fetch their water mainly from Lake collection points, while further inland most commonly used water points are dams, ground catchments and water holes.
In the northern and eastern part of the District the most frequently used water points are springs and wells (Fig. C-7).
Water collected from the Lake, springs and roof catchments is almost everywhere used for drinking, but water from dams, ground catchments and water holes are only for less than 80 % used for drinking (Fig. C-3).
Striking is the relatively high percentage (10-12 %) of boreholes and wells not used for drinking, because of a bitter taste of the water (probably caused by a high manganese and/or iron concentration).

A large percentage of wells (40 %) and roof catchments (90 %) are private facilities (Fig. C-4).
Springs, dams, rivers, boreholes and ground catchments are almost exclusively considered as communal water supply facilities.

D GROUND WATER RESOURCES

Siaya District is for 90 % underlain by hard rocks of mainly volcanic and volcano sedimentary origin. The rocks are intensively jointed, fractured and faulted and covered with a layer of weathered rock material. The remaining 10 % of the District is covered with Recent alluvial sedimentary deposits.

Consequently ground water can be present in

- the weathered layer
- fault and fracture zones
- sedimentary deposits

D-1 *Ground water within the weathered layer*

The relatively high amount of annual rainfall in the north and northeastern parts of the District causes a reliable and steady recharge into the weathered layer. The ground water level varies between 5 - 15 (m-gl), which makes the ground water easily accessible through hand dug wells.
In the southern part however, little or no ground water is found within the weathered layer due to a very low recharge in this part of the District.

Because of the rather clayey weathering of the volcanic rocks, the well yields generally are low, but are sufficient for hand pump use (1-2 m^3/hr).
The weathered material of the Kavirondian rock types generally produce slightly higher well yields (2-5 m^3/hr).

D-2 *Ground water in fault and fracture aquifers*

From the results of the ground water survey and the on-going borehole drilling programme in Nyanza Province it appears that relatively high yield wells (10-50 M^3/hr.) can be constructed in major fault zones while the surrounding areas have only a moderate or no ground water potential at all.

Well construction in this type of aquifer can only be done through machine drilling of boreholes. For successful borehole location in this aquifer type special exploration techniques are warranted.
The Programme has developed a combination of survey techniques based on remote sensing, aerial photograph interpretation and ground geophysical survey.

D-3 *Ground water in sedimentary deposits*

About 10 % of Siaya District is covered by sediments, mainly Pleistocene to Recent in age, and consisting of lacustrine and fluviatile deposits. Relatively thick deposits of sediments are found near the mouth of the Yala and Nzoia Rivers (Yala Swamp area).
Ground water generally is present in the coarse layers at a relatively shallow depth (5-8 m-gl).

Ground water presence and quality in these sedimentary deposits are explored by means of the drilling of hand auger survey holes.

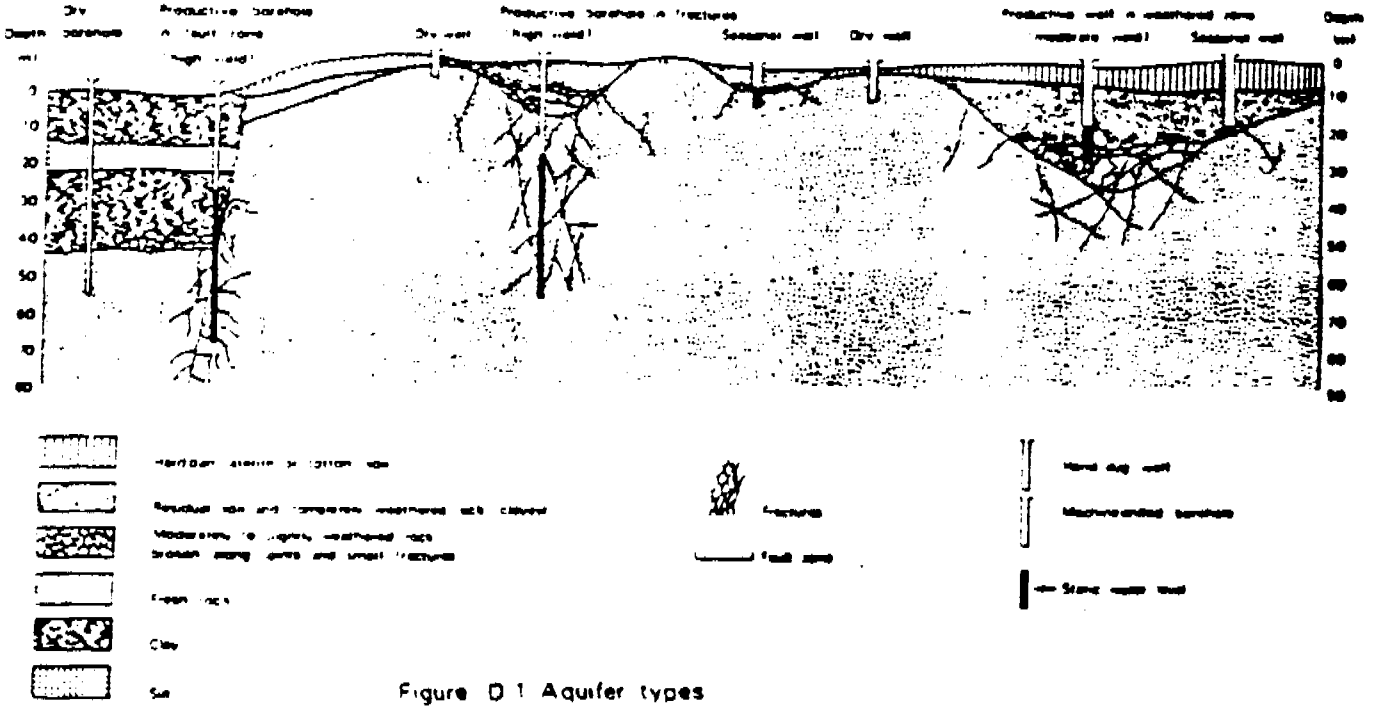


Figure D 1 Aquifer types

D-4 *Ground water potential*

Based on rainfall, runoff and evaporation data the amount of recharge per catchment area was estimated (Table D-1). In total a fair amount of recharge takes place in Siaya District of about 110 x 10^6 (m^3/year). Comparing this total amount with the demand of the total population of Siaya District, on an average 436 (litres/capita/day) is presently available.
However, ground water recharge takes place mainly in the northern and northeastern part of the District, while hardly any recharge takes place in the southern part of the area.
Hence based on ground water potential in Siaya District 3 zones have been distinguished (Fig. D-2).

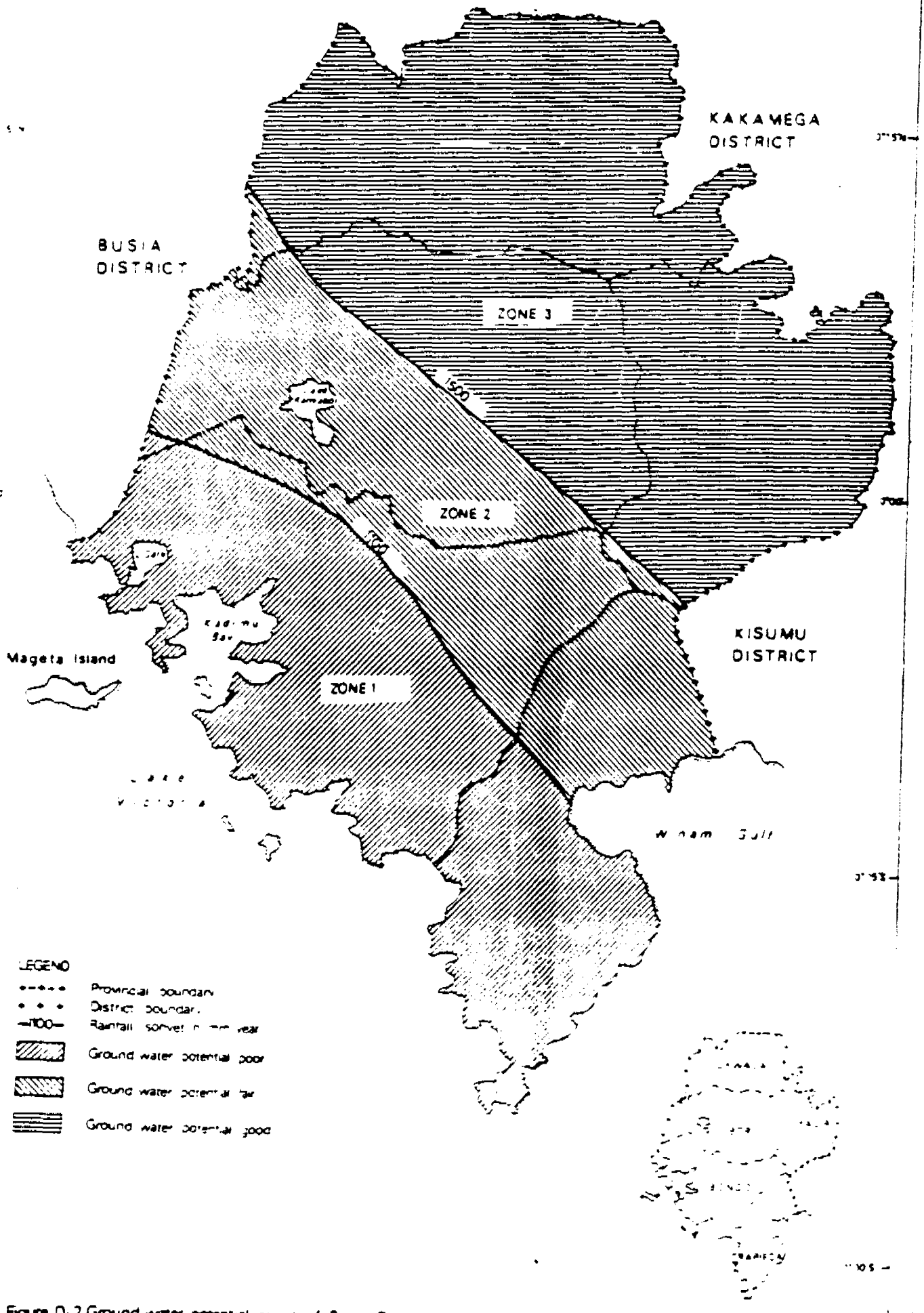


Figure 0·2 Ground water potential zones of Siaya District

- Zone 1, with a low ground water potential covering the southern part of Siaya District.

- Zone 2, with a intermediate ground water potential, covering the central area of the District.

- Zone 3, with a good ground water potential located in the north and northeast part of the District.

TABLE D-1 GROUND WATER POTENTIAL PER CATCHMENT

CATCHMENT NAME	CATCHMENT CODE	SURFACE AREA IN (KM^2)	TOTAL VOL. GROUND WATER 10^6 (M^3/YEAR)
LAKE VICTORIA E.	1HB	177	4.9
LAKE VICTORIA W.	1HC	615	1.8
YALA	1FG	887	45.2
NZOIA	1EE	233	24.5
SIYOGA	1EF	238	10.5
WUOROYA	1EG	337	23.3
SIAYA DISTRICT		2487	110.2

D-5 *Ground water quality*

Water analyses carried out on a large number of ground water samples showed that the physical and chemical quality of the water is generally good and can be used without any treatment in most parts of the District. Occasionally the ground water may contain high concentrations of iron and/or manganese which gives a bitter taste to the water, and may cause stains on laundry. In large areas along the Lake Victoria shore and in and around Yala Swamp area saline ground water is found (Fig. D-2. Locally ground water was found to be contaminated (faecal coliforms) which is caused by surface pollution near the collection point, or due to the absence (or bad condition) of a spring or well cover. The ground water originating from properly protected water points however can safely be used.

E SURFACE WATER RESOURCES

A surface water survey was implemented with the aim to investigate the opportunities for piped water supply in Siaya District.

Main conclusions of the surface water survey are:

- Lake Victoria can be used for piped water supply.
  Severe contamination or pollution of the water has not been found.
  The chemical constituents of the water are within Kenyan Standards for domestic water supply. The iron and manganese concentrations which are incidentally found to be too high can be reduced by sedimentation and filtration. It is advised to build raw water storage basins to bridge periods in which an intake of water is impossible due to for instance algae blooms.
  The colour and turbidity figures are rather low and do not fluctuate much. Pre-treatment of the water can be rather simple if a proper intake site is selected. The need for coagulation should be investigated on the spot. Chlorination of the water is always needed.

- Lake Kanyaboli is not suitable for piped water supply.
  The lake water is getting brackish because there is no replenishment of the water via River Yala and a large evaporation surplus.
  Desalination of the water is not feasible. Ground catchments , dams and water holes will continue to be used because their water tastes better

- Most rivers in Bondo, Rarieda and Boro Divisions are seasonal and therefore unsuited, for piped water supply.

- The minimum flows of most perennial rivers in Yala and Ukwala enables to use them for small scale piped water supplies (<10,000 consumers).

- River Wuoroya could be used as a source for a medium scale piped water supply (up to 30,000 consumers).

- River Yala is suitable for piped water supply. No severe pollution has been found. Using the river water requires a full treatment, including coagulation, filtration and chlorination.

- River Nzoia is unsuitable for piped water supply.
  The river is severely polluted, causing low oxygen levels. The risk of anaerobic conditions causing harmful reductions of nitrate and sulphate is manifest.
  Cadmium and phenol concentrations were found to be too high. A long time sustainable treatment of the water to reduce these substances is not feasible.

F ON-GOING CONSTRUCTION OF POINT SOURCES

Upto the present only a limited number of point water supplies have been constructed in Siaya District. Besides the RDWSSP (with an expected total of 90 water points completed by the end of 1988), several governmental and non-governmental organizations have been active in the implementation of water points in the District.
Most of the activities are concentrated on the construction of hand dug wells, but on a limited scale spring protections, boreholes and rain catchment systems have been constructed as well.
In total 527 improved water points have been made till so far in Siaya District by the following organizations:

- KEFINCO (289)
- MINISTRY OF HEALTH (119)
- FGCSP/IFAD (32)
- RURAL DEVELOPMENT FUND (35)
- CARE (7)
- DIOCESE OF MASENO WEST (5)
- RDWSSP (45)

According to the planning of the above mentioned organizations it is expected that not more than 150-200 water points will be constructed in Siaya District during (1989).

WATER SUPPLY PLAN

G WATER SUPPLY PLAN

G-1 *The RDWSSP policy to improve rural water supply in Siaya District*

The RDWSSP favours to improve rural water supply in Siaya District in 2 phases.
The first phase aims at reaching a water supply level , indicated as Level I , on which the entire rural population of Siaya District has ***access to good quality drinking water.*** The amount of water available has to be sufficient for safe drinking and cooking.
The second phase aims at reaching a water supply level II.
Level II is defined as: the entire rural population of Siaya District is supplied with ***sufficient and good quality drinking water,*** enough to use the water at home for all domestic purposes including washing and bathing.

Level I implies, the presence of a dense network of safe and reliable communal water points.
Level II can only be achieved by constructing piped water supplies with private house or yard taps.

The present Water Supply Plan for Siaya District describes what is needed to achieve Level I. Developments aimed at reaching Level II are supported if the conditions for a long time sustainable piped water supply system are fulfilled.

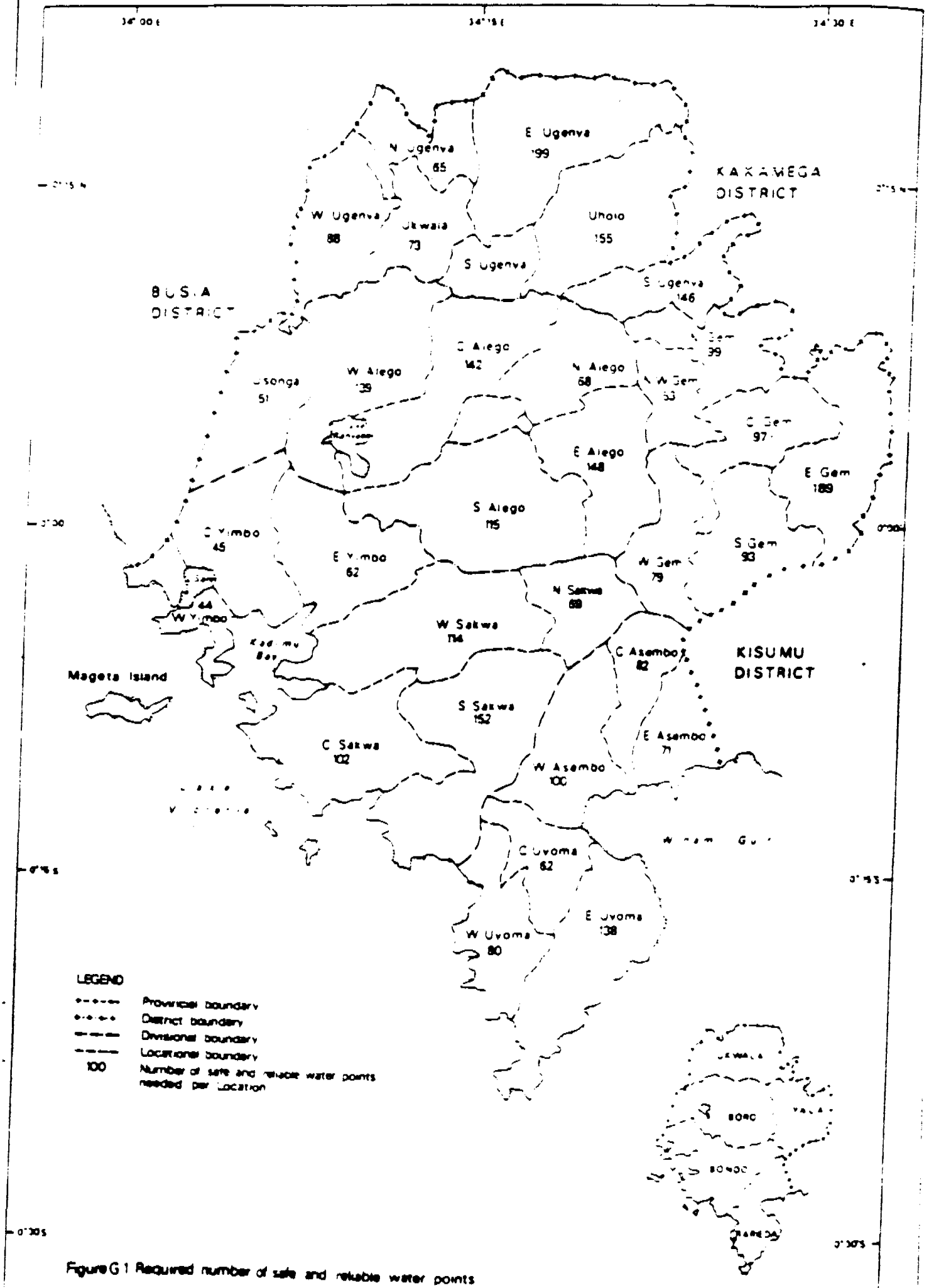


Figure G 1 Required number of safe and reliable water points

G-2 *Targets*

A dense network of safe and reliable communal water points is needed to give everybody access to good quality drinking water. The target set by the RDWSSP is to have an improved communal water point within 500 (m) from each home.

Assuming that each improved water point will cover a circular area with a radius of 500 (m), the required number of improved water points is calculated using formula (G-1).

$$N = \frac{A_i}{0.785} \qquad (G-1)$$

N = Required number of safe and reliable water points.

A_i = Inhabited area (km^2).

Most of the water points needed in Siaya District are hand dug wells.
The water supply capacity of such a well is limited. Most of the hand dug wells can supply up to 250 consumers.
This figure of 250 consumers per water point, is therefore used as a maximum.

$$N > = \frac{P_s}{250} \qquad (G-2)$$

P_s = Actual population having no private good water points.

Fig. G.1. shows how many safe and reliable public water points are needed in each Location of Siaya District using both formulas (G.1) and (G.2). The total number of water points needed equals to 3,120.

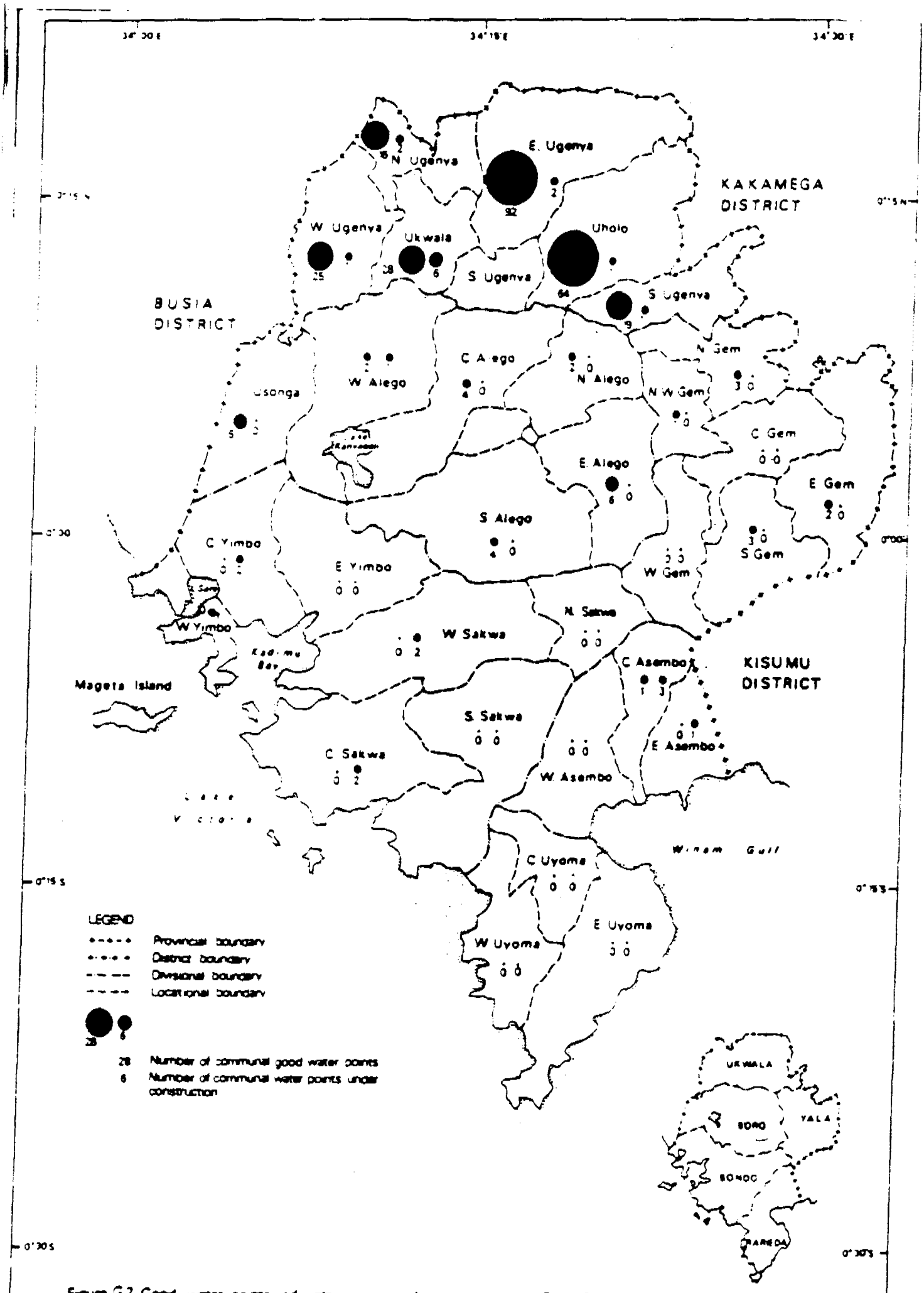


Figure G.2 Good water points and water points under construction in Siaya District

G.3. *Water supply plan*

Good water points and water points under construction

The first step in preparing the Water Supply Plan was to identify which existing communal water points are already safe and reliable.
During the inventory survey , part of the water points were found to be "good". A good water point fulfills the following requirements:

- It is used for drinking
- It's general condition is "good".
- It does not dry up.
- It is not contaminated.
- It has a slab (wells and boreholes) which is in a good condition as well as a working hand pump.
- It has a cover (springs) which is in a good condition, a proper drainage and no possibility of upstream pollution.
- It has gutters and a storage tank (roof catchments) which are in a good condition.

A total number of 333 good water points were found. Out of these 333 good water points, 259 are used as communal water points, do not need improvement and have been included in the water supply plan.

During the inventory survey also a number of wells, and roof catchments were found to be under construction. Part of these water points will be used as communal facilities. With due support e.g. technical advice, delivery of pump equipment, etc. these water points will be safe and reliable in future.
Twenty five (25) communal water points were found to be under construction. The communal water points under construction have also been included in the Water Supply Plan
Fig. G.2 shows the numbers of good water points and water points under construction per Location.

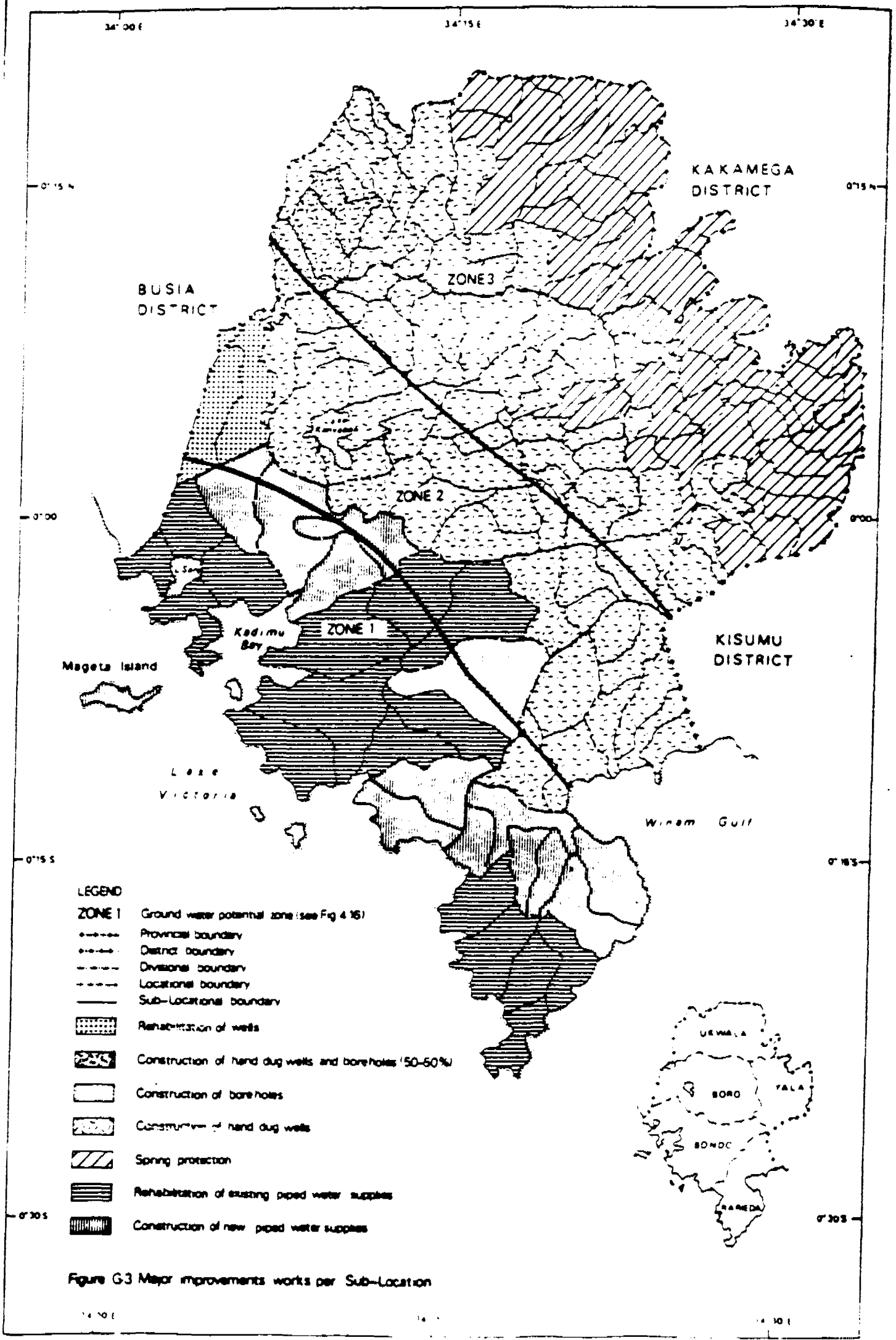


Figure G3 Major improvements works per Sub-Location

Improvement of existing water points; major improvement works per zone

Siaya District has been subdivided into 3 different zones.
The area south of the 1100 (mm) mean annual rainfall isohyet (Bondo, Rarieda and part of Boro Division) is indicated as zone 1. Zone 1 has a poor ground water potential. Springs and wells are hardly found in this zone 1. People use ground catchments and dams or walk to Lake Victoria.
The area between the 1100 (mm) and 1500 (mm) isohyets, indicated as zone 2, has a fair ground water potential. Many people living in zone 2 use ground catchments and dams. Wells and water holes however are also frequently found.
The area north of the 1500 (mm) isohyet, zone 3, has good opportunities for using ground water. Most frequently used water sources are wells and in particular springs.

Based on this subdivision into ground water potential zones as well as the results of the inventory survey describing the existing water supply resources, the major improvement works for each zone are different. Fig. G.3 shows this in detail.

In Bondo and Rarieda Divisions, existing piped water supplies have to be improved. New piped water supplies are needed at Mageta Island, in the northwestern part of Bondo Division and in the central part of Rarieda Division.
Rehabilitation of existing wells will be the major activity in the western part of Boro Division (Usonga Location).
The rest of zone 2 and a large part of zone 3 will be covered by making hand dug wells.
Spring protection will be the most important activity in the eastern part of zone 3 (Ukwala and Yala Divisions).

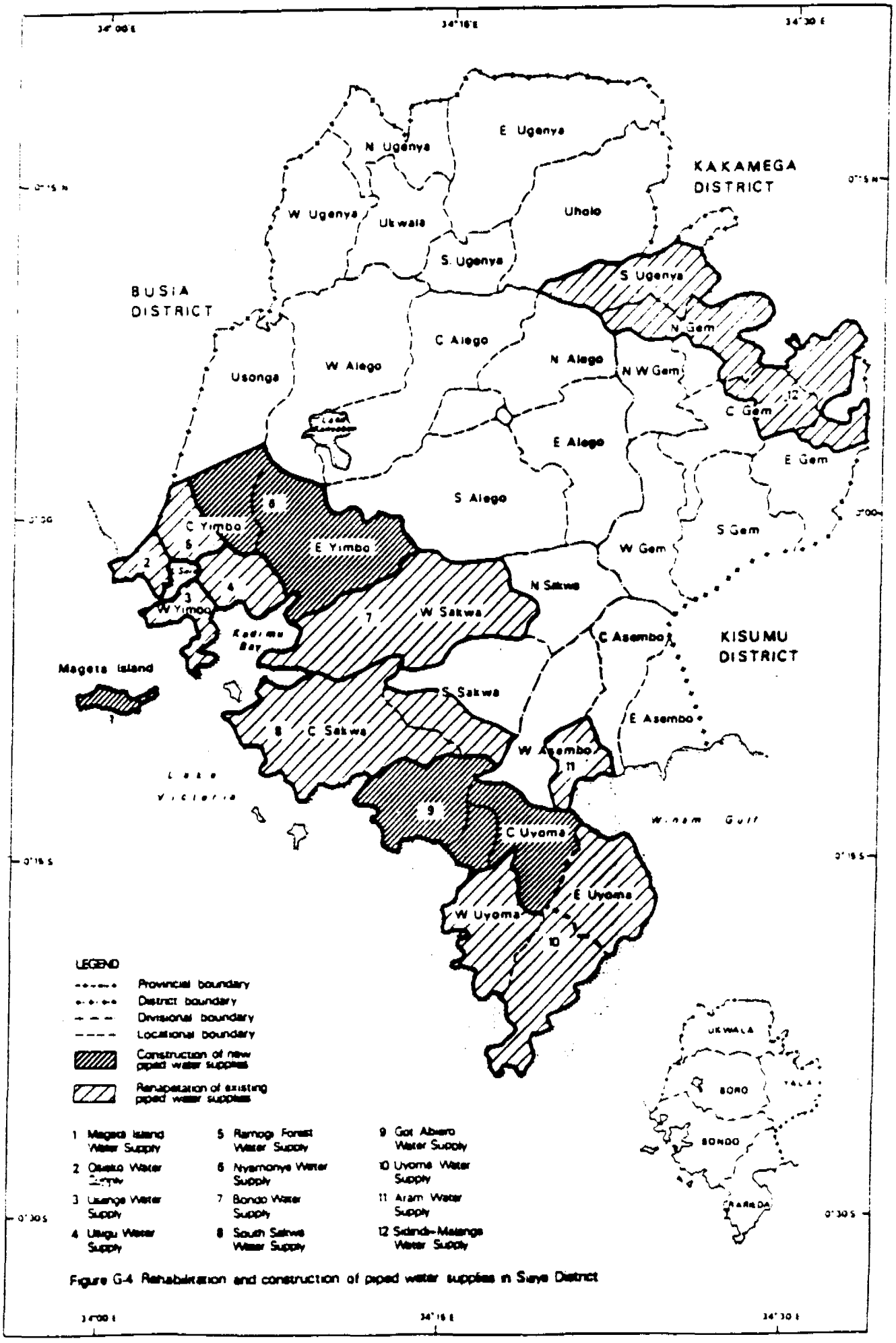


Figure G-4 Rehabilitation and construction of piped water supplies in Siaya District

Piped water supply

Fig. G.4 shows which existing piped water supplies have to be improved and where new piped systems have been planned. A total number of 12 different piped water supply projects have been identified.

Rehabilitation of the following existing schemes is planned:

- Osieko Water Supply
- Usenge Water Supply
- Usigu Water Supply
- Ramogi Forest Water Supply
- Bondo Water Supply
- South Sakwa Water Supply
- Uyoma Water Supply
- Aram Water Supply
- Sidindi-Malanga Water Supply

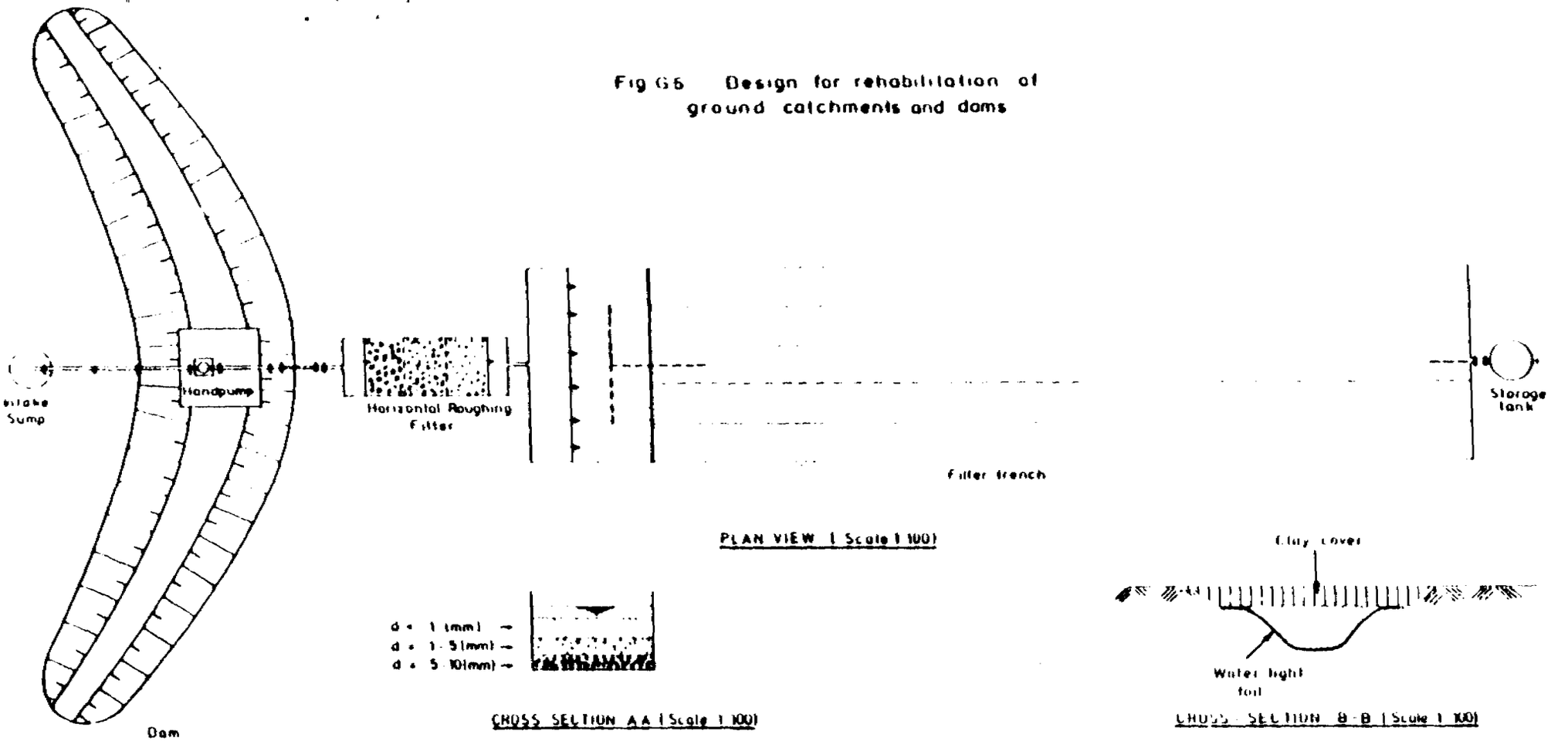
Construction of 3 new piped water supplies.

- Mageta Island Water Supply
- Nyamonye Water Supply
- Got Abiero Water Supply

Rehabilitation of ground catchments and dams

An adequate sanitary improvement of existing ground catchments and dams is hard to realize.
Rehabilitation, as planned in Bondo, Rarieda and Boro Divisions is therefore considered to be of second level, subordinate to rehabilitation and construction of piped water supplies in these areas.
Nevertheless it should be realized that most people living in Bondo and Rarieda Divisions, use ground catchments and dams for domestic water supply.
Also in future this type of water points will be frequently used.

Fig 66 Design for rehabilitation of ground catchments and dams



PLAN VIEW (Scale 1 100)

CROSS SECTION A A (Scale 1 100)

CROSS SECTION B - B (Scale 1 100)

LONGITUDINAL SECTION (Scale 1 100)

Fig. G.5 shows a tentative design for rehabilitation of ground catchments and dams. It is based on 2 basic ideas.

- The water stored in a ground catchment or a dam is always polluted and there are no ways to exclude or prevent this pollution.
  The water should therefore be treated.

- Underground storage of water after treatment reduces the water losses due to evaporation and enables to use the water for drinking and cooking.
  Polluting activities as cattle watering and washing can be done at the open upstream reservoir.

Water is pumped or sucked via a siphon from a culvert intake and flows to a horizontal roughing filter followed by a trench filter. The first part of this trench filter consists of a small slow sand filter. Passing the trench filter the water is stored in a small tank from which it can be abstracted with a pump or a tap.

Rehabilitation of existing roof catchment supplies

Roof catchment water supply is considered to be an appropriate rural water supply system which however can only be used by a small group of consumers. Construction of new roof catchment systems has proved to be rather expensive. A large system including a 50 (m^3) storage tank costs about Ksh 200,000/-
RDWSSP therefore only plans to rehabilitate existing roof catchment systems of schools, churches, health centres etc., which have a limited number of consumers and sufficient roof size to supply these consumers.
Rehabilitation works aim at taking bottlenecks away; bottlenecks, which block the effective use of a roof catchment system.

Some of these bottle necks are:

- gutters which are missing
- gutters which have to be aligned
- pipe connection between gutters and storage tank which is missing
- leaking storage tanks.

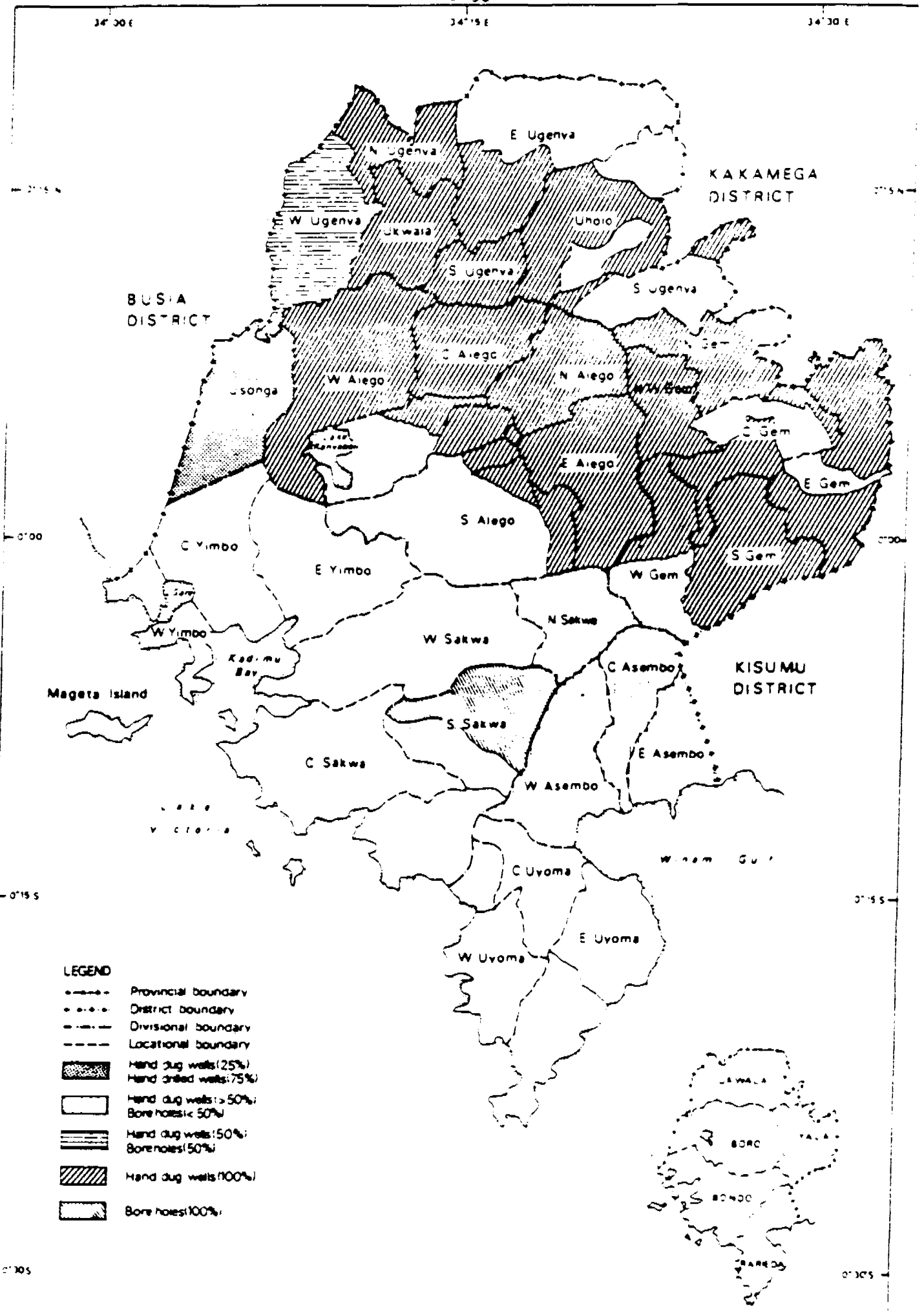


Figure G 6 Construction of new wells

Rehabilitation and construction of wells and boreholes

Rehabilitation of existing wells and boreholes is in particular needed in zone 2 and the northern part of zone 3. (see Fig. G.3).

A total number of 116 wells are planned to be rehabilitated. Most of the wells to be rehabilitated (72 %) are located in Boro Division. More than 55 % of the wells recommended for rehabilitation have a lining, about 40 % have a slab and 25 % have a pump of which however only a few are working.

In Ukwala Division 11 existing boreholes are recommended for rehabilitation. Rehabilitation works include fencing, improved drainage, repair of a slab, construction of a cattle trough and/or washing facilities, repair of a pump and installation of a pump.
Repair of the pump or installation of a pump are the most frequently indicated problems.

Fig. G.6 shows in which Locations new wells have to be made.
In most areas all wells can be made by hand digging.
Boreholes are only needed in West Ugenya, the southern parts of Central and South Alego, North and part of South Sakwa, the southern part of West Gem and West, Central and East Asembo Locations.
In Usonga Location it is possible to make hand drilled wells.

Fig. G.7. shows the RDWSSP hand dug well design.
Most characteristic of this design is the top culvert which rises up to 0.60 (m) above the surrounding ground level. Buckets are put besides the covering slab to better protect the well against surface runoff from entering into the well and exclusion of water splashing on the cover and anchor bolts.
A manhole in the concrete cover gives access to the well in case down hole activities are needed.
The well site is fenced with barbed wire and cedar poles. SWN-80 hand pumps are installed at all hand dug wells.

It is common practice to install in all hand dug wells a lining. The presence of a lining increases the life time of a well considerably. It also offers a better protection against polluted surface and sub-surface runoff from entering into the well.(the upper part of the lining is impermeable).

Fig. G.8. shows the RDWSSP design of machine or hand drilled wells.
Slotted PVC pipes are used as a screen. The screen is surrounded by gravel pack. Diameter of the casing and screen pipes is 110 or 125 (mm). The slot size used is about 0.6-0.8 (mm). Gravel pack is sieved between 1.2 (mm) and 4.6 (mm) sieves. A wooden plug is inserted in the bottom of the filter pipe. The aquifer is sealed using clay or concrete, after which the borehole is back filled.
A barbed wire fence is constructed around the well.
SWN-80 hand pumps are installed at all hand or machine drilled wells.

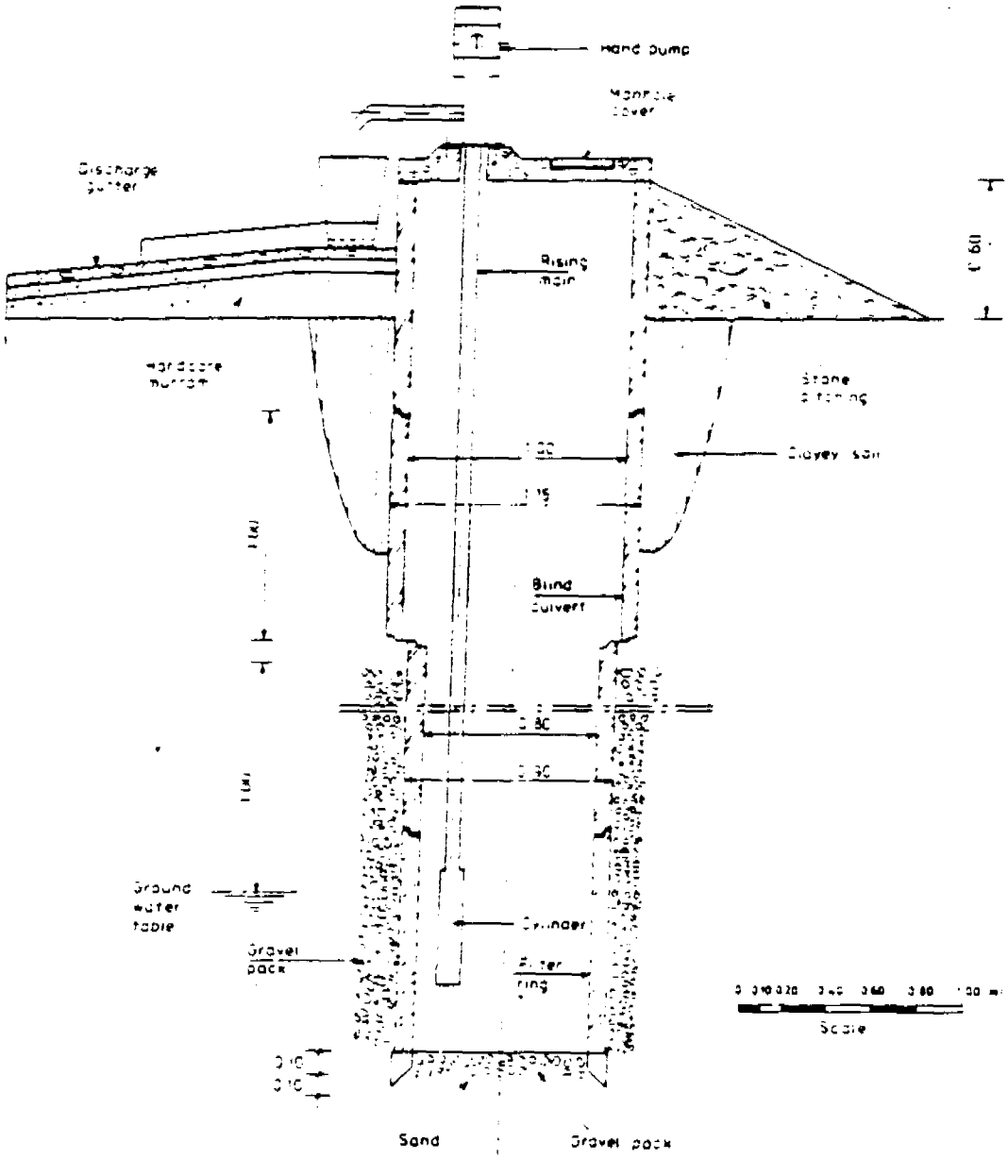


Figure G 7 RDWSSP HAND DUG WELL DESIGN

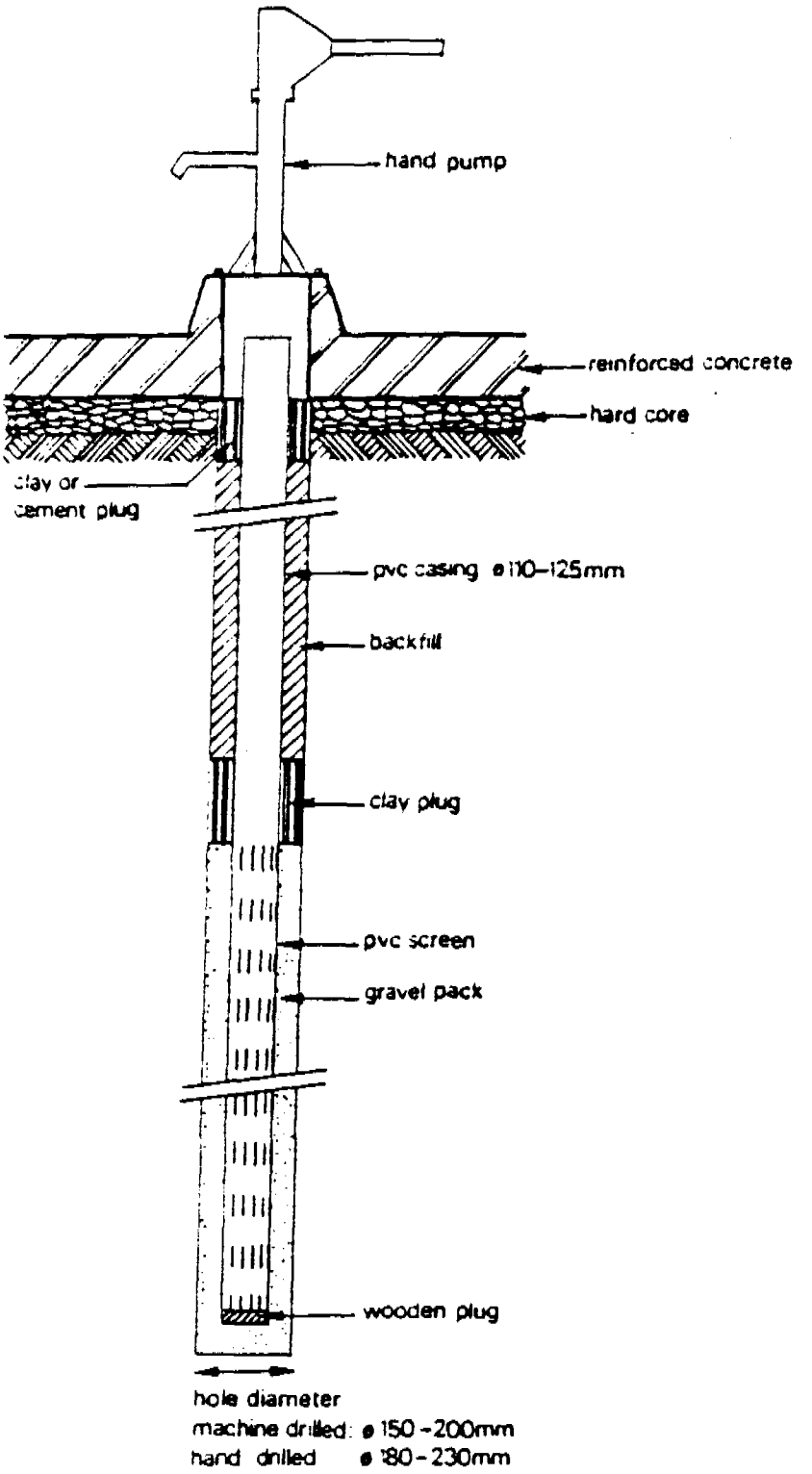


Figure G.8 RDWSSP hand drilled well and bore hole design.

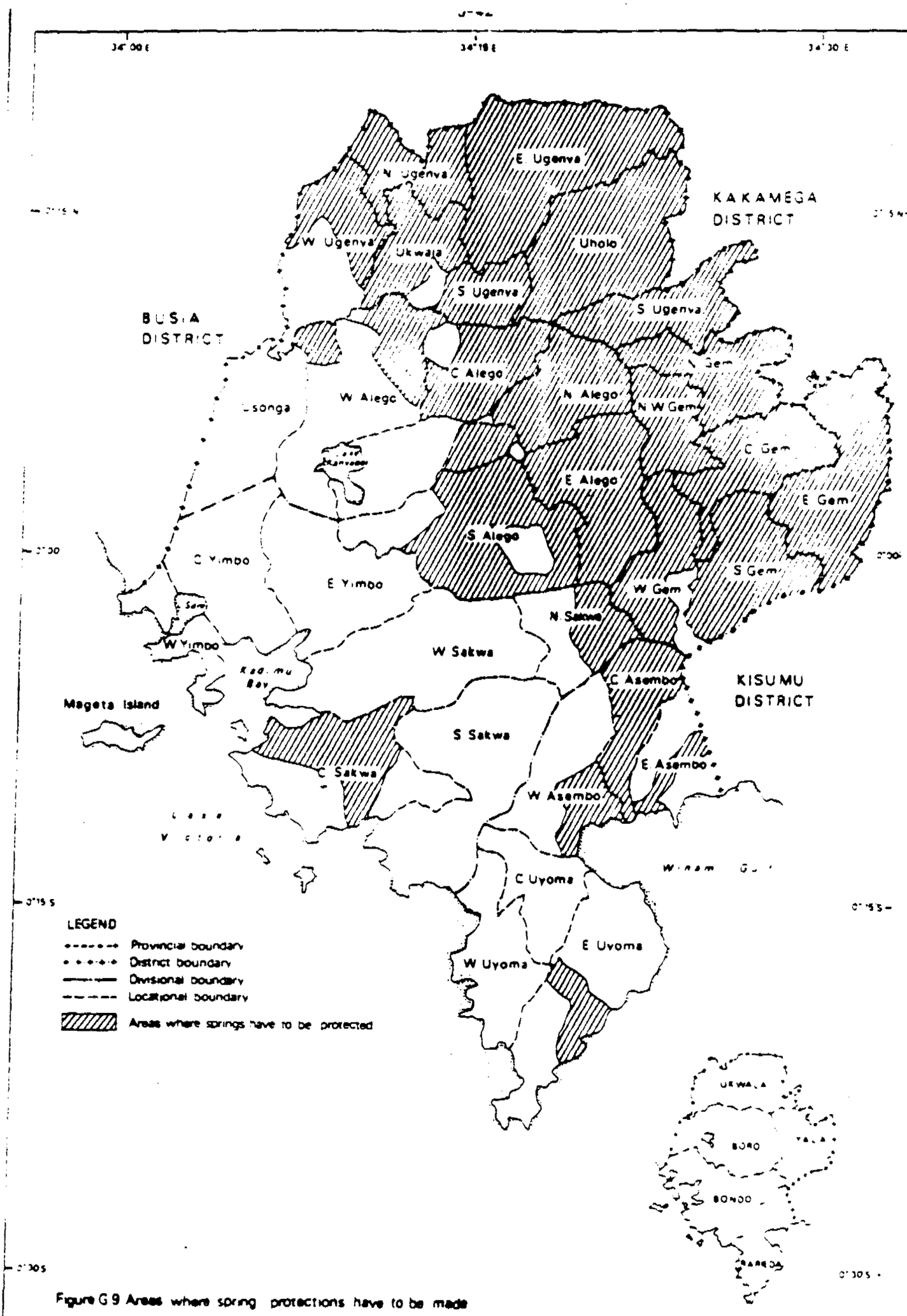


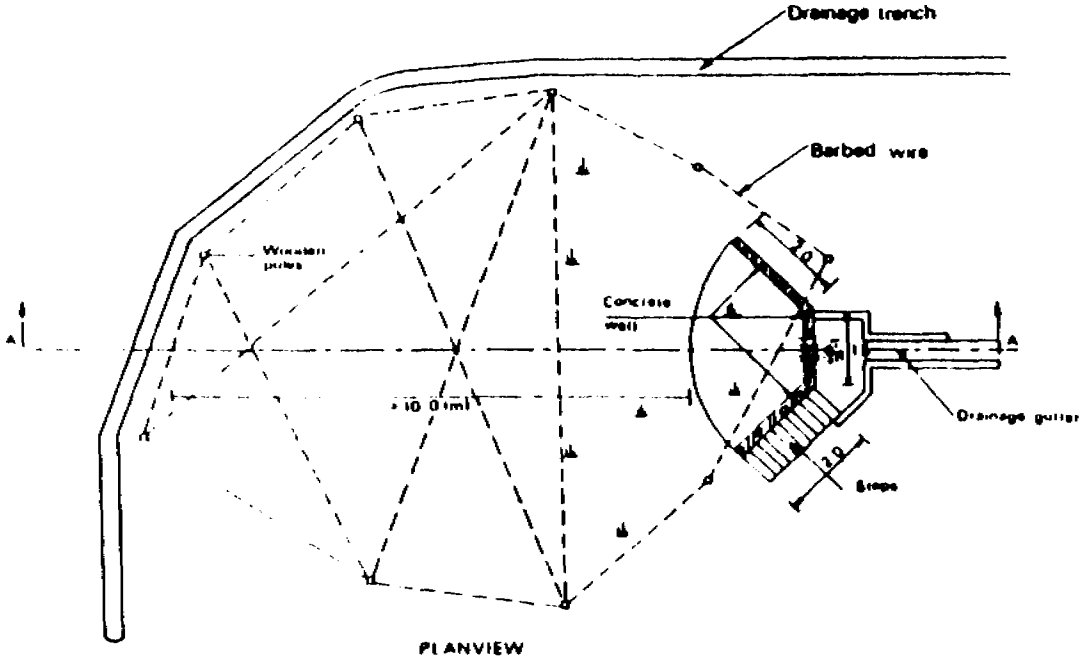
Figure G 9 Areas where spring protections have to be made

Spring protection

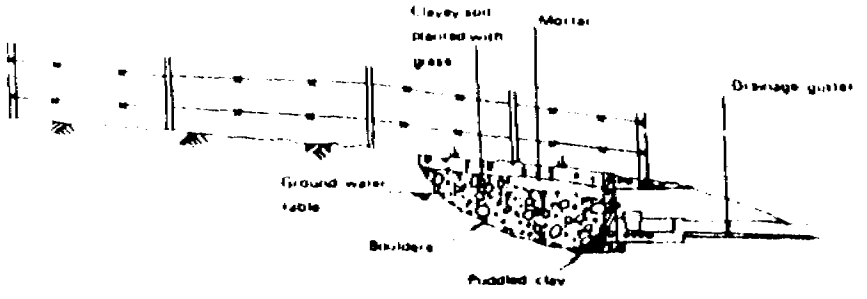
Fig. G.9. shows that spring protections are almost exclusively planned in zone 3, having good opportunities for using ground water.

Fig. G.10. shows the RDWSSP design which is used in case of good drainage opportunities.
The overflow pipe and draw off pipe are made at almost the same height. A scour pipe is installed to flush away any blockages of the pipes.
Hardcore, natural stones are embedded in the bottom slab to prevend that the slab is worn out by the water flowing from the pipes.
The area upstream is fenced with cedar poles and barbed wire. A drainage trench prevents polluted surface runoff from reaching the spring water.
Puddled clay is used to exclude that the concrete wall is undermined.

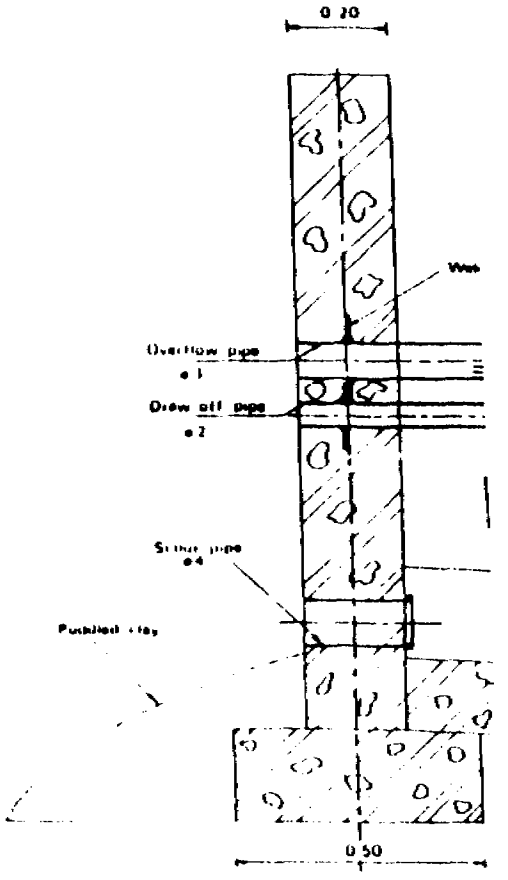
It is estimated that about 36 % of all springs to be improved, can be protected by making a gravity flow protection as indicated in Fig. G.10. At 64 % of the spring sites a shallow well has to be made or there should be good opportunities for piping the water to a site with better drainage opportunities.



PLANVIEW



LONGITUDINAL SECTION A A



DETAIL RETAINING WALL

Figure G10 SPRING PROTECTION ROWSSP
GOOD DRAINAGE OPPORTUNITIES

Table 6.1 Water Supply Plan

Area	Required number of safe and reliable water points	Good water points and water points under cons.	Remaining number of water points to be improved or newly constructed	PIPED WATER SUPPLIES	RAIN WATER			WELLS							SPRINGS	TOTAL
								HAND DUG WELLS				HAND DRILLED WELLS	BOREHOLES			
					Ground catchm.	Dams	Roof catch.	Rehab of wells	New wells	Water holes	Shallow well spring protect.		Rehab of bore holes	New bore holes	Springs gravity flow protect.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Bondo	588	7	581	410	20	30	9	3	32	2	2	0	0	87	6	581
Rarieda	533	5	528	273	15	14	5	7	165	19	11	0	0	19	0	528
Boro	663	18	645	0	4	0	4	84	368	31	101	15	0	25	4	645
Yala	610	13	597	37	0	0	0	0	184	16	252	0	0	11	89	597
Ukwala	728	241	485	20	0	0	2	14	182	3	87	0	11	26	160	485
Siaya District	3,120	284	2,836	740	39	53	20	116	911	71	453	15	11	148	259	2,836

Review of rehabilitation and construction works

Table G.1. presents a breakdown per Division and type of water supply facilities of the rehabilitation and construction works which are needed. Column (4) shows show many safe and reliable water points are needed after subtraction of the existing good water points and the water points under construction.
Column (5) shows that rehabilitation and construction of piped water supplies is almost completely concentrated in Bondo and Rarieda Divisions.
This also applies for rehabilitation of rain and surface water systems as ground catchments, dams and roof catchments. (column 6, 7 and 8).
Construction of wells is concentrated in Boro Division where 624 wells are planned (94 % of all water points needed in Boro).
Most boreholes are needed in Bondo Division.
Only in Ukwala Division existing boreholes have to be rehabilitated (pump repair and installation of pumps).
Spring protection is the major activity in Ukwala and Yala Divisions.

Table G.2. Construction costs of piped water supplies planned to be rehabilitated or newly constructed in Siaya District

Piped water supply	Works needed	Unit costs (Ksh)	Total costs (Ksh)
Mageta Island Water Supply	New scheme	Kshs 300,000/km^2	2,100,000
Osieko Water Supply	Rehabilitation	Kshs 150,000/km^2	1,950,000
Usenge Water Supply	Rehabilitation	Kshs 150,000/km^2	3,000,000
Usigu Water Supply	Rehabilitation	Kshs 150,000/km^2	3,450,000
Ramogi Forest Water Supply	Rehabilitation	Kshs 150,000/km^2	2,700,000
Nyamonye Water Supply	New scheme	Kshs 300,000/km^2	30,000,000
Bondo Water Supply	Rehabilitation + major extension	Kshs 300,000/km^2	33,900,000
South Sakwa Water Supply	Compl. of scheme under constr.	Kshs 225,000/km^2	28,125,000
Got Abiero Water Supply	New scheme	Kshs 300,000/km^2	48,600,000
Uyoma Water Supply	Rehabilitation	Kshs 150,000/km^2	13,650,000
Aram Water Supply	Rehabilitation	Kshs 150,000/km^2	1,050,000
Sidindi-Malanga Water Supply	Rehabilitation	-	4,420,000
		Total	172,945,000

G-4. *Construction cost*

The water supply plan as described in section G-3 includes:

- construction and rehabilitation of piped water supplies;
- rehabilitation of roof catchments;
- rehabilitation of ground catchments and dams;
- rehabilitation and construction of wells;
- spring protection.

The RDWSSP only has a wide experience in rehabilitation and construction of wells and protection of springs.
There is no detailed information available about the costs of construction and rehabilitation of piped water supplies, roof catchments, ground catchments and dams.

Piped water supplies

From literature, estimated construction costs of new piped water supplies were gathered. The cost figures were updated using a price index figure for civil engineering works of 13.5 %.
For 1988, the average costs per (km^2) of distribution area were found to be Kshs 300,000/-.
Based on this unit figure per (km^2) the construction costs of all planned piped schemes were estimated (Table G.2.).

Table G.3 Cost estimates for improvement of groundcatchments and dams

	Ground catchment	Dam
Culvert intake sump (3 culvert rings)	4,500	4,500
Low lift hand pump	15,000	15,000
Horizontal roughing filter		
Filter tank	18,000	18,000
Filter material	3,000	3,000
Slow sand filter		
Filter tank	15,000	15,000
Filter material	5,000	5,000
Filter trench		
Water-tight foil	1,500	1,500
Filter material + clay cover	5,000	5,000
Storage tank (2 blind culvert rings)	7,500	7,500
Piping materials	5,000	5,000
Sub-Total - Water treatment system	79,500	79,500
Planting catchment area	5,000	10,000
Deepening of dam reservoir	75,000	150,000
Improvement or construction of spillway	0	50,000
Sub-Total - Additional works	80,000	210,000
Contractors profit (15 %)	24,000	43,500
Design, supervision and administration (25 %)	39,900	72,400
Total	224,000	406,000

Remarks : Trench digging , planting
deepening (as far as done by hand)
are done by the community

Roof catchments

Improvement of roof catchment systems aims at taking bottle necks away. Technical advises and small repairs are assumed to be given or done by the project. It is estimated that the "non owner" component paid by the project is about Kshs 5000/- per roof catchment system.
All other costs are paid by the owner of the roof catchment system.

Ground catchments and dams

Table G.3. presents cost estimates for rehabilitation of existing ground catchments and dams.
Rehabilitation includes deepening of the reservoir, planting the upstream catchment area, deepening and protection of the spillway (dams) and construction of the water treatment system as described before.
The costs for improving a ground catchment are estimated at Kshs 224,000/-.
The costs for improving a dam are estimated at Kshs 406,000/-.

Table 6-4. Construction costs of hand dug , hand drilled and machine drilled wells
(in Ksh , price level June 1988 , based on RDMSSP experiences)

Description		HAND DUG WELLS			HAND DRILLED WELLS	BOREHOLES		
		Well depth (m)				Borehole depth (m)		
		10	15	20		50	60	70
WELL	. Digging or drilling	5,300	8,100	11,700	5,000	65,000	78,000	91,000
	. Transport of hand dug or hand drill equipment	3,300	3,500	4,500	3,000	0	0	0
	. Lining (transport + installation)	12,900	17,900	22,900	2,000	10,000	12,300	14,000
	. Supervision	7,000	7,000	7,950	1,000	4,950	4,950	4,950
SUB TOTAL WELL		27,900	36,500	47,050	11,000	79,950	94,950	109,950
SUPER	. Site clearance + excav.	5,200	5,200	5,200	5,200	5,200	5,200	5,200
STRUCTURE	. Concrete works	5,300	5,000	5,000	5,000	5,000	5,300	5,000
	. Fencing	2,800	2,800	2,800	2,800	2,800	2,800	2,800
	. Mobilisation and transport slab/well apron	1,500	1,500	1,500	1,500	1,500	1,500	1,500
	. Supervision	5,500	5,500	5,500	5,500	5,500	5,500	5,500
SUB TOTAL SUPERSTRUCTURE		20,000	20,000	20,000	20,000	20,000	20,000	20,000
PUMP *	. Pump head + stand	5,297	5,297	5,297	5,297	6,000	6,300	6,000
	. Pump cylinder	3,536	3,536	3,536	3,536	2,470	2,470	2,470
	. Rising main + pump rod	3,285	5,110	6,935	3,285	10,950	14,600	18,250
	. Various small items	400	400	400	400	400	400	400
	. Installation (incl.transp.	1,300	1,250	1,500	1,300	3,300	3,500	4,000
	. Supervision	700	700	700	700	700	700	700
SUB TOTAL PUMP		14,218	16,293	18,368	14,218	23,520	27,670	31,820
TOTAL COSTS		62,118	72,793	85,418	45,218	123,470	142,620	161,770

* Based on duty free imported equipment

* 1 Survey costs (Ksh 4000.- per site) not included

* 2 Costs of expatriate staff not included

* 3 Succes rate of well construction not included

Rehabilitation and construction of wells

Table G.4. gives a review of the costs for making hand dug, hand drilled or machine drilled wells of different depths.
The figures are based on the ongoing RDWSSP construction programme.

All RDWSSP construction works for making a hand dug well are done by local contractors.
The unit prices as indicated in Table G.4, therefore include a contractor's profit.
RDWSSP is responsible for design, supervision and administration. Supervision includes training of the contractor to fulfill the required construction and installation standards. Also this has been taken into account.

The costs for making machine drilled boreholes are based on drilling and testing of the holes by a qualified contractor, and comprise the following activities: set-up of equipment, drilling of an 8" borehole, inserting of casing and gravel pack, top grouting, development and test pumping.

Survey costs, for well siting are not included in Table G.4. On an average the survey costs equal about Kshs 4,000/- per site. Figures as indicated in Table G.4. apply for successfully constructed wells. The success rate of well construction is not taken into account.

Prices of the superstructure and pump installation are based on rates of Kenyan contractors. Prices of pump equipment and PVC casing are based on tax free imported materials.

Depreciation of means of transport e.g. motor bikes used by supervisors and the costs of expatriate staff are not included.

Construction of a hand dug well costs between Kshs 62,000/- and Kshs 85,000/-.
For a hand drilled well an amount of about Kshs 45,000/- is needed.
Borehole drilling is between Kshs 123,000/- and Kshs 162,000/-.

Table G-5. Construction costs of spring protections
(in Ksh ; price level June 1988 ; based on RDWSSP experiences)

Description		Gravity flow protection	Shallow well protection
WELL	. Digging (labour)	-	2,700/-
	. Transport of equipment (Tripod, Dewatering pump)	-	3,000/-
	. Lining (transport + installation)	-	9,830/-
	. Supervision	-	4,000/-
SUB TOTAL WELL		-	19,530/-
SUPER STRUCTURE	. Site clearance + excav.	3,600/-	5,200/-
	. Concrete works	7,000/-	5,000/-
	. Fencing	1,400/-	2,800/-
	. Mobilisation + transport slab/wall mould	1,500/-	1,500/-
	. Supervision	5,500/-	5,500/-
SUB TOTAL SUPERSTRUCTURE		19,000/-	20,000/-
PUMP *	. Pump head + stand	-	5,297/-
	. Pump cylinder	-	3,536/-
	. Rising main + pump rod	-	1,460/-
	. Various small items	-	400/-
	. Installation (incl.transp.)	-	750/-
	. Supervision	-	700/-
SUB TOTAL PUMP		-	12,143/-
TOTAL COSTS		19,000/-	51,673/-

* Based on duty free imported equipment * 1 Costs of expatriate staff not included

Springs

Table G.5. gives a review of the costs for making spring protections.
A so called gravity flow protection is rated at Kshs 19,000/-.
This figure is based on the ongoing spring protection works in Kisii District.
If drainage opportunities at the spring site are insufficient a shallow well is made. The construction cost are assumed to be equal to a well with a maximum depth of 5 (m).
The costs of such a well are about Kshs 52,000/-.

Like hand dug wells, also spring protections are made by local contractors.
Works range from transport of construction materials like sand, stone chippings and ballast to in situ casting of the retaining wall and cover of the spring.
RDWSSP is responsible for design, supervision and administration. Supervision includes training of the contractor to fulfill the required construction and installation standards.

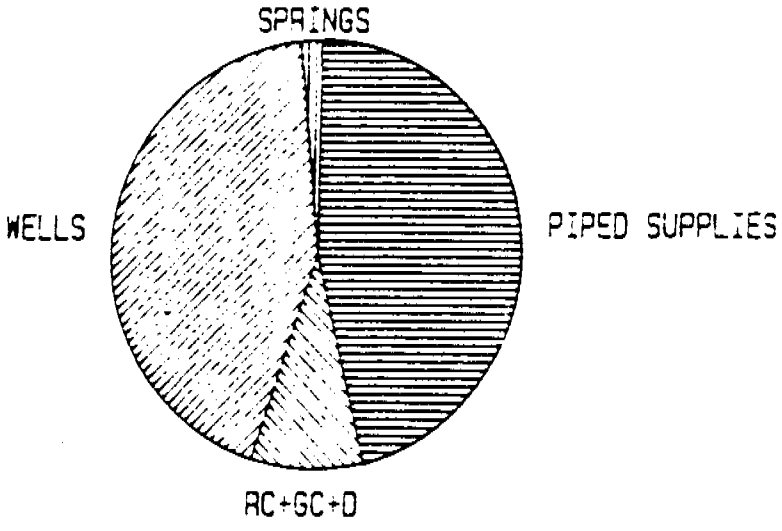
Depreciation of means transport e.g. motor bikes used by supervisors is not included in the costs figures.

The costs of expatriate staff are not included.

Table G-6 Review of construction costs

Area	Construction costs (Ksh*1000)						
	Piped water supplies	Roof catchments	Ground catchments	Dams	Wells	Spring protections	Total
Bondo	119,925	45	4,480	12,180	17,431	114	154,175
Rarieda	48,600	25	3,360	5,684	21,667	0	79,336
Boro	0	20	896	3,654	47,757	76	52,403
Yala	4,220	0	0	0	30,562	1,691	36,473
Ukwala	200	10	0	0	20,855	3,040	24,105
Siaya District	172,945	100	8,736	21,518	138,272	4,921	346,492

FIG. G.11a CONSTRUCTION COSTS PER TYPE OF WATER POINT



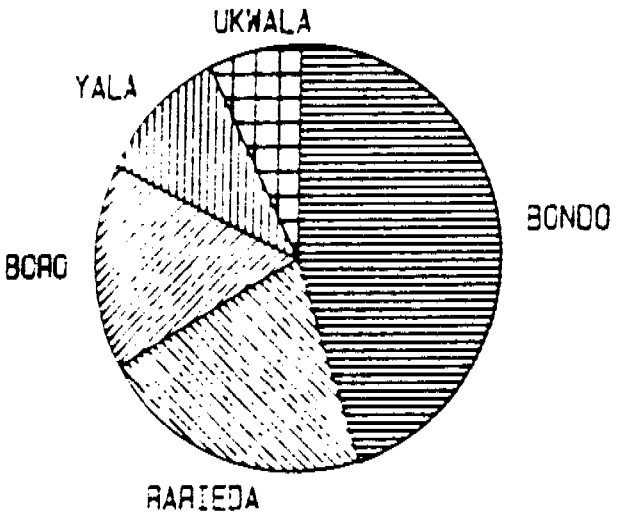
Review of costs

Table G.6. presents a review of the construction costs.
A breakdown is given per Division and type of water supply.

The survey costs and the success rate of well construction have been taken into account. Also the fact that part of the wells are to be rehabilitated which makes them less costly, (no survey) is considered.

The total costs of the Water Supply Plan are estimated at Kshs 346,000,000.
Construction of wells and boreholes and construction of piped water supplies are the most expensive components of the Water Supply Plan (see Fig. G.11. A).
45 % of the total costs have to be spend in Bondo Division ig. G.11. B).

FIG. G 11b CONSTRUCTION COSTS PER DIVISION

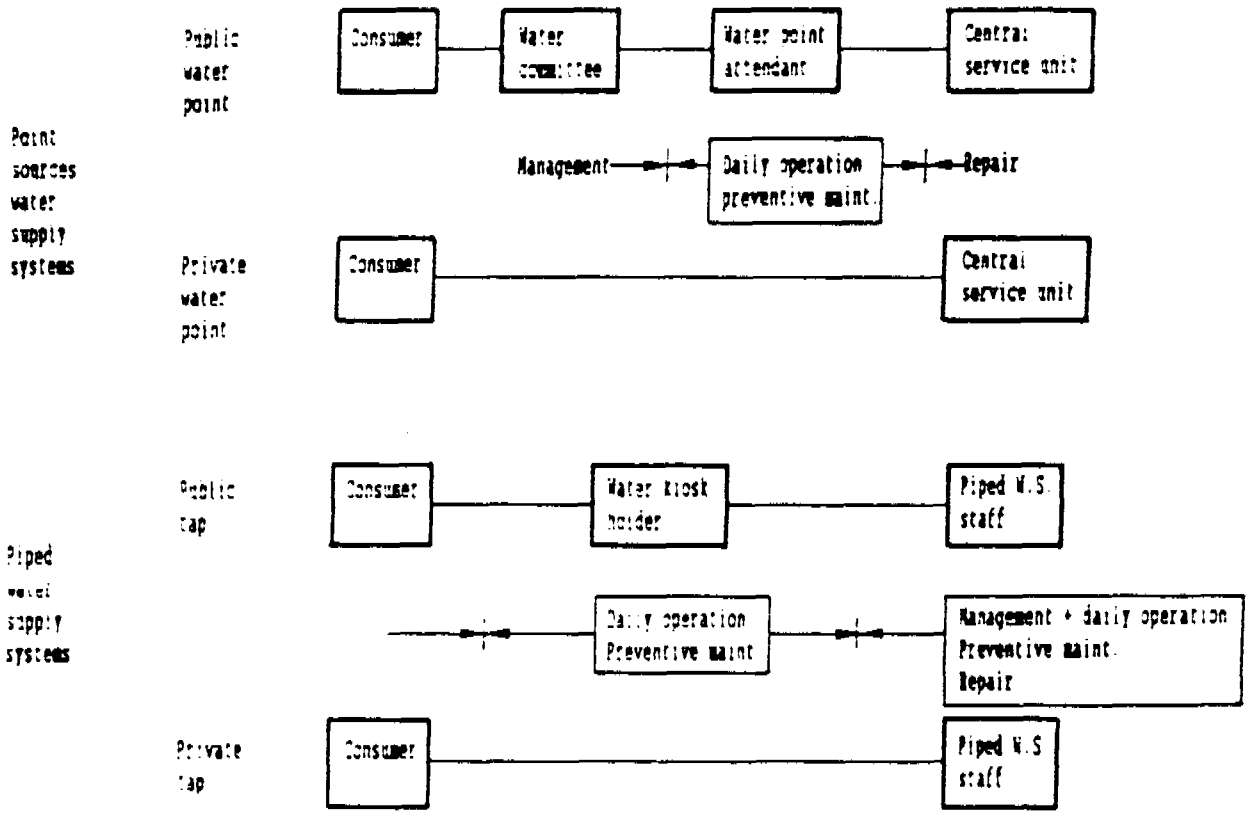


G.5. *Operation and maintenance*

Organizational set-up

Fig. G.12. shows how operation and maintenance of point source water supplies and piped water supply systems can best be organized.
For private water points or private connections both systems are identical and consist of the user at one hand and a central service unit or a central operation and maintenance unit at the other hand.
For communal point sources and public taps there are differences. Point sources have a water point attendant who is responsible for small repairs and a proper use of the water point. The attendant is supervised and paid by a water committee consisting of user representatives.
Each public tap of a piped water supply system has a water kiosk holder who is infact a third party. Like a water point attendant , he is also responsible for small repairs and maintenance of the public tap, however he does not receive any salary. Each user of a public tap has to pay a certain amount of money to the kiosk holder for collecting water. The kiosk holder in his turn has to pay for each (m^3) of water supplied to him via the distribution system.

Fig. G.12 Management of operation and maintenance of rural piped water supplies



Point sources

Proper operation and maintenance of point sources requires :

- Community mobilisation
- Community participation
- Daily operation, preventive maintenance
- Repair

Community mobilisation

Community mobilisation starts with selecting which spring, dam or ground catchment has to be improved or where a new well has to be made.
Having selected the most appropriate site, the RDWSSP survey crew has to approve the chosen site or to recommend a better one.

Once the construction site has been selected, the community is mobilized to participate in the construction works. Apart from cost savings, the aim of this approach is to create the awareness that the community will be the owner of the water point and will be responsible for operation and maintenance.

Community participation

Prior to the start of the construction works a number of preconditions have to be fulfilled.

- There are no disputes about the land where the water point is made. The community has free access to the water point.

- There is a water committee, registered by the Ministry of Culture and Social Services.

- The water committee has raised and banked a prescribed minimum amount of money for maintenance of the water point.
  For a gravity flow protected spring a minimum amount of Kshs 1000.- is required. For water points having a pump this minimum amount has been fixed at Kshs 2000.-

Construction works are done in close cooperation with contractors which are supervised by RDWSSP. The community is involved in the following activities.

- Construction of a proper access road to the water point to enable transport of construction materials and equipment.
- The construction site should be cleared.
- The community brings local construction materials as stones used for back filling and stone pitching to the construction site.
- The community assists in finding accommodation for the construction crew.
- The community is responsible for trench digging and ground level excavation works (ground catchments and dams).

All other construction works are done by local contractors.

Before construction works are completed, the water committee has to appoint a water point attendant who will be responsible for daily operation, preventive maintenance and small repairs.

When the water point is completed the people are instructed to keep the water point and its surroundings clean and in a good state. A fence is placed around the wells and springs. It is the community's responsibility to keep the fence in good condition and to plant euphorbia or any other hedges around it as additional protection of the site.

The upstream catchment area of ground catchments and dams has to be protected against soil erosion. Conservation requires a constant awareness to plant trees and to sow grass at places which have become bare.
The dam or ground catchment will soon be silted if these measures are not taken.

Daily operation and preventive maintenance

The water committee is responsible for management of the water point which includes:

- management of the maintenance fund
- supervision of the water point attendant
- organizing community maintenance works.

Programme extensionists advice the water committee about these management aspects.
Daily operation and preventative maintenance are done by the water point attendant.
Some of his tasks are:

- To open and to close the water point in case the water committee decides upon restricted use.

- To control people using the water point. Only those who contribute to the operation and maintenance fund are permitted to use the water point.

- To control upon the proper use of the water point (a correct pumping technique and use of taps, exclusion of vandalism).

- To keep the water point clean. (clearing of drainage gutters etc.).

- Preventative maintenance.
  Small repairs of the slab. Prevention that the slab is undermined. Trimming of the natural fence.

It is the projects experience that a well trained and motivated water point attendant is crucial for a proper functioning of the water point.

Repairs

From the day the community starts using the new water point a six months "guarantee" period commences.
Any failure, shortcoming or breakdown which occurs during these 6 months , is solved or repaired by the RDWSSP without charging the community.
At the end of this period the new water point is officially handed over to the community by signing a certificate of ownership.

After 6 months, a breakdown or failure of the water point has to be reported to a field maintenance officer stationed at the central service unit in Siaya Town (DWE's office).

These maintenance officers are responsible for

- proper repair of the water point
- financial control of repairs done
- training of water point attendants

Additionally the maintenance officers inspect the quality of pump installation activities.

When a breakdown occurs, the steps taken towards repair basically are as follows:

- The water point committee reports a breakdown to the maintenance officer.
- The maintenance officer makes a visit to the site within 2 days.
- The maintenance officer diagnosis the breakdown, estimates the cost and hands over an order note for spares and tools to the well committee.
- The water point committee arranges transport of the tools and spares from the central spares depot to the water point site.
- The water point committee informs the maintenance officer that tools and spare parts are on the site and that a minimum of 3 labourers will be available.
- The maintenance officer carries out the repair within 2 days.
- The maintenance officer mails the invoice to the water point committee.
- The water point committee pays the invoice from their bank account.

At present the maintenance officers are employed by the RDWSSP. A maintenance system involving the private sector is not yet feasible, because of the relatively small number of water points to be maintained in the District, the limited number of breakdowns and the low density of new water points. In future when the number of water points has increased to a few hundred per Division, such a set-up might be feasible.

Piped water supplies

Operation and maintenance should be done by the piped water supply staff.
Operation and maintenance of different schemes from one central point (e.g. delivery of diesel via DWE's office) fails, while on the other hand communities lack means and skills to maintain and repair e.g. pumps.
The piped water staff can only do their work in a proper way if they have full control over money and means of transport as well as the authority to take measures of disconnection, water rationing etc. if needed.
The piped water supply system should be headed by a project director who is controlled by local authorities.

The only way to create a long term sustainable operation and maintenance set-up is to run a piped water supply system which is cost effective . Everybody has to pay for the water which is delivered. Charges should be in accordance with the costs for operation and maintenance of the water supply system.
In planning, design and construction of a piped water supply one should be fully aware of the fact that the consumers have to pay for the running costs of the new scheme.
Coagulation, sedimentation and filtration of water might be too expensive for a small community, while on the other hand even supply of raw water might be of great importance for a community.

The most sensitive part of a piped water supply system is the distribution net work. In particular public taps are vulnerable for vandalism and mis-use which often leads to either no supply of water or a massive spillage of water.
At these public taps it is needed to have people who have an economic interest in the proper functioning of the water point.
It is therefore advised to work with water kiosk holders acting as a third party which are paid by the consumers for the water delivered. The kiosk holder pays to the piped water supply for getting water.
Such a system of water vending will only work if it is profitable for both consumers and kiosk holders to use the system.
The kiosk holder is responsible for daily operation of the public tap. He opens and closes the water point at prescribed times. He checks on proper use of the taps. He implements small repairs.
The kiosk holder, reports cases of no supply (no income) or leakages (loss of income) immediately to the project director of the piped water supply, who has to take action in order to exclude that his water revenues will decrease.
Some aspects are not covered by the proposed kiosk holder set-up. Such an aspect is the quality of the delivered water. The consumers should organize themselves in a water committee which can discuss preventing problems with representatives of the MoWD (as a consulting agency) or with local authorities in order to take adequate measures.

H RECOMMENDATIONS

Comparing, the Water Supply Plan with the ongoing construction activities it is concluded that there is a sincere need for proper coordination of design and implementation activities.

* All efforts aimed at improvement of rural water supply in Siaya District should be coordinated.
The Water Supply Plan includes different kind of activities implemented by MoWD, NGOs, LBDA, private contractors etc.

  A proper coordination of activities is needed.
It is advised to assign a Technical Coordinator under the District Water Engineer.

* Nine (9) piped water supplies have to be rehabilitated. In most cases, rehabilitation includes a complete renewal or a major extension of the existing water supply system. In addition 3 new piped schemes have to be built.
The works needed are beyond the capacity of the existing district organizations involved in piped water supply (MoWD, NGOs and communities).

  It is therefore advised to work with private contractors which are fully responsible for the implementation of the required rehabilitation and construction works. Design and supervision of implementation works have to be done by a well experienced Water Supply Engineer assisted by water technicians of the DWEs office. The Water Supply Engineer should work directly under the Technical Coordinator.

* Construction of 259 spring protections, 1551 hand dug wells and 15 hand drilled wells necessitates to enlarge the capacity of the existing RDWSSP District Implementation Unit. Well construction should be intensified and a spring protection unit should be started.

* About 150 boreholes have to be made. Borehole drilling is and will be done by local contractors.
Borehole siting and supervision of drilling works require the input of a Hydrogeologist of the Survey and Design unit of RDWSSP.

* Part of the Water Supply Plan is to rehabilitate existing roof catchments and to improve ground catchments and dams.

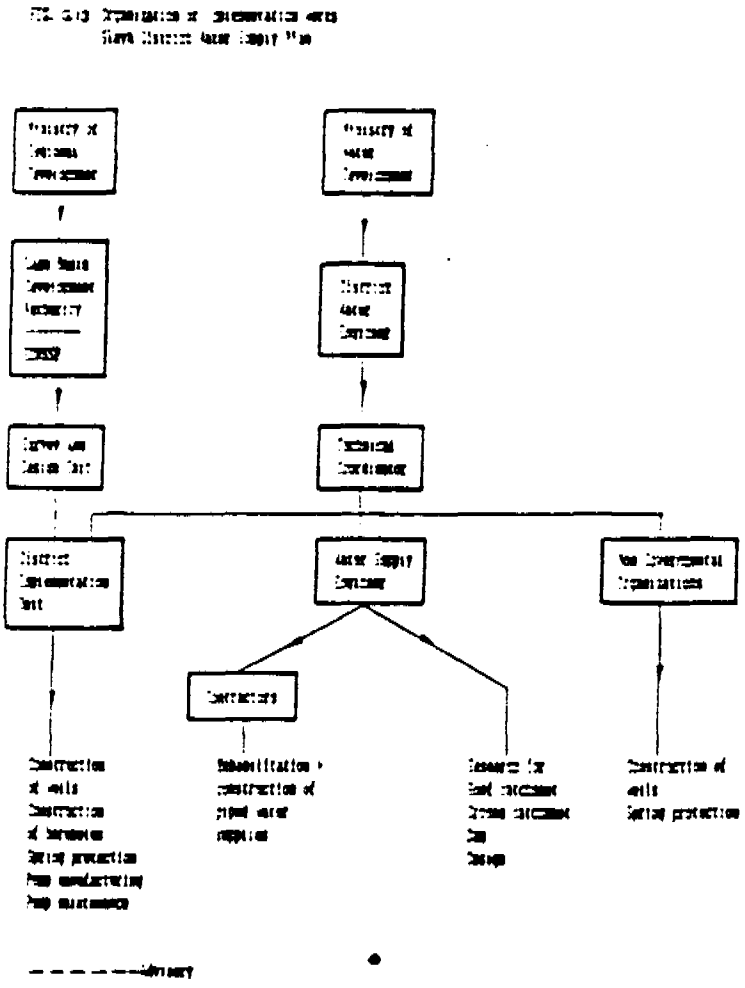
More research is needed to improve the roof catchment design.
Short duration rainfall analyses should be made to find better design criteria for the roof gutters and pipe connection to the storage tank. Self registrating rainfall recorders should be installed at some strategic points to measure 5 min. rainfall amounts. High rainfall intensities should be analysed to draw up design rules for roof gutters applicable for Siaya District.

Long series of real time daily rainfall amounts should be analysed to improve the storage tank design.
The existing network of rainfall stations (daily recording) should be checked and improved.

Fig. G.5. shows a preliminary design for improvement of existing ground catchments and dams.
This design should be further elaborated and tested.

The Water Supply Engineer who will be in charge of the piped water systems should also be responsible for this research work.

Fig. G.13. presents a diagram showing the position of the Technical Coordinator, the Water Supply Engineer , the contractors, the District Implementation Unit and the advisory role of the RDWSSP Survey and Design Unit.



ANNEX 2
Hand Pump Breakdown and Community Response

Annex 2a

DIVISION : NDHIWA

DISTRICT : HOMA BAY

REVIEW OF BREAK-DOWNS, REPAIRS AND COSTS OF HAND PUMPS AS PER DECEMBER, 1989

Site reference number	Name of site	Type of well	Static water level (m)	Pump intake depth (m)	Date of breakdown(s)	Type(s) of breakdown(s) 01	02	03	04	Direct repair costs (Ksh)	Contribution by community: invoiced (Ksh)	Contribution by community: paid (Y/N)	Contribution paid by RDWSSP (Ksh)
Nd-001	Obera Secondary School	DG			16-Feb-89	R4				77.00	165.00	Yes	-88.00
Nd-003	Ndhiwa Inst. for Rural Dev	DG			23-Feb-89	C6	C8			960.00	520.00	No	440.00
Nd-004	Ndhiwa Market	DG			11-Sep-89						125.00	Yes	-125.00
Nd-010	Ongeng Market	DG			21-Jul-89	R4				262.00	185.00	Yes	77.00
Nd-012	Nirogi Boys Secondary School	MD			23-Sep-89	R1	C6				520.00	No	-520.00
Nd-014	Ndisi Primary School	MD			17-Apr-89	R1	R4	M3		749.00	450.00	Yes	299.00
Nd-056B	Ndhiwa Women M. Group	MD			10-Mar-89	R1				400.00	260.00	Yes	140.00
Nd-071	Adhula	DG			13-Jan-89	C1					250.00	Yes	-250.00
Nd-077	Kasake	DG			1-Apr-89	M3				140.00	125.00	Yes	15.00
Nd-085	Ningeyi Village	BG			13-Jan-89	C5				200.00	250.00	Yes	-50.00
					20-Jun-89	M1				410.00	100.00	No	310.00
Nd-086B	Ngolo Village	MD			23-Apr-89	R1	M3			350.00	285.00	Yes	65.00
Nd-087B	Dunga	MD			28-Oct-89	R6				100.00	100.00	No	
Nd-104B	Kaimbo	MD			20-Jun-89	R4				262.00	215.00	Yes	47.00
					11-Mar-89		R5			300.00	210.00	No	90.00
Nd-105	Kamenya Village	DG			20-Nov-87	P3					600.00	Yes	-600.00
Nd-M-02	Ndhiwa Dispensary	DG			24-Aug-89	P3					350.00	Yes	-350.00

Total direct repair costs : Ksh 4210.00

Total amount invoiced to community : Ksh 4710.00

Total amount paid by community : Ksh 3260.00

Total amount outstanding invoices : Ksh 1450.00

Total amount contributed by RDWSSP : Ksh -580.00

Average static water level (m) :

Average pump intake depth (m) :

REFERENCE NUMBERS AND DESCRIPTIONS OF TYPES OF BREAKDOWNS ARE SHOWN ON THE SUMMARY SHEET — Annex 3

Annex 2b

DIVISION : MBITA
DISTRICT : HOMA BAY

REVIEW OF BREAK-DOWNS, REPAIRS AND COSTS OF HAND PUMPS AS PER DECEMBER, 1989

Site reference number	Name of site	Type of well	Static water level (m)	Pump intake depth (m)	Date of breakdown(s)	Type(s) of breakdown(s) 01	02	03	04	Direct repair costs (Ksh)	Contribution by community: invoiced (Ksh)	Contribution by community: paid (Y/N)	Contribution paid by RDWSSP (Ksh)
Mb-022B	Agolo Nuok	HD			4-Jul-88	B3					100.00	Yes	-100.00
Mb-038	Kagunga	HD			26-Feb-89	B6	B3			1472.00	205.00	No	1267.00
Mb-045	Waondo	HD			16-Apr-89	B4				132.00	311.00	Yes	-179.00
Mb-050	Nyatoto	HD			2-Dec-89	B4				205.00	205.00	Yes	
					15-Feb-89	B5				262.00	205.00	Yes	57.00
Mb-060	Gamba Village	DG			1-Sep-87	B4					263.00	No	-263.00
Mb-063	Ochieng Odiere Sch.	DG			20-Jul-88	C1					320.00	Yes	-320.00
Mb-078C	Roo Village	HD			20-Aug-89	P3					350.00	Yes	-350.00
Mb-082	Seka	HD			11-Aug-89	B4					205.00	No	-205.00
Mb-084	Ponge	HD			30-Jun-89	B4				855.00	441.00	No	414.00
Mb-085	Ogongo	HD			18-Jan-89	B4				1630.00	525.00	Yes	1105.00
					11-Apr-89	B4				142.00	307.00	Yes	-165.00
Mb-093	Mukitende	HD			3-Feb-89	C5				200.00	272.00	Yes	-72.00
Mb-095	Kigoto	HD			11-Mar-89	P3				250.00	350.00	Yes	-100.00
Mb-104	Masaria	HD			11-May-89	B1					400.00	No	-400.00
Mb-110	Nakaya	HD			7-Jul-89	C3				16.00	116.00	Yes	-100.00
Mb-114	Luanda/Kiabuya	HD			21-Jul-89	M2					300.00	Yes	-300.00
Mb-115	God Fulu	HD			8-Sep-88	B1					310.00	Yes	-310.00
Mb-116	Gendo/Kibwer School	HD			4-Sep-89	B3					216.00	Yes	-216.00

Total direct repair costs : Ksh 5164.00
Total amount invoiced to community : Ksh 5401.00
Total amount paid by community : Ksh 3887.00
Total amount outstanding invoices : Ksh 1514.00
Total amount contributed by RDWSSP : Ksh -237.00

Average static water level (m) :
Average pump intake depth (m) :

REFERENCE NUMBERS AND DESCRIPTIONS OF TYPES OF BREAKDOWNS ARE SHOWN ON THE SUMMARY SHEET - in Annex 3

Annex 2c

DIVISION : MBITA

DISTRICT : HOMA BAY

SUMMARY OF BREAK-DOWNS PER WELL TYPE AND WATER DEPTH; AS PER DECEMBER, 1989

Ref. number	Types of breakdowns	Number of occurrences per type of well				Number of occurrences related to static water levels		
		DG	HD	MD	Total	0 - 15 (m)	15 - 30 (m)	over 30 (m)
P-1	Pump handle broken	-	-	-	-	-	-	-
P-2	Bearing jammed	-	-	-	-	-	-	-
P-3	Bearing worn out	-	-	2	2	-	-	-
P-4	Bolt/nut for bearing missing	-	-	-	-	-	-	-
P-5	Rod end bearing nut loose/worn	-	-	-	-	-	-	-
P-6	Foot plate sealing leaking	-	-	-	-	-	-	-
P-7	Pump head housing craked	-	-	-	-	-	-	-
P-8		-	-	-	-	-	-	-
R-1	Rod cut at thread end	-	-	2	2	-	-	-
R-2	Rod broken at plain end	-	-	-	-	-	-	-
R-3	Rod disconnected	-	-	3	3	-	-	-
R-4	PVC riser cut at thread end	1	-	6	7	-	-	-
R-5	PVC riser disconnected	-	-	1	1	-	-	-
R-6	PVC riser side worn	-	-	1	1	-	-	-
R-7		-	-	-	-	-	-	-
R-8		-	-	-	-	-	-	-
C-1	Cylinder blocked	1	-	-	1	-	-	-
C-2	Cylinder pipe worn out	-	-	-	-	-	-	-
C-3	Cylinder disconnected	-	-	1	1	-	-	-
C-4	Cylinder manchette worn out	-	-	-	-	-	-	-
C-5	Piston seal jammed	-	-	1	1	-	-	-
C-6	Piston seal worn out	-	-	-	-	-	-	-
C-7	Piston rod broken	-	-	-	-	-	-	-
C-8	Foot valve worn/leaking	-	-	-	-	-	-	-
C-9		-	-	-	-	-	-	-
W-1	Water finishing	-	-	-	-	-	-	-
W-2	Well/borehole caved	-	-	1	1	-	-	-
W-3	Sealing plate worn out	-	-	-	-	-	-	-
W-4		-	-	-	-	-	-	-
	Total number per Division	2	-	18	20	-	-	-

Annex 3C

DIVISION : NORTHERN
DISTRICT : HOMA BAY

SUMMARY OF BREAK-DOWNS PER WELL TYPE AND WATER DEPTH; AS PER DECEMBER, 1989

Ref. number	Types of breakdowns	Number of occurrences per type of well				Number of occurrences related to static water levels		
		DG	HD	MD	Total	0 - 15 (m)	15 - 30 (m)	over 30 (m)
P-1	Pump handle broken	-	-	-	-	-	-	-
P-2	Bearing jammed	-	-	-	-	-	-	-
P-3	Bearing worn out	2	-	-	2	-	-	-
P-4	Bolt/nut for bearing missing	-	-	-	-	-	-	-
P-5	Rod end bearing nut loose/worn	-	-	-	-	-	-	-
P-6	Foot plate sealing leaking	-	-	-	-	-	-	-
P-7	Pump head housing craked	-	-	-	-	-	-	-
P-8		-	-	-	-	-	-	-
R-1	Rod cut at thread end	-	-	4	4	-	-	-
R-2	Rod broken at plain end	-	-	-	-	-	-	-
R-3	Rod disconnected	-	-	-	-	-	-	-
R-4	PVC riser cut at thread end	2	-	2	4	-	-	-
R-5	PVC riser disconnected	-	-	1	1	-	-	-
R-6	PVC riser side worn	-	-	1	1	-	-	-
R-7		-	-	-	-	-	-	-
R-8		-	-	-	-	-	-	-
C-1	Cylinder blocked	1	-	-	1	-	-	-
C-2	Cylinder pipe worn out	-	-	-	-	-	-	-
C-3	Cylinder disconnected	-	-	-	-	-	-	-
C-4	Cylinder manchette worn out	-	-	-	-	-	-	-
C-5	Piston seal jammed	1	-	-	1	-	-	-
C-6	Piston seal worn out	1	-	1	2	-	-	-
C-7	Piston rod broken	-	-	-	-	-	-	-
C-8	Foot valve worn/leaking	1	-	-	1	-	-	-
C-9		-	-	-	-	-	-	-
W-1	Water finishing	1	-	-	1	-	-	-
W-2	Well/borehole caved	-	-	-	-	-	-	-
W-3	Sealing plate worn out	1	-	2	3	-	-	-
W-4		-	-	-	-	-	-	-
	Total number per Division	10	-	11	21	-	-	-