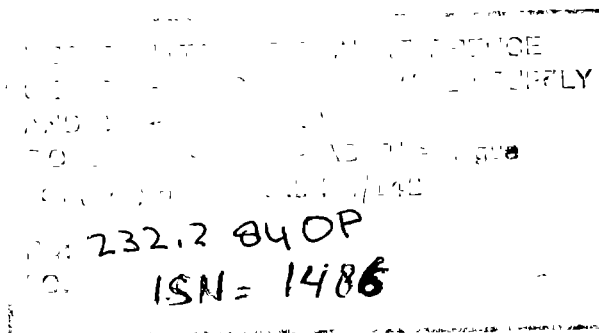


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OPERATION AND MAINTENANCE OF SHALLOW WELLS  
IN MOROGORO REGION  
- HAND PUMP ASPECTS

by

KIGINGI, ABUBAKARY K.

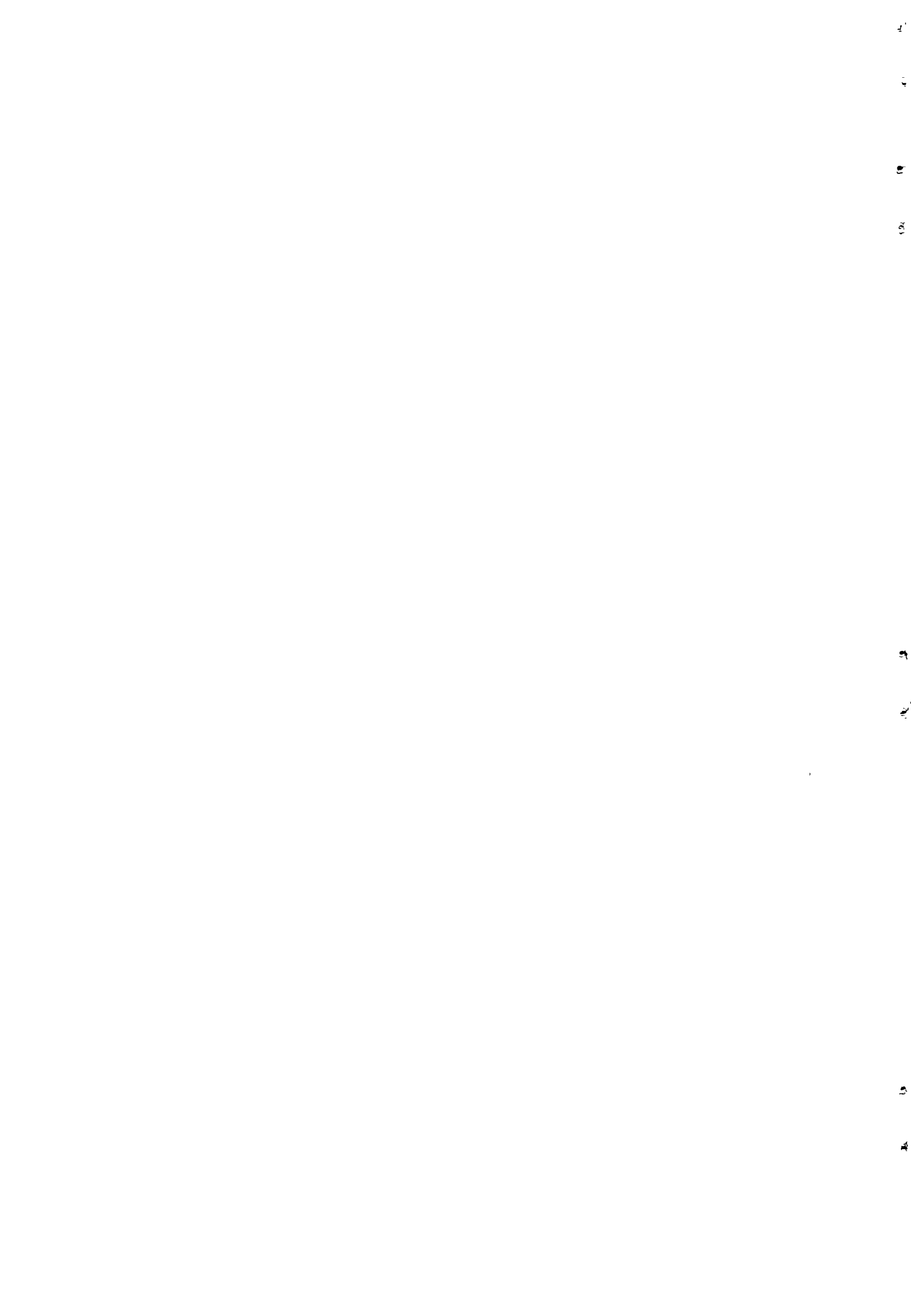


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for Communities and Water Supply

Thesis submitted to the department  
of civil engineering, Tampere  
University of Technology, Finland  
in partial fulfillment of the  
requirements for the degree of  
Master of Science in Engineering

March 1984

Dar es Salaam, Tanzania

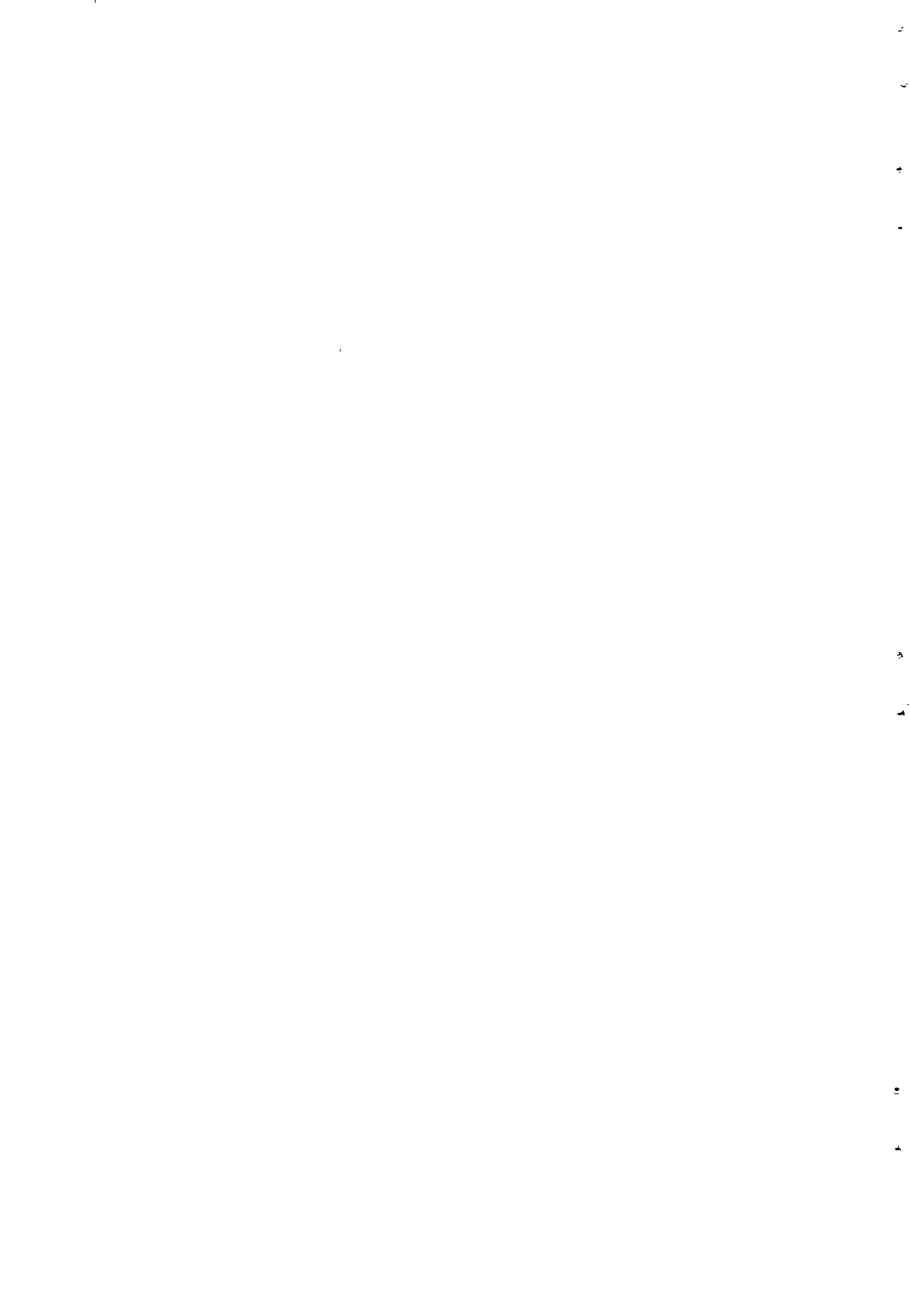


OPERATION AND MAINTENANCE OF SHALLOW WELLS IN  
MOROGORO REGION  
- HAND PUMP ASPECTS

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## ACKNOWLEDGEMENT

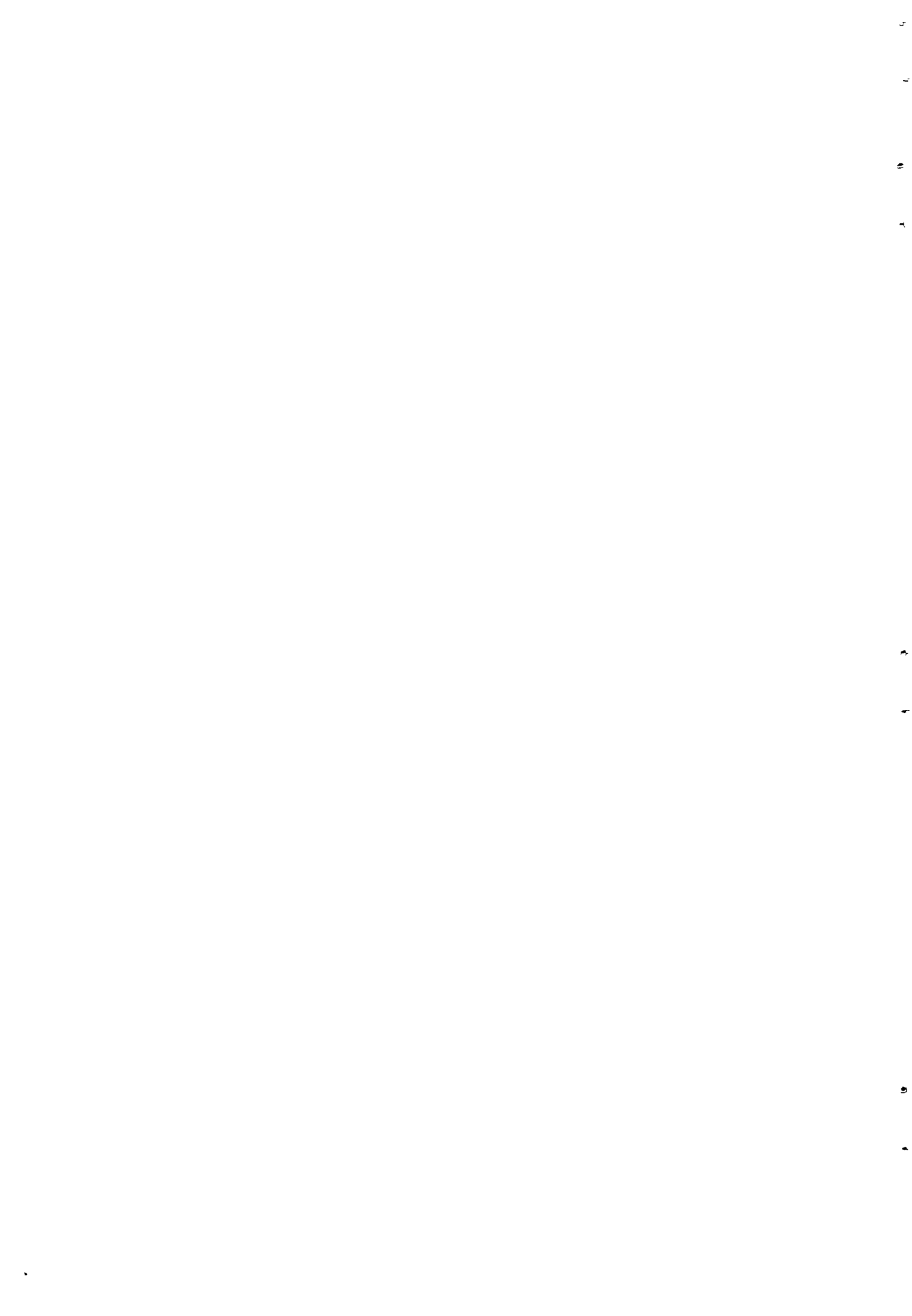
I wish to acknowledge with gratitudes, the two governments of Finland and Tanzania, for establishing such a Post Graduate Course in Water Engineering, of which I had been one of the participants, which led to writing of this thesis paper.

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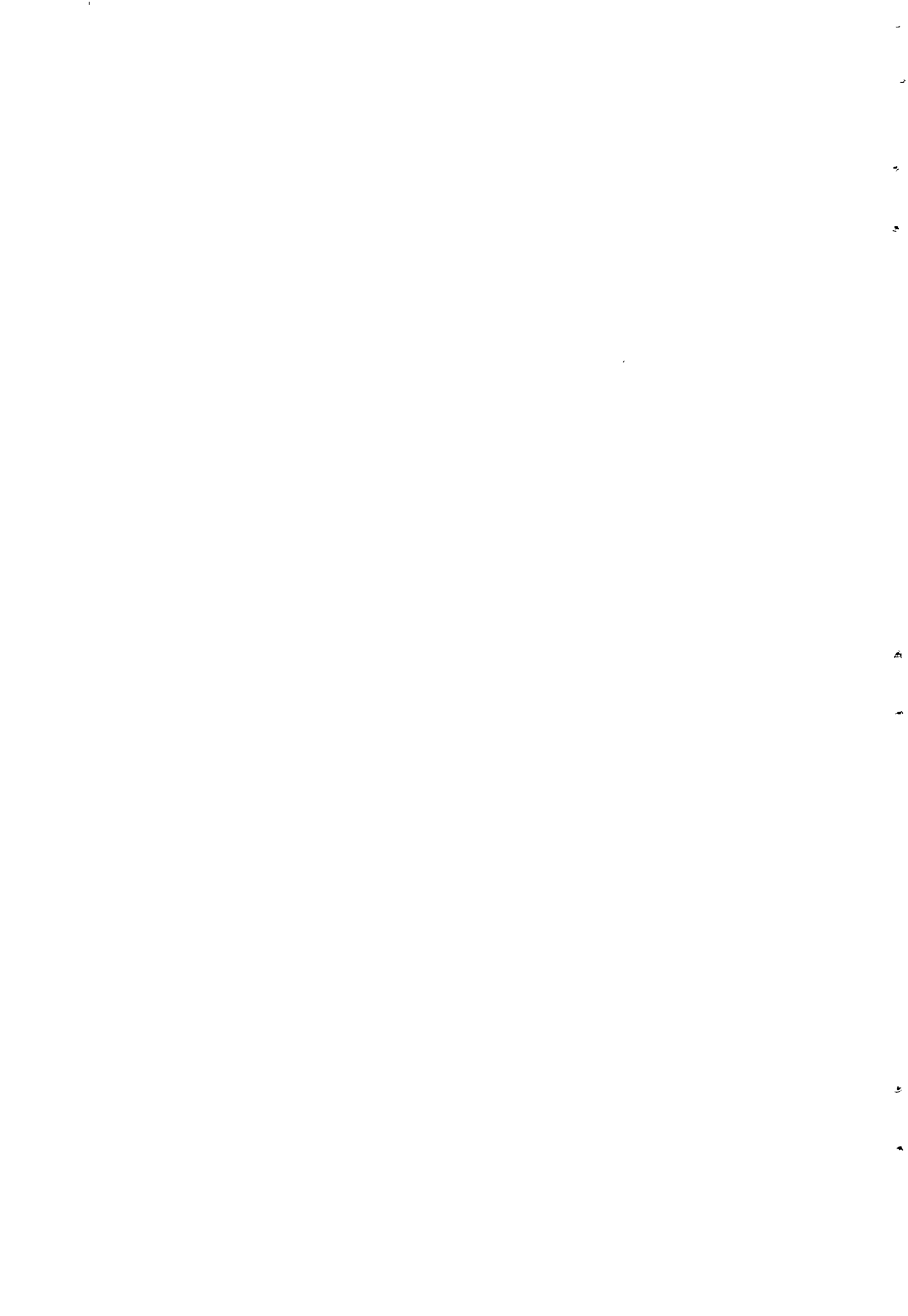
## ABSTRACT

The technical and economic feasibility of the hand pumps for rural water supplies is not indoubt, and this can be substantiated by their well known advantages as compared to other water supplies. That is low initial investment cost, low operation and running cost, low maintenance cost, low cost per capita and assurance of supply of water even if one pump is out of order. However, experience shows that the communal use of hand pumps presents serious problems with regards to engineering design, quality of manufacture, installation and maintenance.

As such this paper has drawn attention to operation and maintenance of hand pumps, which are installed on shallow wells, as practiced in Morogoro Region. In this case the paper will provide information on the existing maintenance system in Morogoro Region, with a light descriptive maintenance systems on some selected (visited) Regions Shinyanga, Mwanza, Mtwara and Lindi; this has provided a basis for discussion and conclusions. It has been attempted to elucidate the practiced maintenance system with respect to organization set up, execution, physical and financial aspects, transportation and manpower assessment.

With all this the paper tries to emphasize that hand pumps should have minimum maintenance at low cost, and should be acceptable to the users, with a working programme which requires satisfactory relationship between users, technology and institutional structure.

Even though a wise pump design may prevent many difficulties, but regular and proper maintenance is the key to a reliable pump performance.



## ABBREVIATIONS

MAJI	Ministry of Water and Energy
RDD	Regional Development Director
DDD	District Development Director
RWE	Regional Water Engineer
DWE	District Water Engineer
RMO	Regional Maintenance Officer
DMO	District Maintenance Officer
RMU	Regional Maintenance Unit
MDWSP	Morogoro Domestic Water Supply Plan
MWCP	Morogoro Wells Construction Project
WSSSM	Water Supply Survey Southern Morogoro
RIDEP	Regional Integrated Development Programme
DHV	Dwars, Heederik en Verhey
ITAD	International Technical Assistance Department
UN	United Nations
WHO	World Health Organization
IDWSD	International Drinking Water Supply and Sanitation Decade
VLOM	Village Level Operation and Maintenance
PVC	Polyvinyl Chloride
UNICEF	United Nations Childrens Fund
RTC	Regional Trading Company

## Currency Equivalents

USD 1,00 = TAS 12,00 (1983)



## 1. INTRODUCTION

World wide there has been an appreciable progress being made, in particular in many developing countries, with regards to well drilling and pump installation for rural water supplies, but it is unfortunately not true of the maintenance of wells and pumps once they are installed. The purpose for the well drilling and pump installation is to cater for one of the basic needs, and perhaps the first need of the village communities i.e. safe drinking water. However, with the provision of these wells and pumps, many of the pumps face breakdowns and remain unrepaired for long periods of time due to lack of adequate maintenance. The UN having realized such a problem of maintenance of hand pumps, has embarked on a programme aimed at establishing a village level operation and maintenance (VLOM) of pumps, which is geared to simple pump designs using, if possible, local available materials and can be maintained at village level.

It is the intention of this paper to provide the current practiced maintenance systems in Morogoro Region which is seemingly geared to the aim set out by UN. The period used in compiling and writing this paper is six months, out of which, a portion has been spent in the field. The field visits were carried out in Shinyanga, Mwanza, Mtwara, Lindi Regions and the concerned Morogoro Region, where data were obtained from personal communication with RWEs, DWEs, RMOs and project managers (MWCP and Finnwater), and in many instances data were obtained from progress reports, files and very limited literature available concerning maintenance of hand pumps.

The design and manufacture of hand pumps, on one hand, have been promoted to suit the human power or in some areas to suit animal or wind power, and on the other hand, they have to suit the low level technology in rural area where in many cases energy for power, for example fuel or electricity, is far beyond reach. On the same line of reasoning, different types

of hand pumps have been produced to try to achieve the goal of low level village technology. In as far as the current practiced maintenance systems, in particular Morogoro Region, and with all these technological hand pump development are concerned, still problems exist in the maintenance system. These problems include

- organization, financial and transportation deficiencies
- lack of level of responsibilities
- insufficient manpower
- improper pump quality.

All these, and many others, as discussed in this paper, attribute to uneffective maintenance system which is found to exist in Morogoro Region. It is from all these problems, after discussion, that formulated the recommendation given in this paper.

Hence it is considered, therefore, that a hand pump is only appropriate if it fits the pattern of organization, social responsibility and skill which exists in the community. Suitable pumps cannot be produced if the arrangements for maintenance and water use in the community where they will be used, are never examined. Programmes based only on laboratory tests and technical investigations can improve the construction and reliability of hand pumps and subsequently reliable maintenance system, but can never make them more acceptable to the users without the community involvement.

Note:

A hand pump, in this paper, will mean or include foot pumps if not mentioned. And when referring to maintenance in this paper, more of it or almost all will concentrate on hand pumps rather than shallow wells because there has been very little troubles arising from shallow wells.

## 1.1 General

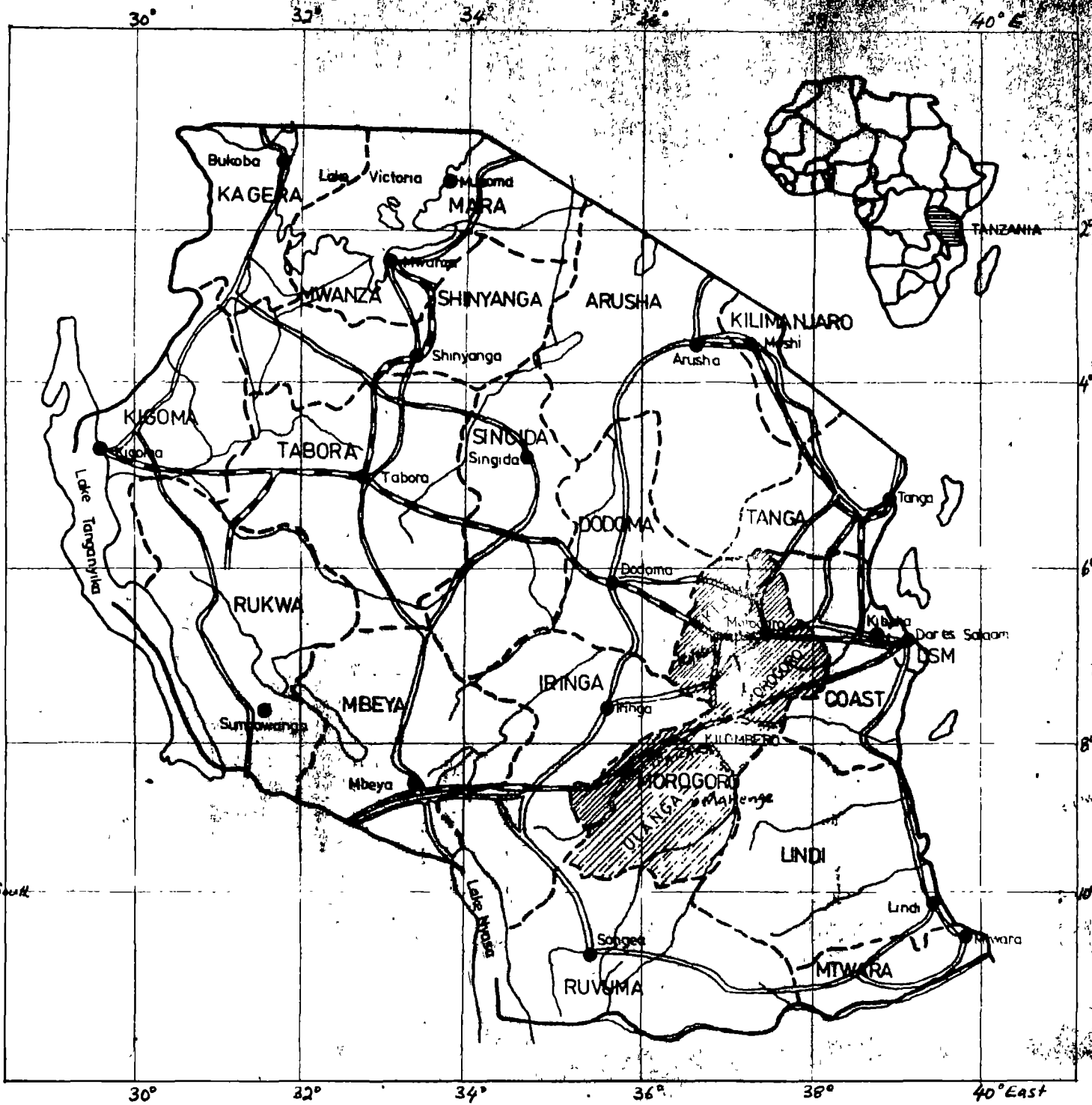
Morogoro is amongst the twenty regions of Tanzania Mainland (excluding Zanzibar) which is located almost in the eastern part of Tanzania mainland. It is situated approximately between latitude  $6^{\circ}$  and  $10^{\circ}$  south of Equator ( $0^{\circ}$  line), and between longitude  $35^{\circ}$  to  $38^{\circ}$  east of Greenwich. See Fig. 1 which is showing the administrative regions of Tanzania.



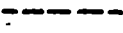

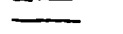

The total population of the region is about 1 100 000 people (1983), out of this about 890 000 people (which is about 81 % of the total population) live in rural areas, in four of its districts, namely Morogoro Rural, Kilosa, Kilombero and Ulanga (Mpango wa Maendeleo wa Mkoa 1983).

The total surface area of the region is about 7 300 km<sup>2</sup>, with the populace's main activity centred on agriculture (cultivating rice, maize, cotton and millet) and livestock keeping (grazing cattle, goats and sheep).

The region has a tropical climate with two distinct seasons, the rainy season which starts on December up to April and the remaining months contribute to dry season. During rainy season, renders part of the southern region (Kilombero and Ulanga Districts) inaccessible, and in dry season, part of Northern Morogoro Rural and Kilosa Districts, experiences water shortage situation. This water shortage in these areas is commonly surface water, but there are areas, particularly mountaineous and those areas bordering Dodoma Region, face even underground water shortage. However, where possible, underground water has been exploited to serve the rural areas, and this has been either as shallow or deep wells, and the shallow well exploitation in this region is about 71 % of the total underground water tapped. For more information about rural water supply in the region see annex 15.





-  AREA OF STUDY - MOROGORO REGION
-  RAILWAY
-  REGIONAL BOUNDARY
-  DISTRICT BOUNDARY
-  ROADS
-  RIVERS

SOURCE - MAP TANZANIA, IN MAPS (BY L BERRY)  
 SCALE APPROX 1:7700 000  
 (REDUCED FROM 1:3 000 000)

Fig.1 Map of Tanzania showing administrative regions

### 1.1.1 Shallow wells background

Following administrative arrangement between the Governments of Netherlands and Tanzania, charged the DHV Consulting Engineers, at the beginning of 1977, to execute the Morogoro Domestic Water Supply Plan (MDWSP). And the Maji Ministry, as an authoritative body for the implementation and execution of the plan (WSSSM, Final Report 1982).

From the results of MDWSP, several recommendations were laid down for the Maji Ministry to consider them; amongs them was the implementation of shallow wells in most hit and crucial areas, where surface water was critical in dry season, thus leaving the inhabitants with a problem of fetching water, in particular northern part of Morogoro Region. With this recommendation, led to several bilateral talks between the two governments, which resulted to the introduction of Morogoro Wells Construction Project (MWCP) in the middle of 1978, under the DHV Consulting Engineers from the Netherlands.

With the major aim of providing water to these needy areas, MWCP was supposed to produce 750 wells for 3 years, at an average annual production of about 250 wells (with each well assumed to serve 250 people), hence at the middle of 1981, when the project was to end, the population to have been served with water would have been about 188 000 people. But actually by the end of June 1981, only 550 wells have been constructed with an assumed population to have served of about 137 500 people (MWCP, Sixth Progress Report 1981). This represented only 73 % of the work supposed to have done as per contract.

Also among other agreements, the MWCP was, after construction, to maintain these wells for a minimum period of 3 months, after which they were supposed to be handed over to the RWEs, whose responsibility would be to maintain them with funds to be allocated by RDD each year. This handing over was supposed

to be gradual and eventually would have led to a total complete transfer of all constructed and properly functioning wells at the end of the contract. But unfortunately, due to several reasons, this has not been the case up to the time of writing this paper.

Due to several further extensions of the MWCP, at the end of 1983, there were 827 wells with an assumed served population of about 206 750 people, only in the northern part of Morogoro Region i.e. Morogoro Rural and Kilosa Districts (MWCP, Tenth Progress Report, 1983). This number includes even the wells constructed under the Rehabilitation Programme which started in July 1982, after the re-extension of the MWCP. The main aim of Rehabilitation Programme was to be a basis of formal handing over of the wells to the RWE (MWCP, Ninth Progress Report 1983).

Another agreement which was due to bilateral talk between the two governments, held in early 1981, was that there should be a gradual transfer of MWCP activities (survey and construction of wells) to RWE, in order that the RWE's office could start to accommodate and familiarize with these activities such that at the end of the projects' contract, the RWE's office could be in a position to carry on the activities with much less problems. Thus in July 1981, two groups of surveyors and two groups of construction were transferred to RWE's office. These groups could concentrate in siting and constructing shallow wells in Southern Morogoro, i.e. Kilombero and Mahenge Districts. If possible, these groups should follow recommendations made by WSSSM and DWE's office. The funds for siting and construction would be that part which was being contributed by Tanzanian government, as local component and should be funnelled through RDD to RWE (MWCP, Sixth Progress Report 1981).

Hence with the inclusion of wells constructed by these transferred groups to RWE's office, the total number of wells (functioning) all over the region is 935 (see drawing 31-83 annex 1) and assumed to have served a population of about 234 000 people, which brings to about 30 % of the rural population, of this region, to have been served with shallow wells at the end of 1983.

Before the introduction of MWCP, subsequently introduction of tube wells, the region has been undertaking the construction of ring wells. The construction was undertaken by the DWE's under the assistance of RWE, and the construction technique was by means of sinking ring or blockwork, while underneath of ring or blockwork excavation continues. On completion of construction a hand pump - Sigma pump (Fig. 2) was installed, and these amounted to 41 wells before the introduction of tube wells by MWCP.

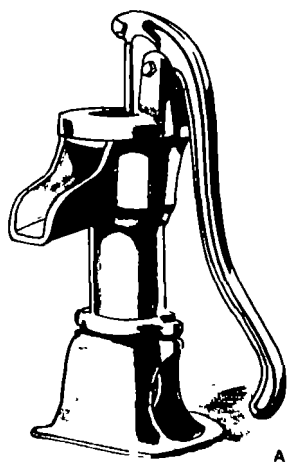


Fig. 2. Sigma pump.

Due to several problems created by these Sigma hand pumps, quite a substantial number of ring wells was rendered un-useful and eventually most of these broken hand pumps had to be changed or replaced by other types of hand pumps (SWN and Kangaroo) introduced by MWCP and this was done recently.

Quite obvious, with the inclusion of these ring wells with hand pumps, seemed to be a relatively demanding task for the RWE in maintaining them. However the RWE has to plan carefully his workload to contain this situation, when availing to him all necessary and required facilities.

#### 1.1.2 Type of wells used in the region

Before the introduction of tube wells by MWCP, the region, as stated before, was constructing ring or block work wells. And where there were no ring wells or block work wells, the village communities used to draw water from hand dug wells which were dug according to local village technology available by the villagers themselves.

Thus with the introduction of tube wells, at present, most existing shallow wells are tube wells. According to experience from MWCP, the tube well construction technology seems to be relatively cheap as compared to ring or blockwork wells. The cost of blockwork wells increases with increase in depth due to the fact that dewatering is required at relatively deep depths. The tube well construction is labour intensive using simple and relatively cheap tools and equipment. Ring wells are used only where the yield of aquifer is relatively small, therefore they are constructed in order to provide storage capacity.

### 1.1.3 Construction of shallow wells

In this paper, the shallow wells referred to are regarded as wells with depth up to 15 m, and the structure of these wells will be tube wells.

These wells are constructed using different types of augers, tripods and bailers, depending on the lithology of the soil. By manually rotating these augers, they are driven into the soil, and by emptying the augers and repeating the procedure several times, the required depth is reached (Fig. 3a and 3b). The starting or initial diameter of the well is 250 mm and final or finishing diameter ranges from 125 to 160 mm. During drilling the augers are attached to extension bars and this is connected with wire rope which goes through a pulley system attached or fixed at the top of the tripod. On finishing the well, slotted PVC pipe followed by plain PVC are installed and then gravel pack packed around the slotted PVC and then finishing with backfill (Fig. 4). Above the ground, the slab is constructed, and within the slab, a concrete cover is installed at the centre of the well, to receive the pump.



Fig. 3a. Hand drilling using auger.



Fig. 3b. Hand drilling showing tripod support.

## 2. OPERATION PRINCIPLES OF SHALLOW WELLS AND HAND PUMPS

The operation of the wells with the pumps is by means of pulling up and down of the hand or stepplate for the Kangaroo (footpump), which uses human energy as the source of power. This leads to the fact that the operation costs of the pumps are almost negligible. So in this paper, the operation which will be described will be only the principles with respect to the shallow wells and pumps.

### 2.1 Structure and operational principles of shallow wells

The structure of the shallow well depends on the lithology of the soil which is found out during drilling particularly in well siting. And it is from this well siting (surveying) that the structure is determined by designing.

#### 2.1.1 Structure of shallow wells

Based on the fact that the water to be extracted is below ground level, then water has to be pumped from the aquifers by using hand pumps. Most of the aquifers which are being utilized are unconfined or non-artesian. In order to pump water to the ground surface, a collection of water is required and this can be facilitated by constructing wells the depth of which ranges from 4 - 15 m and with diameters ranging from 125 - 160 mm. After construction, the structure of the well consists of PVC pipes slotted or screened and plain or blind pipes connected in series. At the bottom where the pipes rest, there is a wooden plug fitted to the pipe. Adjacent to the aquifer, the screen pipes are installed depending on the depth of the aquifer, and fixed to this are series of blind PVC pipes up to the ground surface. To make the pipes vertically centred, centre devices made of wood, are fixed around the pipes at defined intervals depending on the depth of the pipes. Around the screen pipes, the gravel



pack is poured up to the height of the screen pipe. After the gravel pack follows the clay seal and the rest filled with backfill material. Just before the ground surface another clay seal is poured. A concrete cover is fitted at the centre of the hole and around it a slab is constructed consisting of packed stones or hardcore of about 230 mm thick and an apron of cement/sand mortar of mix 1:6 and thickness of about 25 mm is poured all around. The diameter of the slab from the centre is about 1,5 m. In order to protect the slab surrounding from the spill water, cement mortar sill is constructed with a provision of a gutter which leads to the drainage ditch. Footsteps are constructed, if a Kangaroo pump is to be installed, and a bucket stand is provided to help the users to rest their buckets after drawing water. For the structure of the well see Fig. 4.

#### 2.1.2 Operation principles of shallow wells

Water is generally tapped from the unconfined aquifers which are relatively shallow, having water table ranging from 1,5 to 5 m deep below ground level, depending on the soil characteristics and conditions. Water passes through the gravel pack to the screen pipes into the well, where it is collected. The gravel pack and screen pipes act as filter media, and those particles bigger than the pores provided by the gravel pack, are retained, and also those particles larger than the slots of the screen, but smaller than the pores provided by gravel pack are retained behind the screen, and hence clear water passes into the well. To clean the retained particles the well is developed by means of a surge plunger, by pushing it up and down through the well.

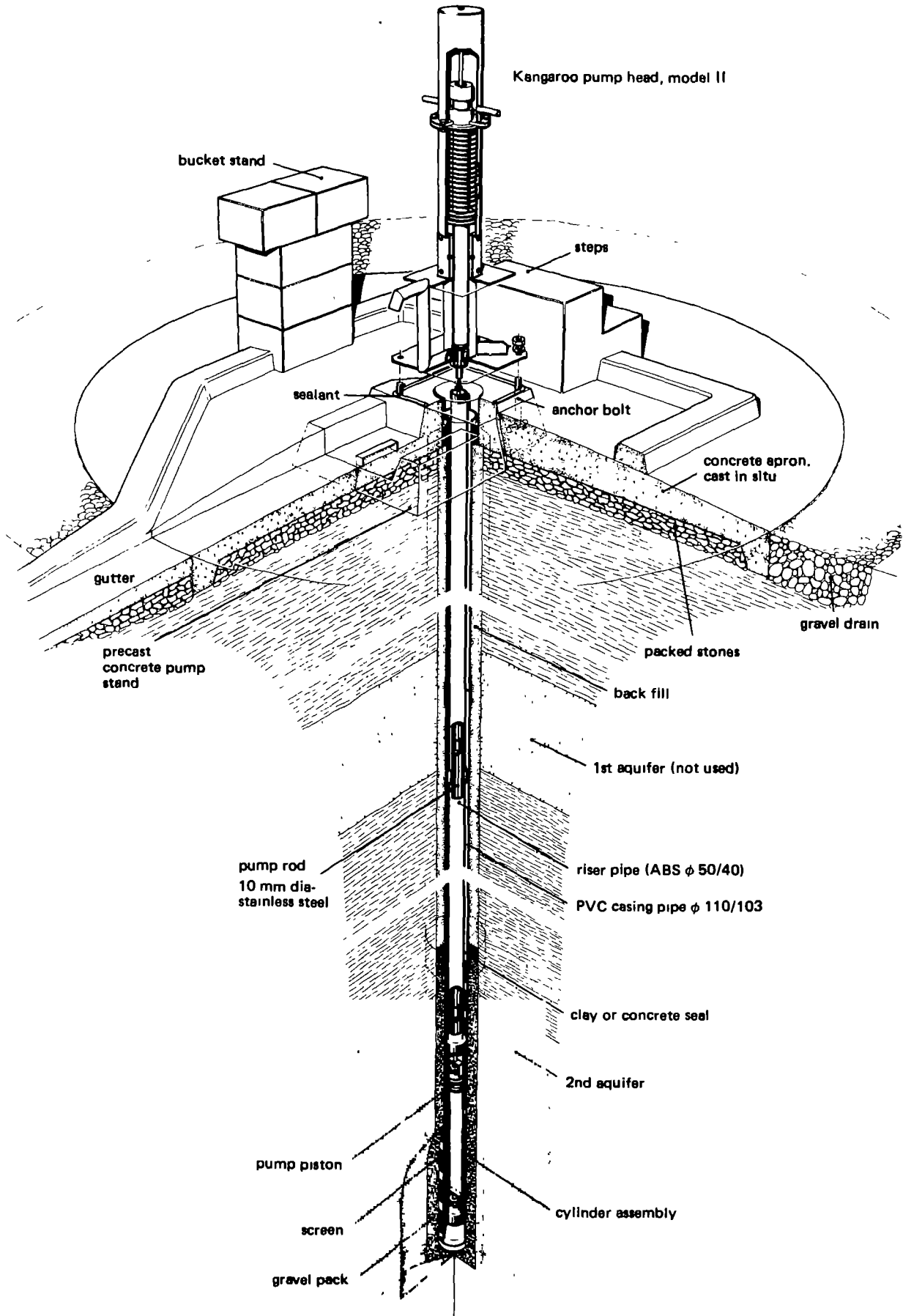


Fig. 4. Tube well structure.

## 2.2 Structure and operational principles of hand pumps

The hand pumps, structurally, are so designed that human energy, as source of power, can be used. And this being the case, the energy input has to be as small as possible to protect the human being from exhausting his energy, and getting tired.

### 2.2.1 Structure of hand pumps

The pumps mainly in use are hand and foot pumps, having the superstructure as the pump head and substructure comprising of rising main, pump rods and pump cylinder. The pump rods hang inside the rising main (drop pipes) and attached to the pump cylinder by a piston to the bottom and fixed to a pump rod of the pump head to the top. The rising mains are attached to the bottom of the pump head, such that they encase the pump rods. To the rising mains, plain sockets are used to connect one after the other, and to the pump rods couplings or connector are used to join them. The cylinder comprises of the piston valve (plunger valve) which is movable on action, and a fixed foot valve at the bottom. For these valves see Fig. 5a and 5b. The pump rod which is fixed inside the pump head is attached to the bearing of which the handle is fixed. For all fixation of the mentioned components of the pump see Fig. 4.

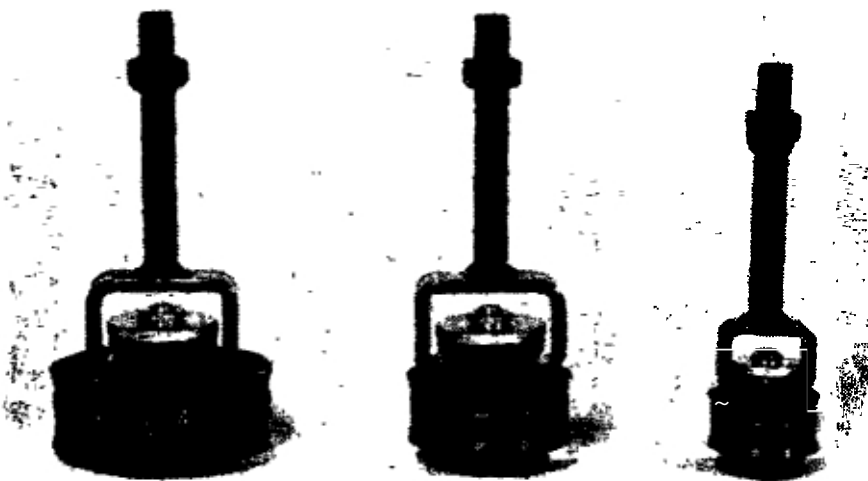


Fig. 5a. Piston assemblies for 4", 3" and 2" cylinders.



Fig. 5b. Foot valves for 4", 3" and 2" cylinders.

#### 2.2.2 Operational principles of hand pumps

The operation of hand pump is based on the principles of reciprocating action, where a displacement of water takes place, and the principle is the same for either a hand or a foot pump.

This type of pump operates on the basis of a plunger and check valve both inside a cylinder (Fig. 6). Depending on the position of the pump cylinder, the pump is a suction pump when the cylinder is above the ground, and the pump is a lift pump when the cylinder is below ground water level. Basically, on downward stroke the check valve is closed and plunger valve, which is connected to a piston, is opened. The upward stroke, the plunger valve is closed due to water above it, and the check valve is opened to allow water to pass through at the same time the water above the plunger is pushed up to the spout where it is discharged. On successive repetition of the downward and upward stroke action the water is continuously drawn from the well to the ground level where it is being collected (Mc Junkin F.E. 1977).

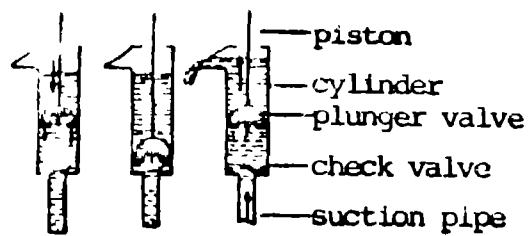


Fig. 6. Downward and upward stroke of reciprocating pump.

### 2.2.3 Pump types in use

There have been different types of pumps which have been in use in this region since the inception of shallow wells, ranging from Sigma to conventional hand and foot pumps. The former pumps have proved to have shorter life span due to frequent breakdowns and subsequently out of use. And repair has been a problem because even after repair, the operation still takes short time.

Very recently the MWCP has introduced the foot operated pump, Kangaroo, starting with a circular cross-section (Fig. 7a), and through modifications, they introduced a square cross-section which is still being used (Fig. 7b). In the early 1980's they introduced a hand pump SWN 80 (Fig. 8a).

According to field tests and appreciation from the users, it has been found out that two pumps have been in permanent use, i.e. the square cross-section Kangaroo (well appreciated by users) and SWN 80 (due to technical viability). Even though these pumps have undergone several modifications, still problems observed from the field necessitate for further modifications.

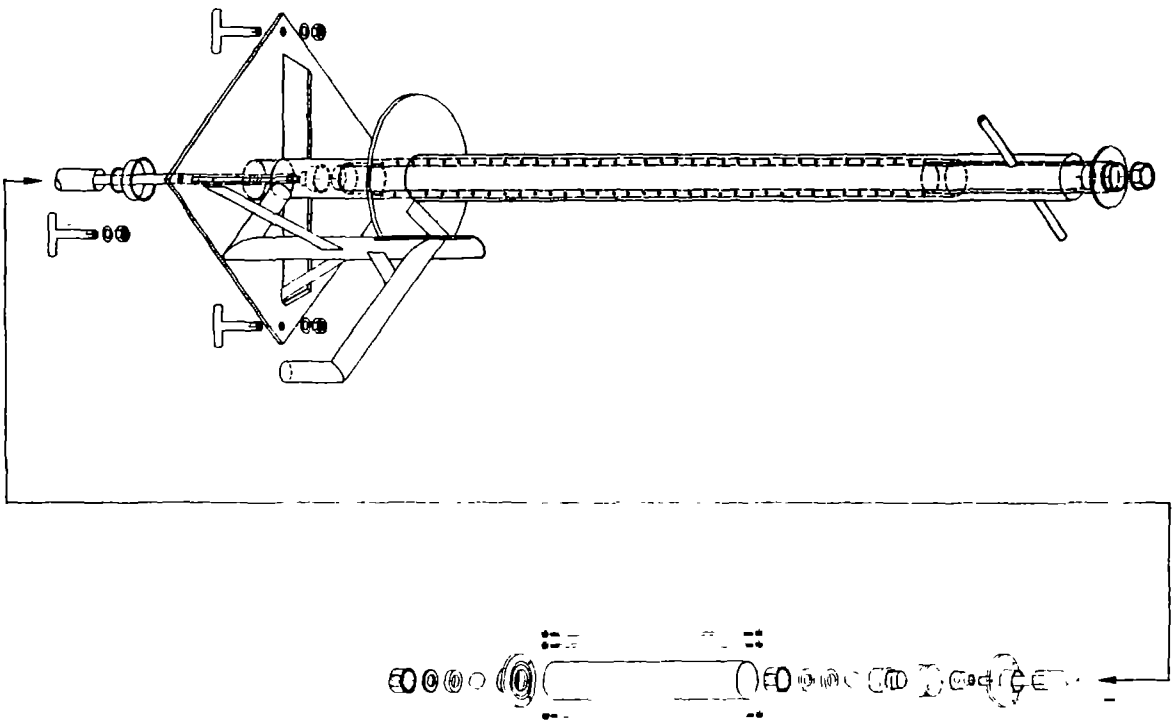


Fig. 7a. The circular Kangaroo pump.

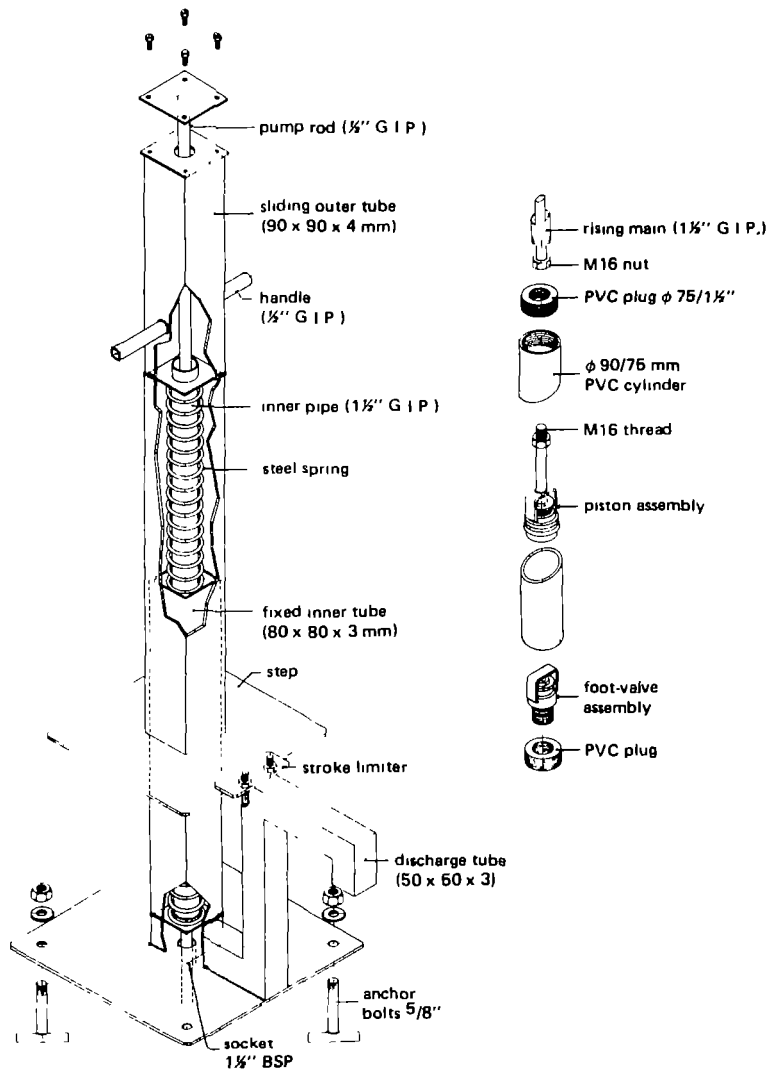
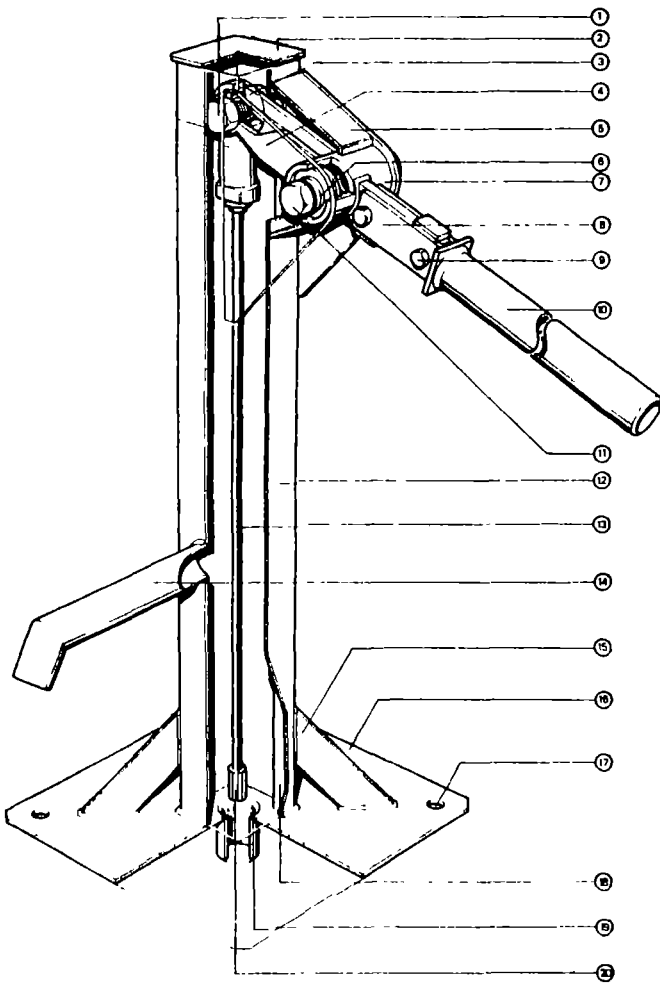


Fig. 7b. The square Kangaroo pump.



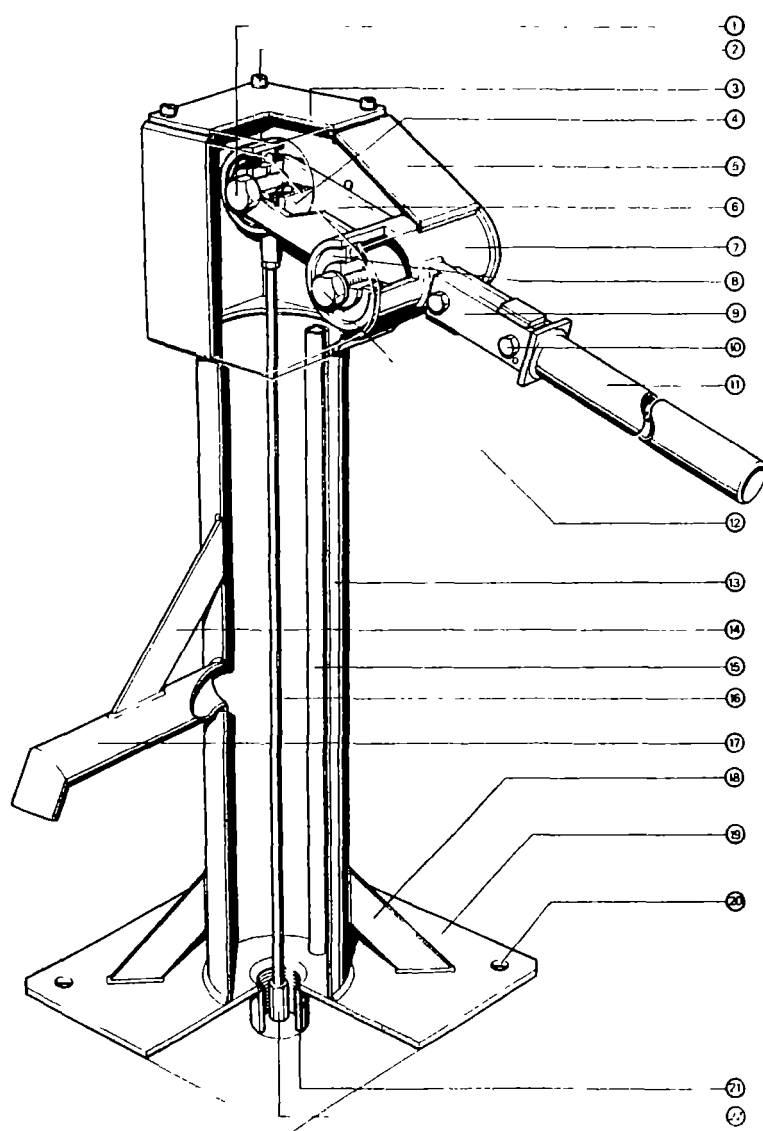
## SWN 80 PUMP HEAD

## Item number Description

- |    |  |
|----|--|
| 1  | pivot bolt (M 20)  |
| 2  | inspection cover (5 mm sheet steel)  |
| 3  | rod end spherical bearing (INA, GIR 30 UK 2RS),<br>static loading capacity 10.2 tonnes             |
| 4  | fulcrum pivot link (50 x 8 mm strips)  |
| 5  | top of pump head (5 mm sheet steel)  |
| 6  | ball bearing SKF 6206 2RS (2 units) static loading capacity 1.02 tonnes each                       |
| 7  | bearing housing (ø 76 1/8 5 mm steel tube)   |
| 8  | connection handle pump head (inner strip 50 x 15 mm,<br>outer strips 50 x 6 mm)                    |
| 9  | handle bolts (M10)   |
| 10 | handle (1 1/2" gas pipe, 48.2 mm outer dia., 3.25 mm wall thickness),<br>handle length as required |
| 11 | pivot bolt (M20)   |
| 12 | pump head body (tube, 100 x 100 x 4 mm)  |
| 13 | pump rod (10 mm dia. stainless steel 316)  |
| 14 | spout (1 1/2" gas pipe)  |
| 15 | pump stand brace (50 x 5 mm strips)  |
| 16 | pump base plate (400 x 400 x 8 mm)   |
| 17 | bolt hole (22 mm dia. 330 mm on centres)   |
| 18 | vent pipe (3/8" gas pipe)  |
| 19 | threaded drop pipe connection (1 1/2" gas thread, modifications on request)                        |
| 20 | threaded pump rod connector (stainless steel 316, M10, spanner size 17,<br>length 40 mm)           |

Fig. 8a. SWN 80 hand pump.





### SWN 81 PUMP HEAD

Item number	Description
1	pivot bolt (M20)
2	hexagon socket cap bolt (M10)
3	inspection cover (160 x 160 x 5 mm)
4	ball bearing (SKF 6210 2RS) covered at both sides by oil seal ring, static loading capacity 1.96 kN (2 tonnes) optional rod end spherical bearing (INA, GIR 30 UK 2RS), static loading capacity 10.2 tonnes
5	top of pump head, 5 mm sheet steel
6	fulcrum pivot link (60 x 6 mm strips)
7	bearing housing (φ 108/88 mm tool steel)
8	ball bearing SKF 6210 2RS (2 units)
9	connection handle pump head (inner strip 50 x 15 mm), outer strips 50 x 6 mm)
10	handle bolts (M 10)
11	handle (1 1/2" gas pipe, 48.2 mm outer dia., 3.25 mm wall thickness) handle length as required, standard lengths 800 and 1100 mm, from centreline pivot point
12	pivot bolt (M20)
13	pump head body welded pipe (152.4 mm O.D., 3 mm wall thickness, length 782 mm)
14	spout brace (50 x 5 mm)
15	vent pipe (3/8" gas pipe)
16	pump rod (10 mm dia. stainless steel 316)
17	spout (1 1/2" gas pipe, center of outflow opening 270 mm from pump head body, 350 mm above level of base plate)
18	pump stand brace (50 x 5 mm)
19	pump base plate (400 x 400 x 8 mm)
20	bolt hole (22 mm dia., 330 mm on centres)
21	threaded drop pipe connection (1 1/2" gas thread, modifications on request)
22	threaded pump rod connector (stainless steel 316, M10, spanner size 17, length 40 mm)

Fig. 8b. SWN 81 hand pump.

### 2.3 Energy source and requirement

Obviously water from the wells cannot be extracted or tapped without the use of power, and hence designs of well pumps are such that they can use one of the following power form:

#### Human power

The application of power lead to the fact that the power for such pumps originates from human energy. As such, and more of the recent designs of pumps, indicates the use of as little energy as possible from human being. Experience from developing countries has shown that the users of hand pumps are predominantly women and children.

Thus the table 1 (McJunkin 1977) which resulted from virtually no measured data, shows that an average human energy output of about 0,10 Hp (75 watts) appears reasonable. From the same table, it shows that power output from human being is a function of age and pumping time. As age increases with increasing time, the useful power produced decreases. And this type of source of power is generally used to extract water for domestic use.

Table 1. Man generated power. Modified from Krendel (1967).

Age of man Years	USEFUL POWER BY DURATION OF EFFORT (in Hp)					
	5 min.	10 min.	15 min.	30 min.	60 min.	480 min.
20	0,29	0,28	0,27	0,24	0,21	0,12
35	0,28	0,27	0,24	0,21	0,18	0,10
60	0,24	0,21	0,20	0,17	0,15	0,08

### Animal power

Though presently it is very rare to see animals used for generation of power for pumping, it has extensively been used during ancient days for lifting water from wells. They have been used to draw water for domestic and agricultural purposes, but more predominantly for agricultural use where much longer time of pumping is required.

### Natural power

Due to technical and economical reasons other sources of power originating naturally e.g. wind, solar and gravity power have been found suitable. Only that there has been very little use in them (wind and solar) due to their prohibitive characteristics.

### 3. PRACTICED MAINTENANCE SYSTEMS ON SELECTED REGIONS

Not only Morogoro Region that has embarked largely on shallow well programme, but several other regions in Tanzania are now or have tuned themselves to adopting shallow wells as source of rural water supply due to several conditions e.g. economical and technical reasons.

Of the twenty regions, Shinyanga, Mtwara, Lindi and Mwanza are famous for these shallow wells. Shinyanga Region started constructing shallow wells under the DHV Consulting Engineers form Netherlands. Mtwara/Lindi Regions are constructing shallow wells under Finnwater Consulting Engineers from Finland. Mwanza Region is constructing shallow wells through World Bank aid and executing it under the RIDEP.

Hence the emphasis on the following maintenance systems of shallow wells for these regions will be on the executorial and organizational aspects.

#### 3.1 Shinyanga Region

This region started shallow well programme in October 1974 concentrating on ring wells with hand pumps, under the DHV Consulting Engineers (Morogoro Conference on Wells 1980). Due to some technical constraints, the region at present is changing from construction of ring wells to tube wells. At the same time changing, where necessary, goes from Shinyanga hand pumps to SWN 80 and 81. For Shinyanga hand pump see Fig. 9, for SWN 80 see Fig. 8a and for SWN 81 see Fig. 8b.

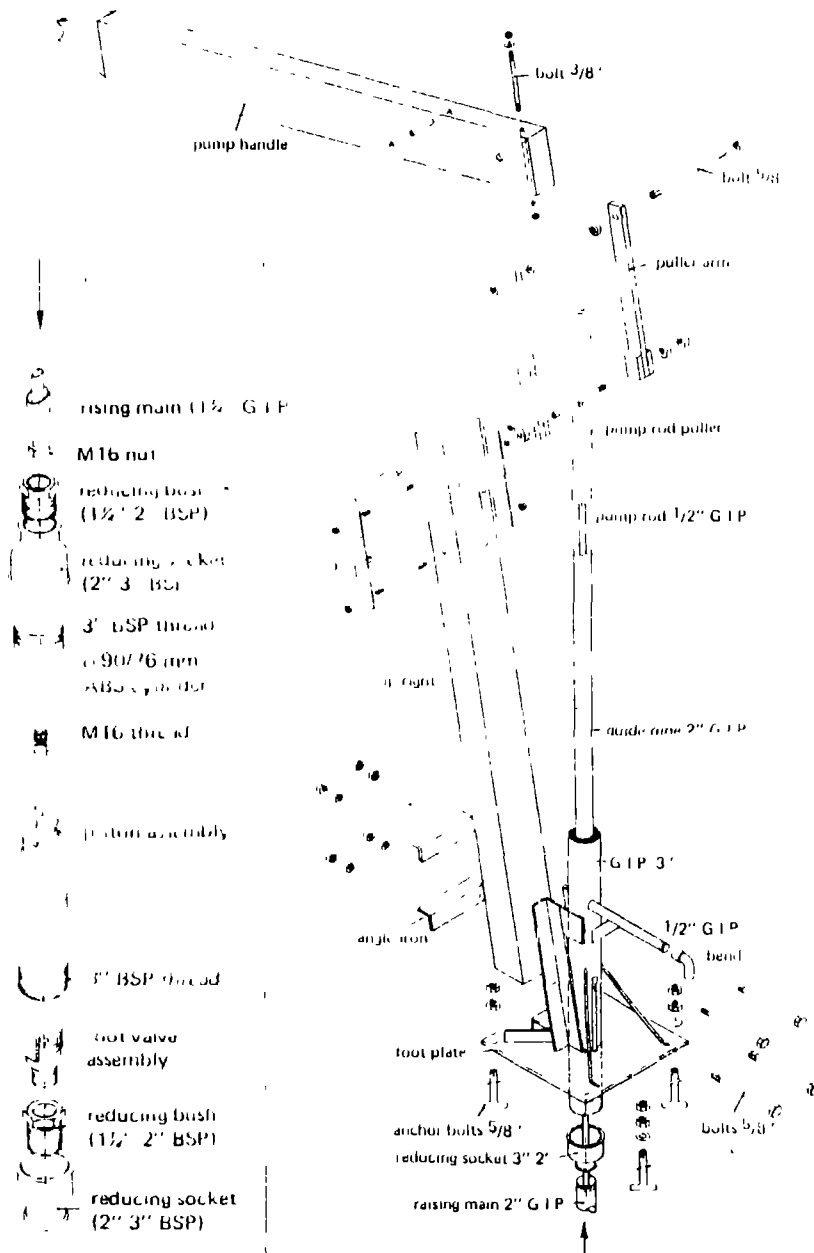


Fig. 9. The Shinyanga pump.

### 3.1.1 Maintenance organization

From what is learnt in the field visit in this region, it has been established that the maintenance organization of shallow wells is under the section of shallow wells, which is among the several sections under the RWE. The shallow wells section is headed by sectional head, just like other sections, who is then responsible for maintenance of shallow wells. The section has sub-section e.g. survey, construction, maintenance and stores, but maintenance is sub-divided into factory, workshop and operation and maintenance (Fig. 10). Therefore operation and maintenance is a sub-division of maintenance sub-section. The maintenance sub-section is headed by Regional Maintenance Officer who is directly responsible to the head of section. Hence the factory, workshop and maintenance and operation sub-divisions are headed by RMO. The factory and workshop are mainly for minor modification, manufacture of simple spare parts, repair of pumps and manufacture of concrete rings respectively while operation and maintenance are for general maintenance activities.

At district levels, there is one section of operation and maintenance headed by District Maintenance Officers (DMOs), and he is under the DWE but also answerable to RMO. Unlike regional level, at district level there are only store and maintenance sections only for shallow wells.

The village communities, as main users of pumps, are also included in the organization at village level in that they are directly concerned with operation of pumps. Where there are pumps in the villages, pump attendants are selected by the village community and trained by government to undertake the general care of the pumps. These pumps attendants are answerable to DMOs and village water committee (Morogoro Conference on Wells 1980).

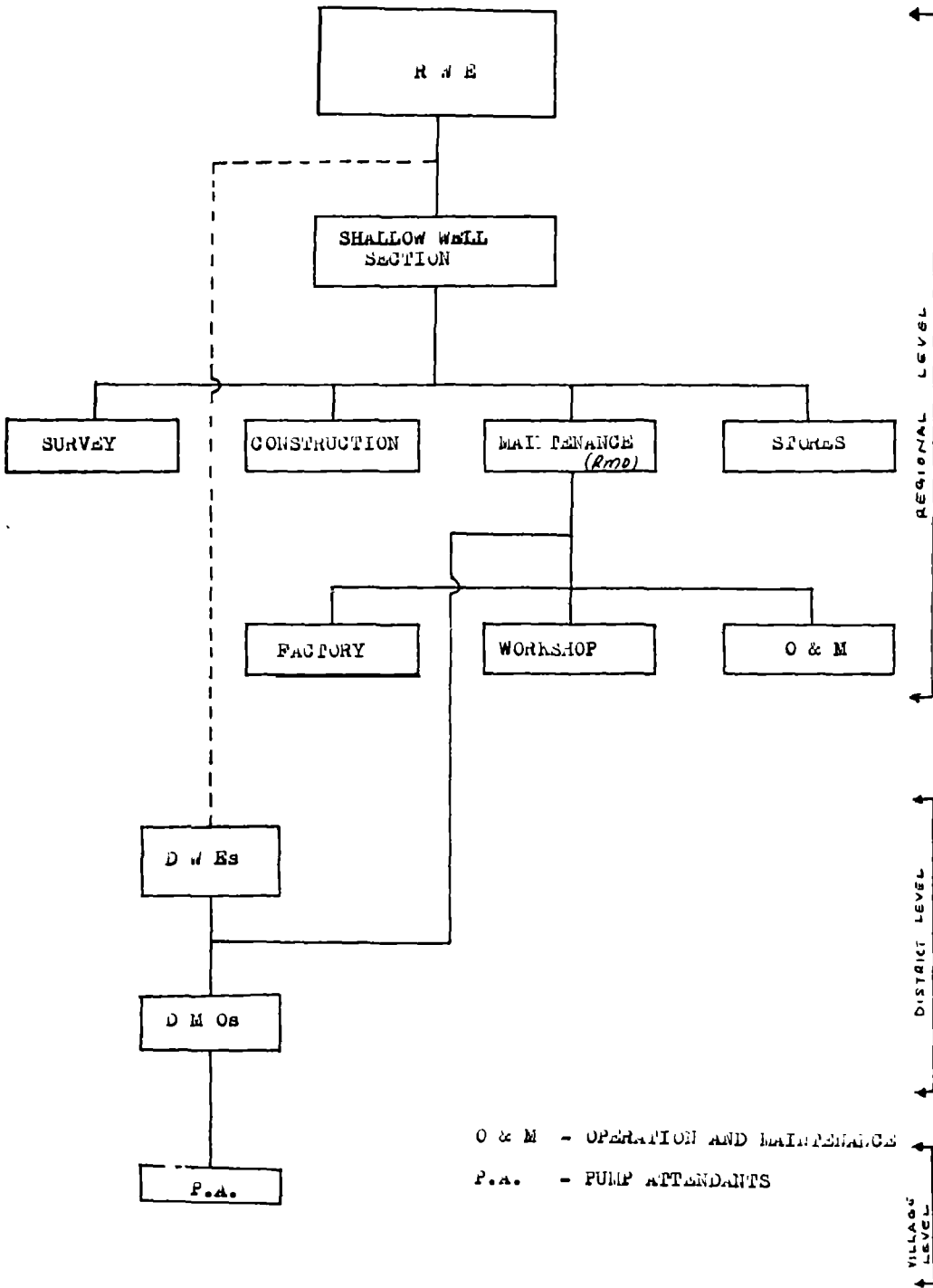


Fig. 10. Shallow well organization chart - Shinyanga Region.

The funds for maintenance are acquired from the RDD, who each year budgets for it, even though it does not meet the requirements and channelled to RWE who is the authorizing officer. Due to financial incapacibilities, the carrying out of maintenance activities has been facing some difficulties. Thus, there has been a supplementary funds given by the Netherlands Government for that purpose.

Thus it shows that the organization of maintenance goes down to the village level where the pumps are located.

### 3.1.2 Maintenance execution

The maintenance of pumps and wells is executed by the RMO who does the major repairs and inspection trips once per three months with his maintenance team. At district level, the DMO is responsible for minor repair and sometimes major repairs, frequent check-ups, and attending to emergency calls from villagers. At village level, the village communities are responsible for the care of the wells and pumps. The reporting chain for a problem which needs attention or if any assistance is required, is through the DMO, from the village level to the RMO.

The villagers or users select one or two pump attendants who are given the responsibility of taking care of the pumps normally ranging from 3 - 4 ring wells per village, and 6 - 9 hand drilled wells per village (Morogoro Conference on Wells 1980). They have to check the following regularly:

- operation of the pump
- bolts and nuts are tightened
- clean the slab
- clean the spoilt gutter
- clean the pump head.



If any pump requires immediate repair, the pump attendants have to fill a request form which is given to them. The request form has got a drawing of a pump with all parts shown with numbers and names to enable the pump attendants to locate the defected part (Annex 2). The request form, after filling it, is sent to the DMO for action.

For the supply of spare parts, it is intended to keep the necessary and frequently used spare parts at district stores. Users may use the same form to request for any spare part they want to replace in the pump in case of very minor repairs which can be done by pump attendants.

Up to now the maintenance system in this region is decentralized up to the district level, but it is the intention of the organization to decentralize the system up to the village level and entirely leave all maintenance to the users. The region and districts will only give assistance on technical matters related to the pumps, make modification where required, manufacture simple spare parts, supply of spare parts and other required materials and making repairs beyond the village level capability.

On the question of ownership of the wells, it has been felt that there is a need to initiate this attitude and inject it to the users. Thus on completion of the pump installation, the well is handed over to the users by signing a handing over certificate. The certificate as shown in Annex 3 is signed by village chairman as recipient and the DDD as a handing over officer. This alone cannot be said is sufficient to alert the users on appropriating the well and pump, but it gives a first impression that they have the right of ownership of the well, and that it belongs to them and not the government, as many of the villagers imply.

From the regional office data, the region has a total number of 1170 wells as per 30th June, 1983, and the cost of maintenance per well per year is approximately TAS 420. This is relatively small compared to other regions and it might be due to lack or improper record keeping and analysis.

### 3.2 Mwanza Region

Like Shinyanga Region, this region is embarking on the construction of ring wells, but also due to some technical problems, they are intending to adopt tube wells (hand drilled wells) in the near future. They have got three types of pumps in use i.e. Shinyanga hand pump which is predominant, Kangaroo pump and hand pump SWN 80. But as it appears they will adopt Kangaroo and SWN 80 in the near future.

The organization of shallow wells is similar to that of Shinyanga, but only lacking maintenance sub-section due to lack of trained manpower. Another difference in this organization is that there is an accounts sub-section dealing with shallow well construction, but still under the authority of RWE, whereas in Shinyanga Region they use the general accounts section.

Maintenance of pumps, presently, is carried out by the District Maintenance Unit which is under DWE's office. This unit is charged with all maintenances of rural water supply schemes in the district. This is an unavoidable work load, which reduces the efficiency of the shallow well maintenance, but it is the intention of the region to train RMO, DMOs and pump attendants, in the near future, so that they could specifically deal with maintenance of shallow wells and pumps. And the region hopes, after the formation of the maintenance section, to follow the same execution as that of Shinyanga. At present the region has a total number of 197 wells as per 31st August, 1983.

### 3.3 Mtwara/Lindi Regions

The construction of shallow wells in these two regions is carried out by Finnwater Consulting Engineers from Finland. At first they started on with the construction of ring wells but due to some technical problems they are adopting tube wells. At the end of September, 1983, there were totally 1500 wells in the two regions, of which 1100 are ring wells and 400 are tube wells. All them are fitted with hand pumps mostly Nira pump (AF-76) (Fig. 11). There are also few SWN 81, Kangaroo, Malawi and Blair pumps. In concentrating more on the VLOM pumps, the World Bank project has designated one expert in Mtwara/Lindi Regions to do the field research studies on the said above pumps. This will result in determining a suitable pump for Tanzanian conditions, and production of that suitable pump might be in large scale.

It should also be noted that the Finnwater Consulting Engineers are not only concentrating on shallow wells alone, as a means of supplying water to these rural areas, but also are engaged in other types of water supply. They are also engaged in the maintenance programme of shallow wells.

#### 3.3.1 Maintenance organization

Since the Finnwater Consulting Engineers are not solely dealing with well construction, maintenance sub-section is under the shallow well construction and headed by sectional head. The maintenance sub-section has similar components (sub-divisions) as that of Shinyanga and having the same functions.

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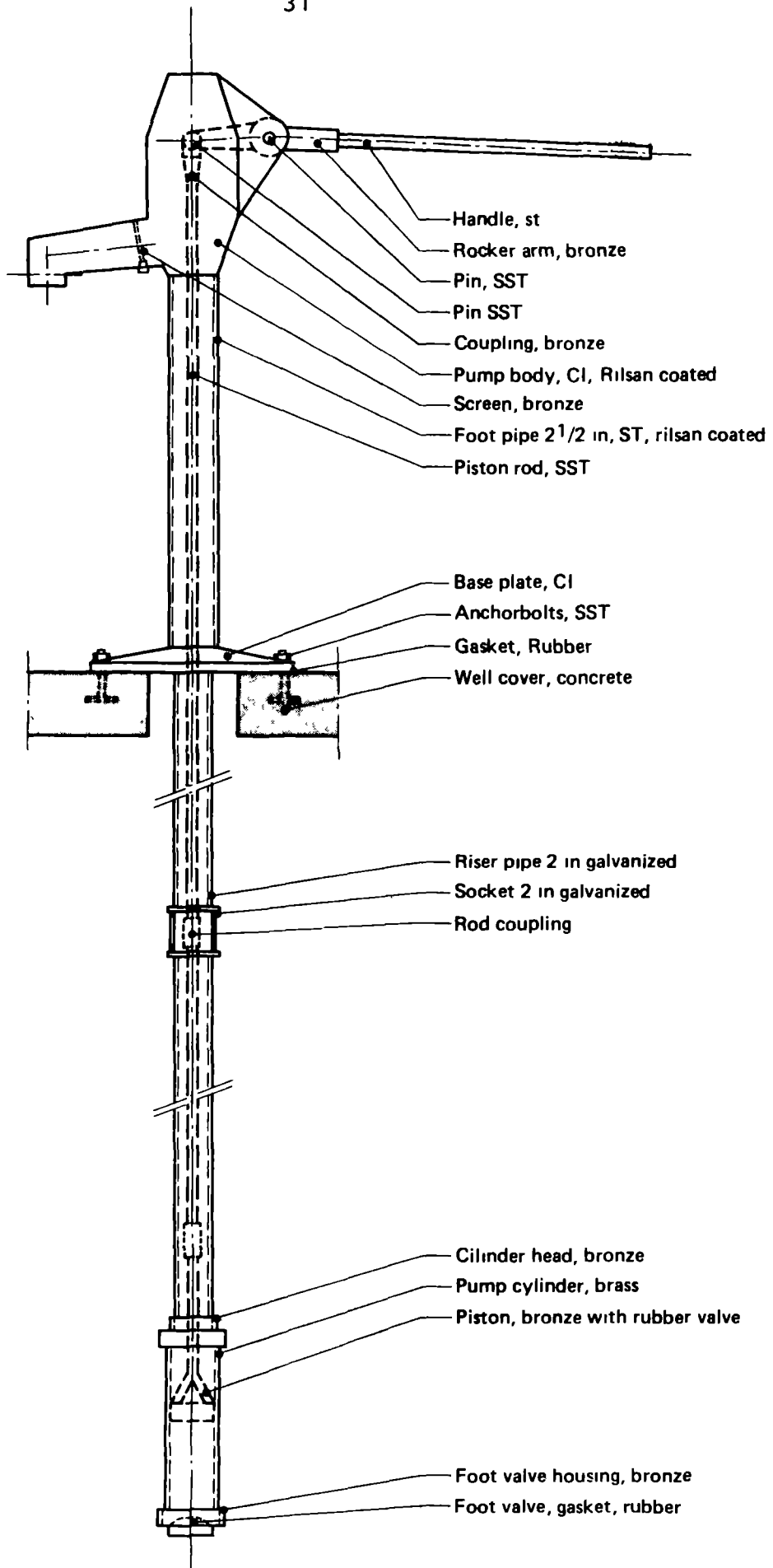


Fig. 11. Nira hand pump.

### 3.3.2 Maintenance execution

Presently the execution of maintenance system is centrally executed i.e. there is one mobile maintenance team which is solely responsible for the maintenance of wells and pumps all over the two regions.

On receiving the village request form (Annex 4) from the users for inoperative hand pump, the team reacts to it accordingly. During round up check the mobile team uses the forms as in Annex 5 to fill it. The mobile team makes a tour of the wells, all over the two regions, every three months with the following duties:

- checking the functioning of the pump
- checking the condition of the well, pump and its surrounding
- checking water quality
- doing preventive maintenance.

For more duties see Annex 6.

From the compilation of maintenance report, it has been found out, conclusively, that the following are common failures to a Nira pump (Fig. 12):

- Drop pipes (rising mains):  
due to thread and pipe rusting resulting to disconnection or drop out.
- Piston rod:  
breaking of the piston rod just above the threads due to bad operation of the lever coupling.
- The cap:  
formation of holes on the upper part of the cap due to wearing out of the absorber of the lever.

### COMPONENTS OF NIRA HAND PUMP

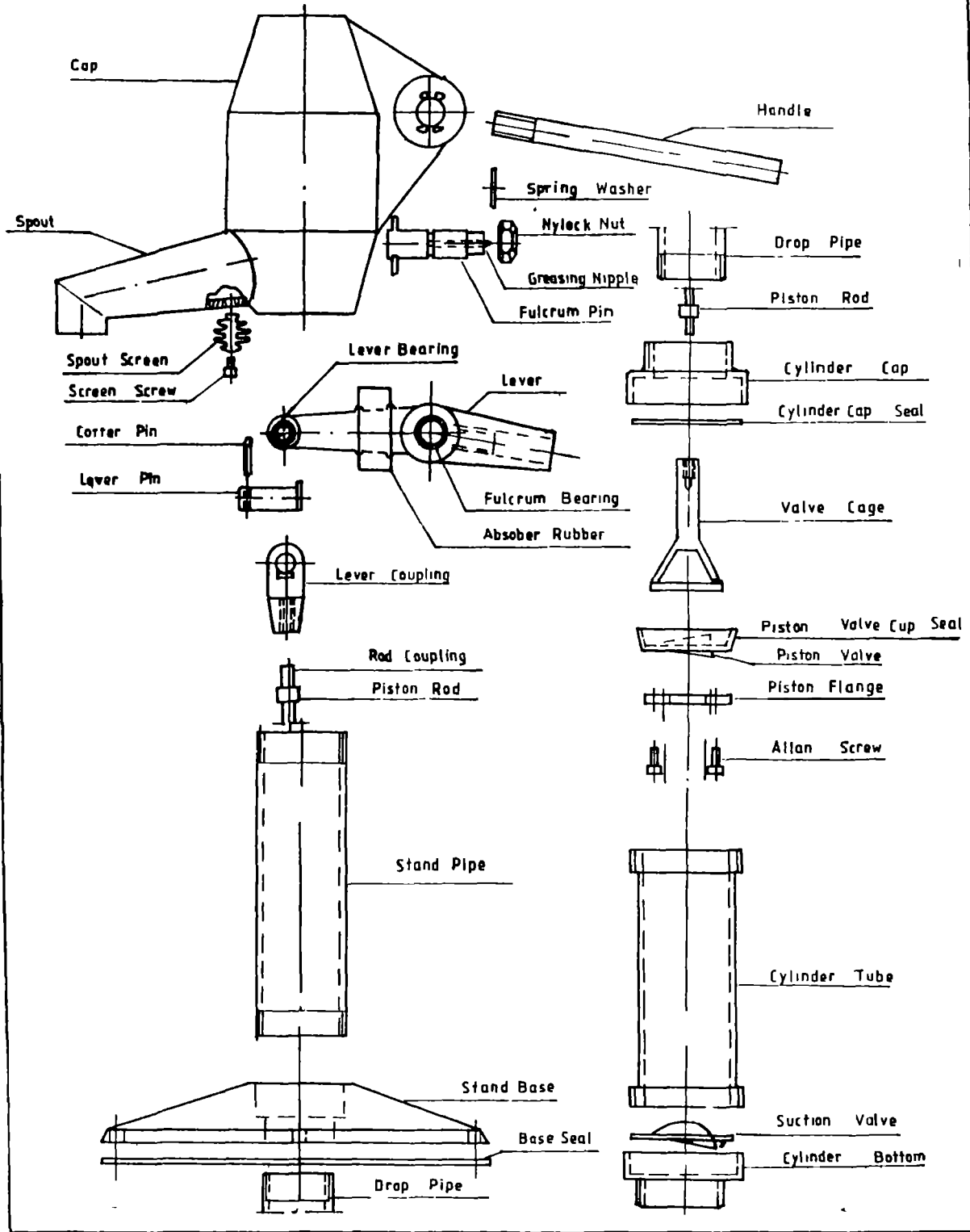


Fig. 12. Components of Nira hand pump.

- The handle and the lever:  
breaking of the handle inside the lever and wearing of coupling and lever.
- The cylinder:  
breaking down of the piston and valves and opening of bottom flange.

On realizing the high expenses of maintenance cost which is largely attributed to the transport cost, the consulting engineers as a contractor, has embarked on a decentralization system of maintenance, whereby training of the village attendants has already started. To follow later on, on this training programme will be the DMOs and RMO who will be responsible for maintenance. According to data released by the contractor, the average cost per well per year is about TAS 1000 and it is assumed that one well could be used by 250 - 300 people. Due to the training programme, stores have already been established at district level where there are stocks of spare parts and required material for maintenance, ready for use after the end of training session.

It is the concept of the contractor to have a one level responsibility just like that one of Shinyanga. In this way it is considered that the maintenance cost will relatively be reduced and more care of the wells and pumps will be increased by the users. Also it is considered that the following will happen:

- By handing over the wells to the users, the question of ownership will be appreciated by users.
- Minor repair and care of the pumps will be at village level and this will enhance village community participation.

- Village communities will be paying for spare parts.
- Pump attendants will be paid by village community depending on agreement.
- Supply of spare parts and material will be from district level.
- DMO will be responsible for major repairs and record keeping.
- RMO will make inspection trips twice a year round.

At the end of the contract, the contractor will relieve all the execution of shallow wells construction and maintenance to the RWEs. And what is gathered from the two RWEs is that they have the same opinion of following the same proposed organization by contractor and having the same maintenance system as followed in Shinyanga.



#### 4. MAINTENANCE PRACTICE OF SHALLOW WELLS IN MOROGORO REGION

With more emphasis laid on the construction of shallow wells in this region, as one of the low cost alternatives to rural water supply, maintenance of the same has drawn high impetus. Several talks have been done and are still going on, on how to achieve an effective and long lasting maintenance programme due to ineffectiveness of the existing programme.

Geared to the promotion of maintenance programmes, the generosity of the donors, particularly of the Dutch Government has been found encouraging and thus very much appreciated by the region and government.

Maintenance of these wells is not that easy. As a means of ensuring adequate and safe constant supply of water to the users, for drinking and probably for agriculture (not yet agreed upon but still under discussion), the region has tried with all its effort, under the RWE to execute the programme in line with the increasing number of wells, but the progress seems to have a very low effectiveness or moving with insufficient speed leading to many pumps still inoperative. Thus the reliability of effective operation of hand pumps is achieved through an effective maintenance system which is bound to take place in future.

Being a newly introduced technology (shallow wells construction - tube wells) with some few years of experience, the maintenance practice in this region, particularly under RWE, is still young. The introduction of full fledged maintenance programme was initiated last year with the training of DMOs who undertook a three months training course on maintenance of hand pumps in the RWE's office with a very good back-up and partial participation of the MWCP. The training started in May and lasted for three months last year. On completion of training the DMOs were sent to their respective districts to execute the maintenance programme.

Realizing the constraints or setbacks that the maintenance system is facing, the regional authority assisted by the MWCP, has proposed to have a village level maintenance system where the users are:

- responsible for minor maintenance and repair
- to be complete owners of the wells and pumps
- responsible in choosing a pump attendant (preferably a bicycle mechanic)
- responsible for payment of the pump attendant's services
- choosing a well caretaker (more preferably the one living near the well, a woman or a ten-cell leader)
- responsible for formation of village water committee who will take care of the problems arising from the pumps and users. And in future probably collecting water charges (in case the ongoing proposal is agreed upon)
- responsible for buying spare parts.

All the above considerations have the implication that the easiness and relatively low cost maintenance will be achieved.

#### 4.1 Introduction to general types of maintenance

In carrying out or executing maintenance of hand pumps, one of the following types of maintenance is bound to be met or in order to ensure effective operation of the pumps, the following types of maintenance in independent or inter-dependent state has to be followed as quoted from Mlengu (1981):

- a) Corrective maintenance  
These are minor changes or substitution of more suitable component within the structure.

- b) Predictive maintenance  
Having erected the structure or element, one tends to use sensing, measuring and monitoring devices to determine significant changes of certain parts of the structure and the result of which might be significant for the change of that part monitored.
- c) Remedial maintenance  
This is doing the maintenance as the need develops and this groups the above a), b) and c) and sometimes called "repair".
- d) Preventive maintenance  
This is actually preventing the structure from breakdowns or from troubles of operation and includes the following routine procedures:
- general check-ups of different parts
  - minor repairs, cleaning and adjustment
  - major repairs such as services pre-planned
  - lubrication.

Of the above types of maintenance, one which tends to have more attention is type d). This has been and is being practiced in this region and almost every other region with shallow wells and hand pumps. Type a) has been practiced by MWCP and this has significantly shown remarkable trend of modifications of some parts of pumps as described in section 4.6.

#### 4.2 Existing maintenance practice

The existing maintenance practice is almost decentralized with the fact that the major responsibilities lie within the district shoulders. At present the DMOs are fully responsible for the maintenance of hand pumps in their respective districts under the authority of DWEs.

#### 4.2.1 Organization set up

In a similar manner as described in chapter 3, the organization set up of this region takes a similar pattern. The RWE is the one who controls the running of maintenance all over the region. Under him is the head of shallow wells section who takes care of construction and maintenance of wells. The RMO falls under the head of this section and he is heading the maintenance sub-section, at regional level. The only difference with other regions is the absence of factory and workshop sub-divisions which up to now are under the control of MWCP. Hence in this region, under the section of shallow wells, there are survey, construction, maintenance and stores sub-sections (Fig. 13). The factory and workshop at MWCP are at disposal for use of RWE on payment basis. The maintenance of the vehicles is done by the Regional Maintenance Unit (RMU) which is a section of the RWE's office.

#### 4.2.2 Level of responsibility

The entire responsibility of maintenance is shouldered by the DMOs at district level. It is still in the government system and being almost a one level, because the RMO is only supplying materials and spare parts and at the same time making inspection trips whereas the DMOs are doing major and minor repairs. The involvement of the users, at present, is mere reporting of any troubles or failures from pumps and in some cases, though very rare, keeping the well surroundings clean.

When the maintenance programme was initiated, the RWE clearly stated the duties and responsibilities of RMO and DMOs as follows:

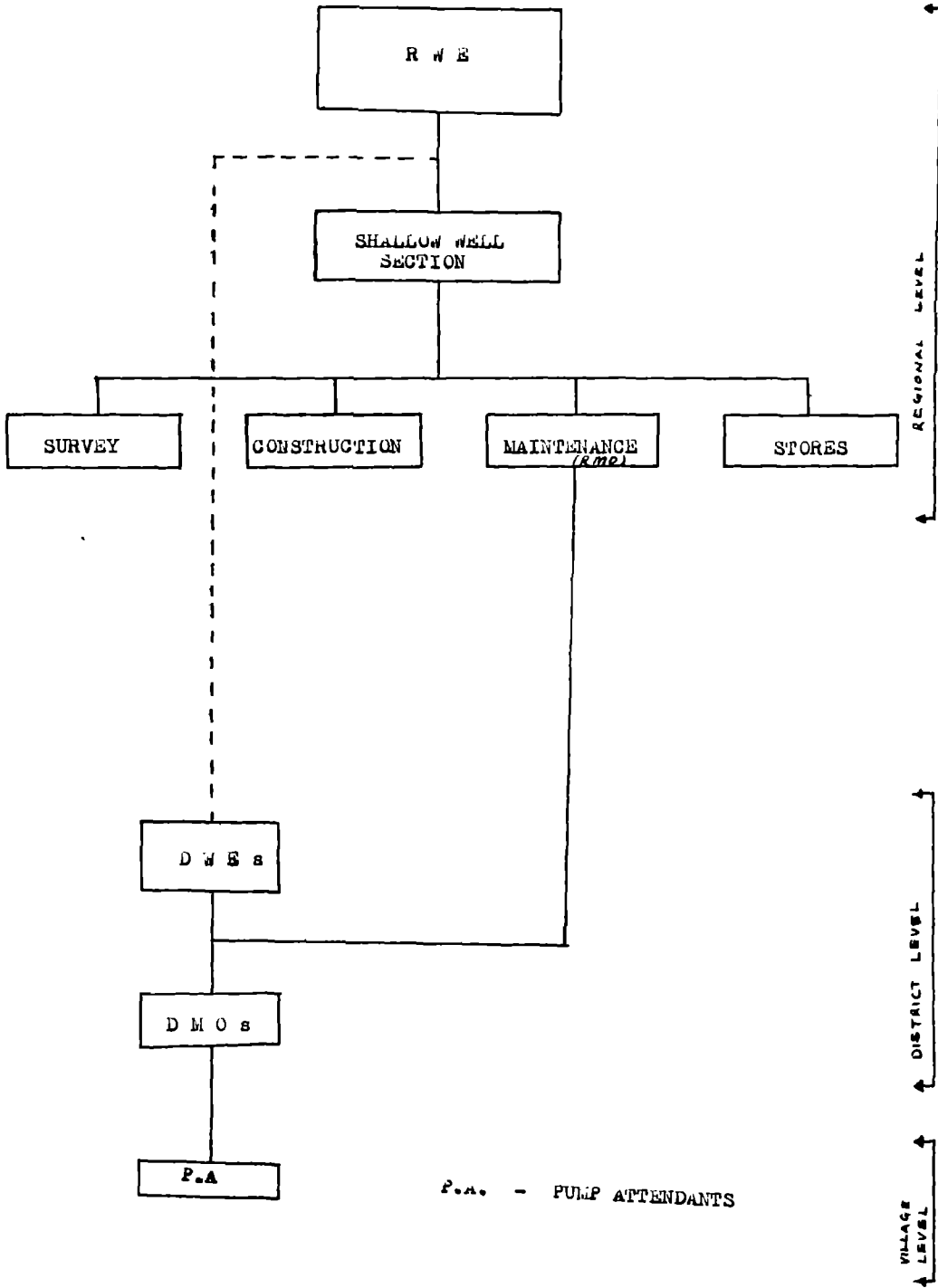


Fig. 13. Morogoro shallow well organization chart.

RMO

- a) Inspecting wells, making reports on conditions of the wells and pumps and at the same time doing repair where necessary.
- b) Identifying the repairs and assigning them to the concerned. Listing the necessary spare parts required, making any recommendations and preparing cost estimate of repairs.
- c) Collecting water samples for quality check-ups on selected wells once in two months, and sending them for analysis to Ubungo or MWCP laboratory.
- d) Reporting back to RWE on matters checked up and preparing report and sending copies to DDDs, DWES and DMOs.
- e) Making orders of spare parts, tools, equipment and materials and supplying them to respective districts.
- f) Receiving requests from DMOs and respond or act accordingly .
- g) Compiling and keeping data of wells in the region of inspected wells, conditions and water quality.
- h) Analysing the compiled data.

DMOs

- a) Inspecting wells, making reports on conditions of wells and at the same time doing repair where needed.
- b) Attending to emergency calls from the users.
- c) Identifying the repairs and doing them, while listing the necessary spare parts required.

- d) Carrying out repairs as per previous report of DMO and RMO and village water committee.
- e) Reporting back to DWE and preparing reports and sending them to RMO.
- f) Making orders of spare parts, tools, equipment and materials and sending the request to RMO.
- g) Compiling and keeping data of wells in district on inspected wells, condition and water quality.

#### 4.2.3 Maintenance execution

After the training of DMOs, the RWE issued a letter to DWEs (ref.No M/4/131/223 dated 16th August, 1982) regarding the implementation of the maintenance programme. The letter clearly explained how the programme should be carried out that:

- DMOs will have to make visits to the well sites each month and making repair and preparing reports. In case of emergency calls, these have to be attended immediately.
- During their normal (inspection) visits or emergency visits the following forms had to be filled:
  - Well check form
  - Maintenance form
  - Weekly report form.

For these forms see Annex 7A, 7B and 7C.

On top of this these reports should be accompanied by a brief monthly report stating:

- activities performed during the whole month
- existing state of the programme
- action plan for future implementation (for the following month).

- The use of transport will be as described in section 4.2.5.
- DMOs have to inform the DWE on their activities and plan one week earlier.

Since the start of this programme, it has been found out that the achievement has been very little due to problems as discussed in section 6.2.4.

#### 4.2.4 Supply line

In carrying out the maintenance programme, as per duties and responsibilities described above; materials, spare parts, tools and equipment had to be acquired from somewhere. In this case, the centre of supply of all above was and still is MWCP, on payment basis. Thus a request had to be sent to MWCP for purchasing the requested items and the responsible person for sending requests is the RMO.

The request form (Annex 7) is originating from the DMO and sent to RMO who places orders for the requested items to the MWCP stores where after payment the items are collected. RMO then sends them to the respective requester. According to the directive issued by the RWE, the DMOs bring the requests during their visit to regional office when they bring vehicles for maintenance. If it is an item requiring repair, the same request forms and the same procedure are used. It also can be brought or taken from/to districts by RMO during his inspection trip.

#### 4.2.5 Transportation

After realizing the transport problems facing the RWE in carrying out the maintenance programme, and also through negotiations, the Dutch Government donated three Land Rovers (pick-ups) with their trailers to be used for maintenance of



shallow wells. These Land Rovers had to be stationed at district level, to be used by DMOs for the mentioned purpose. Thus just after the end of training the DMOs, each district namely Morogoro Rural, Kilosa and Kilombero, were given one Land Rover. Ulanga by then has not yet started shallow well programme and so it was not given any, and after all there were only three vehicles. On dispatching these Land Rovers, the RWE issued a directive to DWEs on the use of these vehicles that:

- i) The DWEs will be responsible for their running.
- ii) They should be used only for shallow wells maintenance.
- iii) The DMOs are not to make trips without the consent of the DWEs.
- iv) Due to inadequate distribution, that Land Rover issued to Morogoro Rural District will frequently be used by RMO.
- v) That one to Kilombero will, later on, be used by Ulanga District after the district has started the programme.
- vi) On visits to districts the RMO will use the vehicle in his inspection trip within that district. And if the need arises or if found necessary the RMO might request for the vehicle to collect him so that he can visit that district.
- vii) Major maintenance will be done by Regional Maintenance Unit (RMU) each month and minor maintenance will be done by the districts.

- viii) The DWEs will use funds allocated to the district for maintenance of shallow wells to make minor maintenance of the vehicles, and will use the same funds for buying fuel for the vehicles.
- ix) On major maintenance at regional level, the funds allocated for maintenance of shallow wells will be used.

#### 4.2.6 Financial assessment

From the same directives and instructions issued by RWE, the DWEs were instructed that they will receive an extra amount of funds for the recurrent expenditure of rural water supplies above their normal allocation, and that extra amount is for maintenance of shallow wells. Thus that amount should be used in shallow well maintenance activities under the authority of DWEs and these activities are:

- disbursement of nightsout allowance for DMOs and drivers
- paying daily paid or casual labourers who will assist the DMOs
- paying for fuels, spare parts and minor repairs at district level.

In the financial year 1982/83 the RDD allocated only TAS 300 000 for shallow well maintenance for the whole region. This amount is by far very small, assuming by that time there were around 700 wells in the region, compared to the required amount of approximately TAS 700 000. This is derived from the assumption that the maintenance cost per well per year is about TAS 1 000. From the amount released, it meant only 300 wells, all over the region, could be maintained leaving about 400 wells unattended. With same number of wells to be maintained, it only represented 45 % of the total wells to have been maintained and the remaining to be dealt in the following financial year.

According to existing data, it shows that the maintenance cost per well per year is about TAS 1 100. This means that assuming all 935 wells are operative, with an average maintenance cost of TAS 1 100 per well per year, the required total amount this financial year (1983/84) should have been TAS 1 030 000. But what has been allocated is TAS 1 000 000 which is a little bit below the requirement. And with the amount allocated, it means 910 wells would be attended. Such situation is a little bit encouraging and perhaps in future allocation might be as per requirement and this might facilitate the maintenance programme.

#### 4.2.7 Physical assessment

Experience from both RWES office and MWCP shows that having one group of DMO, a driver and some few labourers, the following could be achieved within 6 months of maintenance:

- 323 wells could be checked and repaired
- Out of 323 only 192 wells required major repairs
- Major repairs (i.e. pump removed, dismantled, re-assembled and installed). This at maximum on average monthly basis could be 45 major repairs.
- Minor repairs (i.e. well checks inclusive of greasing and tightening bolts and nuts), on average daily basis could be 15 minor repair.
- It follows, therefore (192/45) about 4  $\frac{1}{2}$  months required for major repairs out of 6 months.
- Hence knowing the total number of wells in each district, time required for maintenance could be calculated, particularly rounds per year by one group. For example a district with 500 wells, the following rounds could be estimated:

- \* It can be assumed that 100 wells out of 500 wells could attain regular maintenance of major repairs for approximately 2 months, leaving 400 wells for minor repairs and checking.
  - \* On the basis of 15 wells per day (for minor repairs) and 5 working days per week it follows that 5,3 weeks are required, i.e. roughly 1  $\frac{1}{2}$  months.
  - \* For a complete round of all wells it requires three and half months for major and minor repairs.
- Taking into account leaves, sickness, car maintenance and other delays, this leaves 2 complete rounds per year. And this can be considered enough if the village community co-operate and execute minor, preventive maintenance and no additional wells required.

Therefore in this way it is assumed that one group with a Land Rover and a trailer is enough provided that not more than two rounds per year are required and that other trips are restricted to emergency, with proper planning of trips and wells not exceeding 600 wells (Notes on Maintenance of Shallow Well Programme 1982).

#### 4.2.8 Training

The level of training in particular at village level is still at stake. Up to now there are ongoing discussions between the Maji Ministry, Regional Authorities and the Dutch Government on how to train pump attendants and well care-takers. It seems the pump attendants from different villages will be trained at a selected village, and all appointed village pump

attendants will assemble for a fixed duration of training. The training will be carried out by RWEs' office with assistance from MWCP, and funds are expected from both Dutch and Tanzanian Governments.

The well care-takers will be decided later on at village level by the village community. It would be a good idea for well care-takers, if women are given this responsibility because they are the ones who use, more frequently, the pump.

#### 4.3 Probable causes of poor maintenance

The defectiveness of hand pumps and hence abandonment of the pumps, is not merely poor quality of pumps, but another factor contributing, mainly to abandonment, is inadequate maintenance and thus it is contended that the critical element of hand pump programmes is the maintenance (McJunkin 1977).

Since the establishment of maintenance programme in this region, it has been found out that there is poor maintenance of pumps. It is then assumed that this poor maintenance probably is attributed to:

- a) Absence of definitive specification. Many pumps do not have definitive specifications which could help the maintainers to use in doing the maintenance. Thus lacking this leads to insufficient maintenance. Therefore manufacturers should provide maintenance specifications so that they can be followed by the maintainers.
- b) The technology in use makes frequent lubrication mandatory while there is lack of lubricant reservoirs. Poor fits of some spare parts because of indifferent clearances. And some parts of pump may deteriorate because of exposure to weather.

- c) Underestimates or lack of appreciation of structural and bearing loadings in the well pumps.
- d) Little parts interchangeability, sometimes even between the same models of the same manufacturer.
- e) Lack of feedback from maintenance teams to engineering and procurement personnel, and lack of analysis for example most common failures. And most prominent is the lack of inadequate record keeping.
- f) Poor maintenance skills which is associated with lack of training of personnel to carry out the maintenance and inadequate tools and spare parts. Lack of use of transport and lack of supervision are some other factors.
- g) Invisibility of maintenance and lack of urgency which might lead the users to return to old unhygienical sources.
- h) Lack of maintenance funds or budgeting.
- i) Lack of appreciation of preventive maintenance.

It appears then if the above and many others, which are not mentioned, are given attention to, in any project initiation, might give or provide some insight into improvement of maintenance practice. Lack of promotion of the same will create poor and inadequate maintenance, which is not the aim of any project initiation.

#### 4.4 Some common hand pump troubles or failures

Though there are different types of pumps used which come from different manufacturer, it has been found out, there exists some common troubles or failures on these pumps inspite of their indifferences. In trying to achieve a reasonable maintenance system, which of course will attribute to a relatively low maintenance cost, the design of such pumps or its selection should be geared or oriented to the above risks as outlined in section 4.3.

Experience, not only from this region, but from a variety of countries suggests certain hand pump components as having common troubles or failures which require maintenance emphasis. Some of these common troubles or failures may be caused by:

- the adjoining point where welding or screwing and hinge pins on which the handle pivots
- the handle breakage
- wear, loss or breakages of bolts and nuts
- loss of spring action in foot pumps
- lack of lubrication
- clumsy use (banging the handle against the stops unnecessarily)
- wear of the leather cup seals in the cylinder
- wear or breakages of the valves and this might be prominent particularly where steel ball valves are used due to deformation of metal seat
- breakages of pump rods or pump couplings and trouble with rod bushings.

To illustrate further on these common troubles, table 2 (McJunkin 1977) indicates the troubles, likely causes and the remedy of these problems.

Table 2. Common hand pump troubles and remedies (McJunkin 1977).

TROUBLE	LIKELY CAUSE	REMEDY
1. Pump handle works easily but no water delivered.	A. No Water at the source. Well dry. or	Rehabilitate well, or develop a new source or sources of water.
	B. Level of water has dropped below suction distance of pump. or	Can be checked with vacuum gauge or with weighted string. Reduce pumping rate or lower pump cylinder.
	C. Pump has lost its priming. or	Prime the pump. If the pump repeatedly loses its priming it may be periodically pumping the well dry, the suction line may be leaking, or the suction valve or discharge check valve may be leaking. Repair line or valve. Also check 1-A and 1-B.
	D. The cylinder cup seals ("leathers") may be worn out or	Renew the cylinder cup seals ("leathers").
	E. The valves or valve seats may be worn or corroded. or	Renew valves and repair or renew seats.
	F. With a deep-well plunger pump the plunger rod may be broken. or	This trouble would be indicated by the pump running freer and and probably quieter. Turn the pump over by hand and note if there is resistance on the upstroke. Broken rods must be renewed and this usually means pulling the drop pipe and cylinder out of the well.
	G. Shutoff valve may be closed (force pump). or	Open valve

TROUBLE	LIKELY CAUSE	REMEDY
1. Pump handle works easily but no water delivered (continued)	H. Hole in suction pipe. or	Renew suction pipe. Cylinder may be lowered below water level in well.
	I. The suction pipe may be plugged with scale or iron bacteria growth or sediment. or	Can be checked with vacuum gauge. Remove suction pipe and clean or renew.
	J. The pump cylinder may be cracked. or	Renew the cylinder.
	K. Leak at base of cylinder. or	Renew cylinder gasket.
	L. One or more check valves held open by trash or scale.	Remove valves and inspect for trouble. With deep-well plunger pumps this may mean pulling the pump cylinder or plunger and valves out of the well.



Table 2. Cont'd.

2. Pump runs but delivers only a small amount of water.	A. Plunger leathers badly worn (plunger and piston pumps).	Renew leathers.
	or	
	B. Well not yielding enough water.	Decrease demands or establish new sources of water.
	or	
	C. Cracked cylinder (plunger or piston pump).	Renew cylinder.
	or	
	D. Check valve(s) leaking.	Repair valve(s).
	or	

TROUBLE	LIKELY CAUSE	REMEDY
2. Pump runs but delivers only a small amount of water. (continued)	E. Screen or suction valve may be obstructed.	Remove and clean.
	or	
	F. Suction pipes are too small.	Can be checked with vacuum gauge. Install pipe with larger diameter, or for deep well pump, lower pump cylinder below water level in well.
	or	
	G. Suction valve(s) may be out of order.	Repair valve(s).
	or	
	H. Cracked drop pipe or coupling.	Renew drop pipe or coupling.
3. Pump needs too many strokes to start.	A. Pump has lost its priming.	Prime the pump. If the pump repeatedly loses its priming, it may be periodically pumping the well dry, or the suction line or the suction valve may be leaking. Repair or renew line or valve.
	or	
	B. The cylinder cup seals ("leathers") may be worn out.	Renew the cylinder cup seals.
4. Handle springs up after down stroke.	A. Suction pipe plugged up below pump cylinder.	Remove pump and clean out suction pipe. If well has filled with dirt up to suction pipe, the well should be cleaned out or the pipe cut off.
	or	
	B. Plunger check valve fails to open or to close.	Repair check valve.
	or	

Table 2. Cont'd.

TROUBLE	LIKELY CAUSE	REMEDY
4. Handle springs up after down stroke (continued)	C. Suction pipe too small.  or  D. Water too far below pump (suction pipe too long).	Replace with larger suction pipe.   Place cylinder nearer water.
5. Leaks at stuffing box	A. Packing worn out or loose.  or  B. Plunger rod badly scored.	Renew or tighten packing. Leave packing nut loose enough to allow a slow drip of water. The water serves as a lubricant.  Renew plunger rod.
6. Pump is noisy	A. Bearings or other working parts of the pump are loose.  or  B. Pump is loose on mountings.  or  C. With deep-well plunger pumps having a steel plunger rod the rod may be slipping against the drop line.	Tighten or renew parts.   Righten mountings.  Use a wooden rod or install guides for rod or straighten drop pipe if crooked.

#### 4.5 Pump parts requiring frequent attention

In spite of wise pump design or selection, which avoids many difficulties, the key to a successful pump operation is the regular maintenance. For this reason there are several pump components which require frequent attention to keep the pump operative. From this frequent attention these parts can assist in scheduling maintenance as outlined in section 6.3.1 f). Also it is from some common troubles as described in section 4.4, that the parts requiring frequent attention are derived from. These parts are as outlined below and see Fig. 14.

- Pump handle and stem or house: when exposed to atmosphere deteriorates quickly, thus paint them annually.
- Hinge pins: easy wearing when in use, so lubricate weekly and check annually.
- Pump rod: breaks or disconnects with pump rod coupling and so check monthly.
- Spring: loses action after some time of use and so check monthly.
- Pump rod and couplings (or pump rod connectors): loses its fitness if not well tightened and sometimes breakages occur so check monthly.
- Plunger valve: wears or breaks frequently and so check monthly.
- Suction valve: wears or breaks out frequently and thus check monthly.

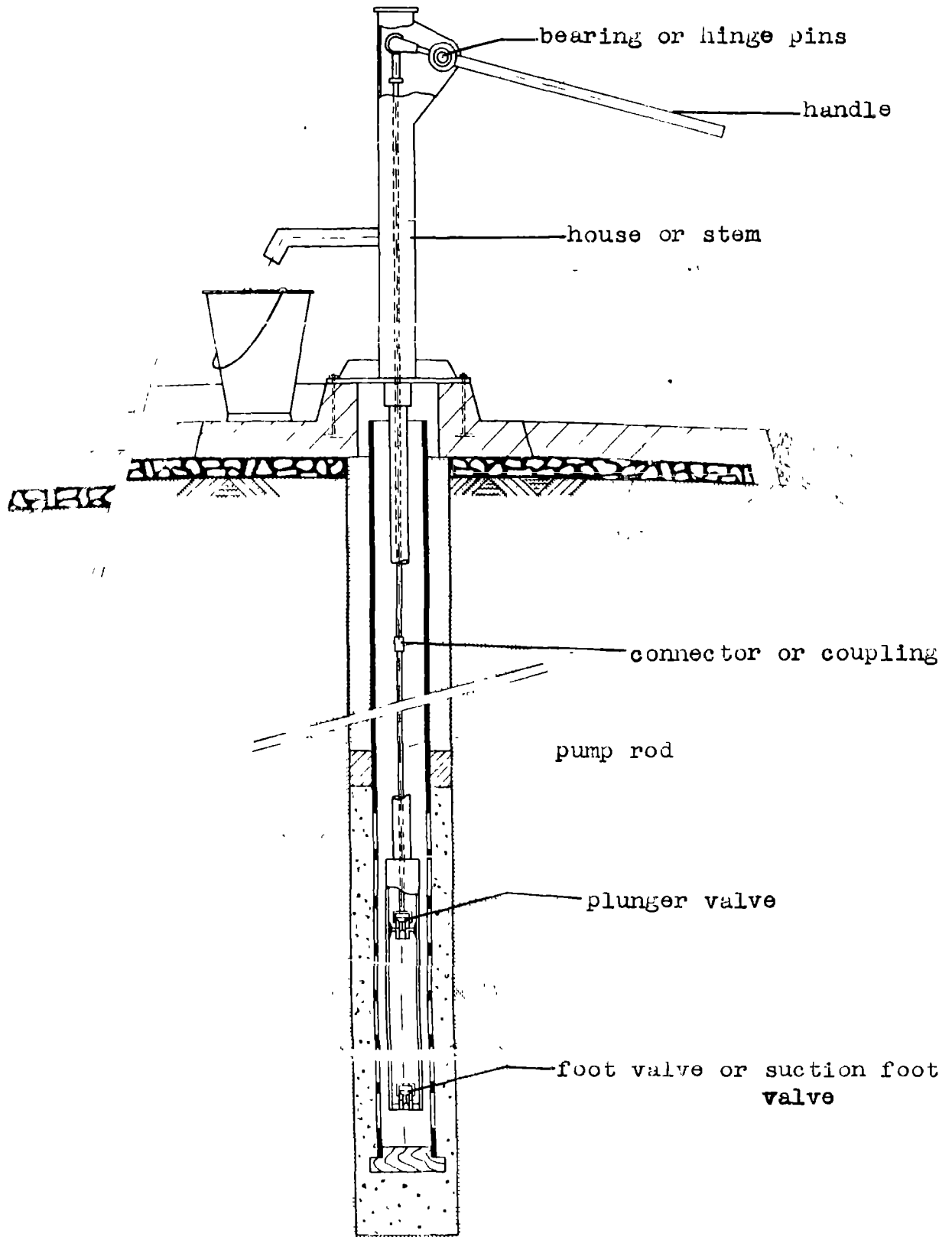


Fig. 14. Pump parts requiring frequent attention.

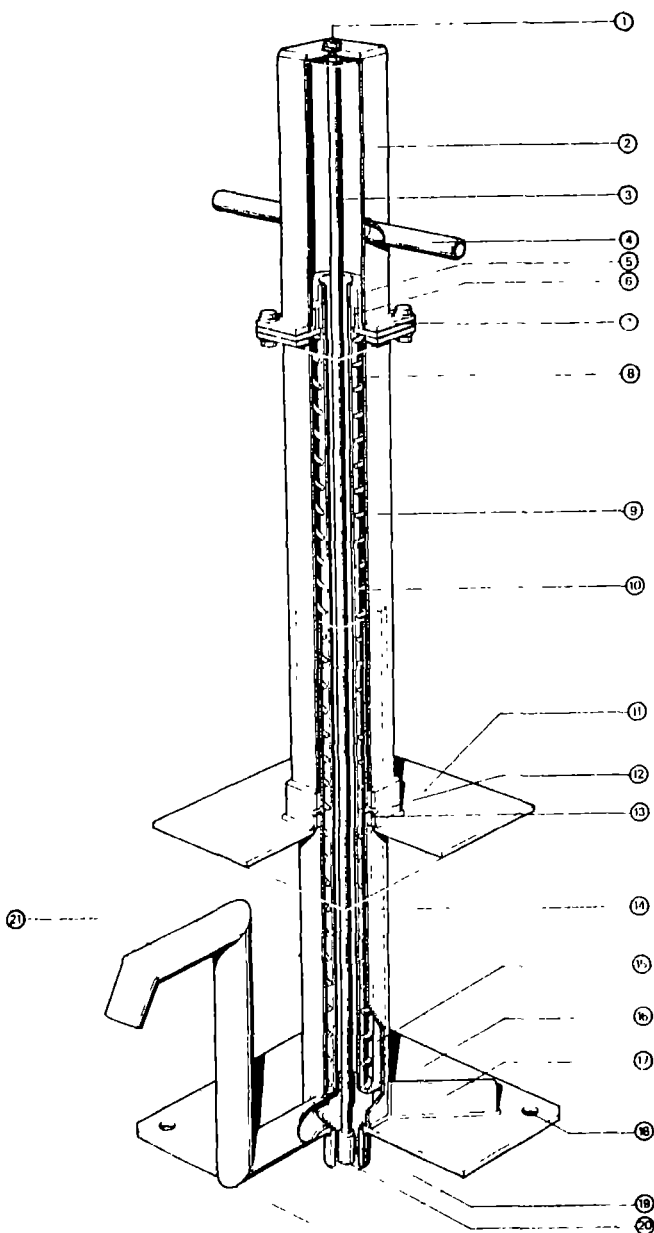
#### 4.6 Development of equipment and pumps

Due to failures or troubles and subsequently parts requiring frequent maintenance, effort has been done and is still on-going in trying to develop such pumps which could cope up with these problems. Thus the development is in progress for several equipment and pumps structure as a whole with its accessories such as pump cylinders, valves, pump rods and bearings.

The development of such items is geared to relatively low initial investment and maintenance cost of the pumps. In discussing these developments, the MWCP is more concerned than the RWE and therefore this section is devoted to the experience gained by MWCP.

The development of hand pumps can be dated as far as 1920's and to date many pump designs have been produced by different manufacturers. In view of the high demand of the pump at a shorter notice, few designers and manufacturers have had the opportunity to fully test their products. This resulted in minor deficiencies in practice, as a result of which a second, third or even further modification of the original pump was marketed. From these unfully tested pumps which were marketed, false conclusions have been derived, due to the comparison made between the untested (old) and newer pumps. This conclusion drawn from such a test can only be valid for that moment and a comparison at a later moment, when all pumps would have been modified (MWCP Fifth Progress Report 1981). In this way the MWCP has been in a situation where, as problems arise, they felt the need for further development of the pump in order to circumvent the necessity of frequent preventive maintenance (MWCP Sixth Progress Report 1981).

From the above the Kangaroo pump has undergone several developments so that it can improve its performance when compared to other pumps. The development of such pump includes the increase in diameter of spring which will, at least, not buckle, and the self-lubricating pads which eliminates high friction as seen in Kangaroo pump MK 1 and 2 as shown in Fig. 15a and 15b. In Fig 15a Kangaroo MK 1, item number 5 shows stroke limiter position as compared to Fig. 7b and Fig. 15b. Kangaroo MK 2 shows self-lubricating pads, item number 13, as compared to Fig. 7b. Even then, from experience, the problems have not yet been solved and still further improvements are in progress. This has led to the development of a Kangaroo pump which can be manufactured locally, using some few local materials and this is shown in Fig. 16.

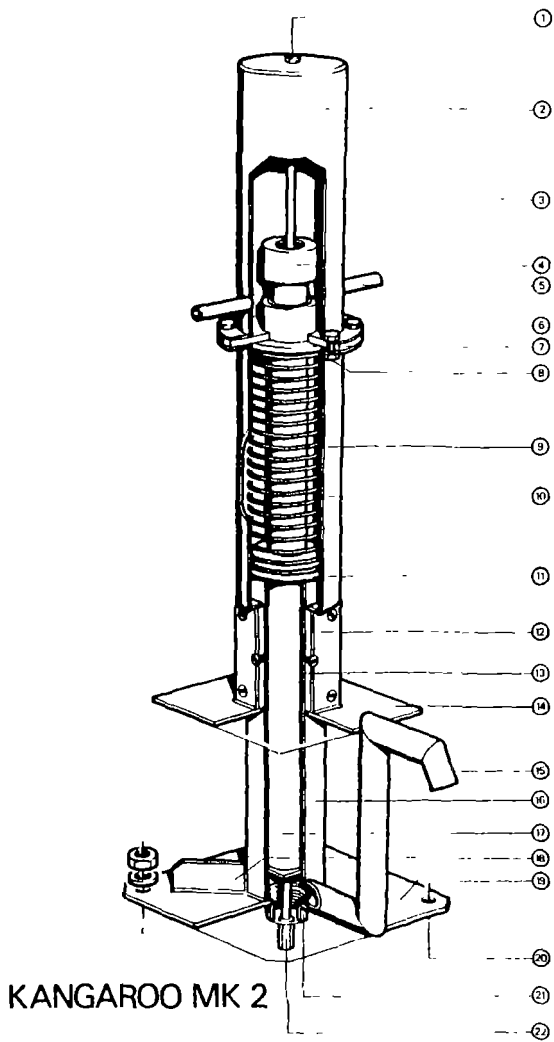


#### KANGAROO MK 1 PUMP HEAD (IMPROVED)

##### Item number Description

1	lock nut (M 10, stainless steel 316)
2	upper part of pump hood (90 x 90 x 4 mm steel tube)
3	pump rod (10 mm dia stainless steel 316)
4	handles (1/2" gas pipe, length 150 mm)
5	stroke limiter (steel 37)
6	spring cap (movable) with inner lining of bronze or Arnite
7	flange (130 x 130 x 6 mm)
8	inner tube (1/2" gas pipe)
9	lower part of pump hood (90 x 90 x 4 mm steel tube)
10	compression spring
11	foot plate (325 x 325 x 6 mm)
12	steel tube (100 x 100 x 4 mm)
13	lining of self lubricating plastic material (delrin, 6 mm thick)
14	stationary steel tube (80 x 80 x 3 mm)
15	vent pipe (10 mm dia)
16	pump base plate (400 x 400 x 8 mm)
17	pump stand brace (steel strip, 50 x 6 mm)
18	bolt hole (22 mm dia, 330 mm on centres)
19	threaded drop pipe connection (1/2" gas thread, modifications on request)
20	threaded pump rod connector (stainless steel 316, M10, spanner size 17, length 40 mm)
21	spout (1/2" gas pipe)

Fig. 15a. Kangaroo MK 1 - improved.



KANGAROO MK 2 PUMP HEAD

Item number	Description
1	lock nut (M10 stainless steel 316)
2	upper part of pump head ( $\phi$ 152.4/146.4 mm steel pipe)
3	pump rod (10 mm dia stainless steel 316)
4	stroke limiter (steel 37)
5	handles ( $1\frac{1}{2}$ " gas pipe length 150 mm)
6	spring cap (movable) with inner lining of bearing bronze
7	flange (205 mm dia thickness 8 mm)
8	bolts and nuts (M10 x 30)
9	Compression spring
10	lower part of pump head ( $\phi$ 152.4/146.4 mm steel pipe)
11	spring cap (stationary)
12	steel tube (110 x 110 x 4 mm)
13	lining of self lubricating plastic material (delrin 10 mm thick)
14	foot plate (325 x 325 x 6 mm)
15	spout ( $1\frac{1}{2}$ " gas pipe)
16	steel tube (80 x 80 x 3 mm)
17	seamless steel tube ( $\phi$ 55/48 mm)
18	pump stand brace (50 x 6 mm steel strip)
19	pump base plate (400 x 400 x 8 mm)
20	bolt hole (22 mm dia 330 mm on centres)
21	threaded drop pipe connector ( $1\frac{1}{2}$ " gas thread modifications on request)
22	threaded pump rod connector (stainless steel 316 M 10, spanner size 17, length 40 mm)

Fig. 15b. Kangaroo MK 2 - improved.



Fig. 16. Locally manufactured Kangaroo pump.

Alongside with the modification and improvement of Kangaroo pump, the hand pump SWN 80 has also been in development to suit local conditions prevailing. The improvement has reached a stage where a local Morogoro hand pump, a prototype of SWN 80, has been produced locally using some few available local materials. This has been improved to use wooden bearing instead of steel bearing, as shown in Fig. 17a.

Fig. 17b shows the locally produced Morogoro hand pump and this Morogoro hand pump has been constructed such that different heads can be fitted as shown in Annex 8 a - e. In Annex 9 a - c show these different heads fixed to the pump stem of SWN 80.



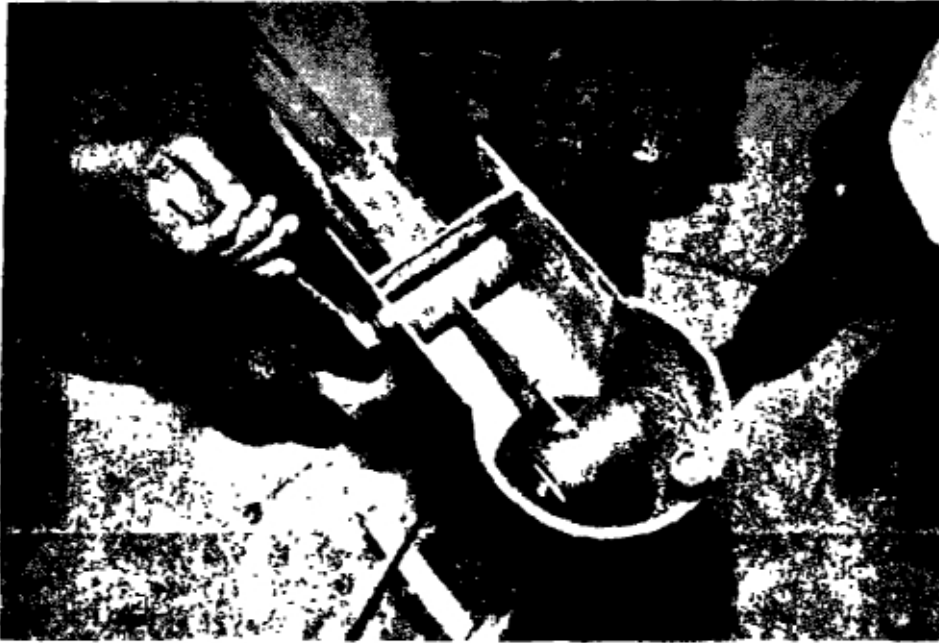


Fig. 17a. Morogoro hand pump entirely locally made showing wooden bearing.



Fig. 17b. The Morogoro hand pump locally made.

## 5. DISCUSSION

Due to inadequate maintenance of pumps, there must exist some problems, and these problems are discussed according to several aspects as found existing in the current situation. In several occasions, these problems arise from different maintenance systems used, and in this discussion the maintenance systems are discussed from different levels.

### 5.1 On maintenance problems

It is not so difficult to keep a single pump in operating condition if it is equipped with care and qualified maintenance attention. It is then equally, in contrast, extremely difficult to keep immense number of hand pumps continually operating, especially when these pumps are widely distributed in difficult areas, in a country with low level of development and having relatively few people with technical training and management experience.

According to the prevailing economic crisis, it becomes an essential element, particularly for the manufacturers of pumps, that any design for large scale use, in rural water supply programme, should fully suit local conditions, operational and maintenance capabilities. It should not be expected alone that the government maintenance structure will resolve all problems of inoperative pumps. But it can be of great assistance in providing back-up services to local pump attendants and should supplement local capabilities and not seeking substitution for them.

#### 5.1.1 Deficiencies in organization

As problems arise within the existing system of maintenance, it has been realized that the participation of the village community, in which the project is undertaken, seems to be of great importance, particularly from the early stages of project initiation.

From the above, recognition start to emerge that there should be one body which is responsible for the whole process of drilling wells up to installation stage, rather than having several bodies performing different activities which are all geared to maintenance organization.

Generally water supply organizations frequently tend to restrict their planning to drilling and installation activity and exclude maintenance activity. Aspects, especially of adequate staffing for maintenance back-up and spare parts provisions are neglected if not considered. As a result these activities are often not budgeted for or are inadequately provided. Poor planning becomes only evident when the maintenance system proves ineffective, at considerable yet avoidable cost.

Therefore it is imperative, when planning in the project initiation, to include maintenance organization aspects for the purpose of achieving a fully working system.

#### 5.1.2 Emphasis on new construction

In fact maintenance activity is one of the most neglected aspects of rural water supply installations and the number of inoperative pumps remains discouragingly high. International and bilateral agencies frequently offer funds for new construction but are not readily prepared to finance maintenance, considering this to be the responsibility of the recipient country. For their part the countries receiving assistance have a legitimate need for additional water supplies but at the same time, find it difficult to make provision for maintenance of existing ones. Before adding new schemes it is essential (if analysis of the existing problems in maintenance are carried out and solution found so) that the new construction will include the maintenance aspects. At this stage of economic crisis emphasis should lie in maintenance of the existing schemes rather than on new construction where, on running the new schemes, the problems of maintenance will accumulate and ultimately render the scheme inoperative.

### 5.1.3 Financial constraints

Whatever programme concerning the hand pumps, requires a long term commitment to provision of spare parts and maintenance. Irrespective of whether the funds are acquired internally (nationally) or externally, there must be a relationship between new installation and maintenance and this should be from the earliest stages of project initiation. Therefore, neglecting the need for maintenance implies risking the investments made in the programme partly or totally.

It is an authentic fact that the government has only very limited or non-existent budget for meeting the maintenance costs of the installed hand pumps, and whenever considered in the budget, the allocation is merely underestimated. Sometimes it is not unusual for the budget authorities to make further reductions of the requested funds when it comes into actual allocations.

Through gained experience from regions, the cost of maintaining hand pumps can be quite substantial, particularly to pumps which are remotely located, where a maintenance centrality has been attempted. In this regard the government should try to avoid an accumulation of recurrent costs which cannot be financed within the regular budget. In this respect the actual maintenance cost is deemed to depend on:

- density of hand pumps installation
- prices of fuel, spare parts, materials and tools
- durability of pumps
- system of maintenance employed.

All these, if considered in the preparation of the maintenance budget, would relieve some of the financial constraints expected to arise.

Whatever planning of maintenance is considered, the key factor is the financial ability, thus careful financial sources should be thought for before the take off of planning.

#### 5.1.4 Effect of poor quality hand pumps

By installing sub-quality hand pumps mar the effectiveness of the hand pump maintenance system. Likewise by installing a defective pump, from manufacturing process, will obviously increase the maintenance cost and any savings effected in the initial cost of the pump are likely to be more than off-set by heavy maintenance costs.

It is advisable on procuring the pumps, to purchase them through a firm which apply recognised specification standards as well as quality control procedures in the manufacture of pumps. Few hand pump programmes have meticulously insisted on standard and quality control of their supplies, and this in turn has considerably contributed to the poor maintenance record.

#### 5.1.5 Neglected preventive maintenance

Virtually, in practice, preventive maintenance hardly receives any attention at all. And even if receives it, hardly in a qualitative standards, merely seeing the site and report back wrong data, which ultimately leads to poor planning of maintenance system. Qualitatively a good maintenance programme should include authentic and proper inspection, lubrication, testing and overhauling of pump. These tasks are deemed to be the foundation on which the programme should be built. In no way can the programme attain its full performance, if cheating of data collected and recorded, is allowed to continually operate. This can be achieved through meticulous, stressed and close followed up supervision.

#### 5.1.6 Impact of negative psychology

An introduction of hand pumps to a village community frequently seems to be a major event, hence this introduction should obtain a maximum benefit and health educational activities.

This will have to involve:

- information on health benefits
- uses of pumps
- explaining reasons for using safe water for drinking, cooking, washing and personal hygiene.

Contribution of the above could be kind of posters and education materials as shown in Annex 10 a and 10 b respectively.

To encourage the village community to rely upon the supply of water through hand pump, it is advisable that the pump be continuously kept in working condition. Because any prolonged repair of a broken pump will revert the users to their old traditional water sources and the opportunities for improving the attitude towards safe water supply will be lost, possibly for years. And in particular where they find that they participated in the construction and their contribution is just wasted like this, they may even lose credibility for the water supply agencies. This will result into a negative psychological impact and the news might even spread to the neighbouring community and ultimately will undermine the confidence of the hand pump programme and this might actuate difficulty in expansion.

#### 5.2 On maintenance systems

Generally in discussing on maintenance systems, the discussion is either centred on one or in combination of the following categories:

- government organized maintenance
- village community based maintenance
- private provision
- varying combinations of the above.

Of the above categorized systems of maintenance can be characterized as one level, two level or three level systems. One level system can be said as where all the maintenance tasks are the responsibility of a central organ e.g. the government or the village community. The two level system, the tasks of maintenance are shared between two responsible organs. While in three level system, one of the three organs (i.e. region, district and villages) assumes a specific part of maintenance duties and the other two organs will take care of the rest of the responsibility for example routine maintenance.

However it is improper to have a hand pumps programme without a parallel maintenance structure since maintenance is a tangible requirement and the question should be how to structure the maintenance, whether it should be the government, the village community or private. But from experience of different regions, in practice, the extremes of government assuming all responsibility is clearly seen. It is uncommon in most cases to find shared responsibility, only that now the government has come to realize that it is proper to have a shared responsibility and thus village communities are now, in few cases, being involved. It is very rare and sometimes unfeasible so far to have a system where maintenance is effected entirely at the users level unless it is privately owned. And nor can maintenance, through other levels, prove entirely effective without active support and participation from the village communities using the pumps.

### 5.2.1 Government organized maintenance system

Where the whole responsibility of maintenance lies entirely on the government, it has the following functions:

- arrangement for procurement and distribution of spare parts, tools and materials
- provision of staff to carry out the programme
- provision of transport facilities
- ensurance of adequate training requirement
- workshop and factory establishment
- ensuring qualitative pump installation
- carrying out major repairs and where necessary making renovation of the pumps.

It is imperative for the government to ensure that there is reasonable infrastructure to the village communities for:

- enhancing safe drinking water concept
- instructing villagers the use and care of the pumps
- increasing the communication for any failure that may happen.

To carry out the above, various agencies might be created up to the lowest level for which the government may govern and control them.

From this maintenance system, which is one level, it can be said, the advantage is that there will be no dubiousity of where the responsibility of maintenance lies. The relevance for this can be seen where more than one organization is involved in installation and maintenance. But where one organization is involved in installation and maintenance, the costs involved would be substantially high for one agency to bear. Thus this type of maintenance system will result in high maintenance cost for the government.



Initially such a system may prove a success but experience has shown that as the project expands, often after some time they become understaffed, undermotivated and physically incapable of meeting the monitoring and logical requirements of maintenance programme. In the absence of detailed and continuous data collection, the planning tends to become unrealistic and inadequate and the maintenance structure will gradually begin to disintegrate.

#### 5.2.2 Village level maintenance system

Up to now it has been found out that the present stage of hand pump development and village community capabilities usually do not allow for a complete village level maintenance and thus it becomes necessary, when we advocate for village level maintenance, that hand pump programmes should eventually move towards such a system.

It is propounded that with village community participation or involvement in the whole affair of maintenance of pumps, may not only stimulate a better care and upkeep of the pumps, but also initiate related activities such as health education and proper use of water for hygiene. Thus this can be seen to provide an entry point for a number of related activities for rural community development, if the community participation is enhanced or encouraged from the initial point of the project.

Implicitly if there is a community involvement at the earliest stages of the project, the community is already involved through the donation of land for siting wells and work assistance through labour force. Therefore the intergrity of all the process in the project for the village participation will in one way or another generate a natural degree of interest to the users. At all these stages, the organizers could utilize this opportunity to make informal communication on aspects of better use of water for health and hygiene by

using educational materials as shown in Annex 10 b. And this could provide an excellent opportunity for a preparatory stage in the process of promoting village community participation.

It should be noted that where wells and pumps are provided without prior adequate introduction and communication on the value of such installation, there will be high tendency of the users seeing it as something provided by the government (as many of them do see up to now) without request or consultation. Frequently under such conditions the community will expect the government to also maintain the pumps.

The organization concerned - government - should not expect the awareness of the importance of safe drinking water, to exist at village level. More often, the village people are unaware of the relationship between their traditional polluted water sources and the incidence of water-borne and water related diseases. Therefore this follows that there is a very need for health education aimed at developing awareness of the relationship between water and health. This could be started by introduction of such posters as shown in Annex 10 a with some mass education either through newspapers, radio, seminars and frequent visits of the people concerned to explain it more in detail as shown in Annex 10 b.

It must also be admitted that encouraging village communities in the use of safe drinking water is not a simple task because it entails changing traditional beliefs and introducing new attitudes and this requires concerted and integrated approach. One thing which is clear is that once there is village involvement in maintenance, there is a substantial reduction in maintenance cost on the government side.

However it is not reasonable to expect village community to fully maintain their pumps as envisaged in the maintenance system as it should eventually be developed. Frequently the direct result of such a system will be large number of pumps out of operation, and resources used in well construction and pump installation will be wasted.

### 5.2.3 Private maintenance

This has got very little for discussion, because privately owned pumps are not many, and their existence in such places, the usage is not intensive compared to community pumps. And because there seemed to be intensive care on these pumps, little attention by organization has been focused. The only problem for these privately owned pumps is where to acquire spare parts from and how to maintain them. So where there are privately owned pumps, the owners should also receive education of the use of pumps, where and how to acquire spare parts.

## 6. CONCLUSIONS

A hand pump is a small technological instrument in a large sociological system, which requires maintenance, like any other facility, to ensure its smooth and uninterrupted operation where necessary.

### 6.1 General

Any facility is as good as the maintenance and care it receives, and thus for any object to be highly appreciated and to last long, the maintenance and care regulations should be adhered. Although millions of dollars are spent in water projects in developing countries, investments in maintenance receive very little attention if not neglected in some projects. As a result of this it has been a waste of the existing scarce resources. For example WHO has estimated that 40 - 80 % of the hand pumps installed in developing countries are inoperable within three years of installation. UNICEF spot studies in Asian countries in 1976 showed 70 % of the pumps not functioning. A systematic maintenance training was then organized as an urgent remedy (IDWSD 1978).

### 6.2 Maintenance system

It is unclear to determine which system is being carried out in this region. But from the general impression, it seems the government organized system is prevailing and it is a one level system due to the fact that all maintenance is carried out by DMOs. After realizing the high cost of maintenance of one level, the concerned agencies are trying to establish a three level system where from regional through district up to village level are to participate by sharing the responsibilities. Hence they are working out a feasible maintenance programme with the assistance from MWCP for implementation in the near future.

### 6.2.1 Financial capability

As regards to the operation and maintenance of shallow wells in this region, the programme has not attained a full swing in performance due to financial incapability. It seems even if the region and districts are having available manpower and transport, the organs cannot execute maintenance programme without the help from any other sources such as donor agencies. This is because the funds allocated to the maintenance programme each year as discussed in section 4.2.6, with the expansion of well construction are quite insufficient. In this case, the funds to be allocated should be in parallel with the expansion of new installations.

### 6.2.2. Village community participation

Gathered experience from MWCP as per their rehabilitation programme, it has been found out that the majority of villages (particularly in Kilosa District) are ready to select pump attendants to maintain the wells and they are prepared to pay for their services either in money or kind depending on the agreement between the two. Pump attendants will receive training of hand pump maintenance from the RWEs office assisted by MWCP. The villagers are also prepared to meet the costs for spare parts.

This shows that the villages are prepared to be self-reliant in maintaining their wells, which is a good approach and should be encouraged as it conforms with the national policy and this will considerably reduce financial burden to the government side as concluded in section 6.2.3.

### 6.2.3 Maintenance cost reduction

With the village participation in the maintenance programme, the government will be relieved on some of the duties and at the same time maintenance cost will be greatly reduced. And in due course, there will be assurance of continuous operation and supply of water to the users. Community participation through hand pump attendants and well care-takers will greatly reduce the transport cost to the government because it will have to make few trips per year for inspection.

From last financial year, MWCP have found out that the maintenance cost per round is about TAS 204 000, that is:

-	transport	20 %
-	nightsout allowances	2 %
-	materials for repair and replacement	78 %

From the above figures, without the participation of the village community, and by making two rounds per year, it will cost about TAS 409 000. Assuming the villages will contribute 60 % on buying materials for repairs, and 40 % from the government, it will then cost the government about TAS 172 000.

This is derived from:

-	inspection trips (transport)	23 %
-	nightsout allowances	3 %
-	40 % for material for repair x 2	74 %

It shows that the government will save about TAS 237 000 each year, which is about 58 % of the total cost if the government had to do all alone the maintenance. It might be true that the saving might increase each year as the villages become more self-reliant.

The same might be considered true for the village communities since they will only incur the expenses of buying spare parts, necessary tools and paying the pump attendants. This can be seen in the following example. Say a village with 1250 people having 5 wells

- Buying spare: Assuming for 500 wells the buying of spares is about TAS 160 000. Buying spares for 5 wells twice a year will cost about TAS 3 200. This amount has to be considered as a maximum since it is based on a twice yearly round whereas a regular weekly check-up and timely preventive maintenance undertaken by villagers will reduce the spare parts costs.
- Paying pump attendants: Assuming the agreement for payment is in money basis. It might be agreed to pay pump attendant at TAS 25 for one day per week and for two pump attendants it will cost them yearly about TAS 2 600. And perhaps the pump attendants might be given one extra day per month for repair and this will be TAS 600 per year. Therefore the total maximum payment to pump attendants per year will be TAS 3 200.

Hence the recurrent cost for a village per year will be TAS 6 400. In terms of cost per head per year will be TAS 5. Assuming 5 people per family, the cost per family per year will be TAS 25. As regards to buying of tools, the contribution might be only once per year, and a set of tools might cost TAS 3 300 and this in terms of per family per year will be TAS 13,50.

Therefore the total amount that would be required from each family per year, as contribution to maintenance of pumps would be about TAS 38,50. This amount for an average poor family seems to be reasonable and this could be afforded by

each family. And here in Morogoro Region the average family income per year is about TAS 1 800, which is relatively enough and the family (rural) could afford it (Mpango wa Maendeleo wa Mkoa 1983).

From the above simple illustration it is considered that the cost of maintenance to the users would be reduced considerably due to the sharing of responsibility.

#### 6.2.4 Transport

The transport available with the current situation as regards to the number of wells seems to suffice up to now with the exception of Ulanga District, the remaining three districts are having one Land Rover with a trailer each. The only existing problem with transport at district level is that the DWEs have grown a tendency of monopolizing these Land Rovers, thus failing to avail them to DMOs to carry out their duties. This situation has led to several pumps unattended and thus leaving them inoperative. It is known that the DWEs fall short of transport, but this monopoly has grown beyond tolerance. After all there was a clear directive from the RWE on the use of the distributed vehicles, but this has not been followed, and as such it has demoralized the DMOs in discharging their duties. Thus the authority concerned should look into this problem and come out with a solution to save the pumps from complete deterioration.

After solving or normalizing the situation, it seems the rate of expansion of pump installation is high, and it will obviously create possibilities of more transport requirement.

#### 6.2.5 Manpower

As per existing situation, only Mahenge District would require DMOs who then have to be trained soonest. This is because up to now wells have been constructed in Mahenge District and



Kilombero District's DMOs cannot accommodate the increase of wells in their district as well as that of Mahenge or Ulanga.

At regional level there is inadequate trained personnel to cope up with the existing activities. These activities are ranging from proper record keeping to analysing them. It then becomes difficult to estimate how much materials have been used and what could be the requirement of the following year. As the situation prevails, it is hard to pick any data required from the recordings. The write up or keeping of record is too general. Forms are provided, as shown in Annex 11, but they are not being used. Hence the responsible personnel for maintenance record keeping and analysis should receive proper training. It should be noted that proper record keeping is the key to a proper analysis of maintenance cost and planning, and this necessitates for trained personnel.

#### 6.2.6 Training

It is unfortunate that since the last training of DMOs, there has been no training undertaken, this is largely due to lack of availability of funds either regionally or ministerially.

For proper planning and execution of maintenance programme, it is essential to have properly trained personnel who could perform their duties properly. Such personnel like DMOs who could take responsibilities in Ulanga District are necessary, and light training to existing DMOs with respect to new development of pumps seems to be essential. As long as the pumps are occasionally being improved, it seems essential to give training to these DMOs in order to cope up with the new development.

Some clerks in the region and districts are deemed to be necessary so that the maintenance system could be performed properly. Such clerks who are engaged in shallow well maintenance should receive training pertaining to:

- procurement and supply of materials, spare parts, tools and equipment
- stocking procedures of the same
- recording and keeping maintenance data
- analysing the maintenance cost
- recording defects of the pump parts as brought in by maintenance team.

In this regard where clerks are required, the authority concerned should try to accommodate few of these clerks in the regional training for one year so that they can equip themselves with necessary tools for their job. A curriculum could be established and sent to Maji Ministry for approval and later on the funds for training could be released.

As seen from several cases, it has been established that the drivers do not use properly the vehicles and log books, as such it becomes difficult to extract the kilometreage used for maintenance. This means that proper log book use and keep is not enhanced, thus it is considered that these drivers should also receive training on the use of vehicles and log books to allow for better extraction of kilometreage. This could be done at the same time the DMOs are receiving light training.

Occasional seminars of DMOs, at an agreed place, are considered essential in view of exchanging of ideas and making proposals on how the best maintenance system and programme could be achieved.

As regards to pump attendants training, the proposal is under discussion and it is hoped the training will start very soon.

### 6.2.7 Water quality analysis

Due to lack of laboratory equipment, it has been very difficult to take some samples for analysis at regional level. Even though water analysis laboratory exists in Dar es Salaam, it takes more than four months to send a sample to Dar es Salaam and receive the results. This long delay discourages the use of water sampling and thus it is rarely practiced.

But actually according to duties and responsibilities as spelt out in section 4.2.2, the DMOs and RMO are supposed to take water sample for analysis of chemical and bacteriological qualities e.g. E.coli, iron, manganese and other chemicals. This has only been practiced by MWCP since they have a mobile laboratory and thus all wells constructed by MWCP receive this attention. Due to too much work load and few staff in MWCP, it has been difficult for RWE's staff to take water samples to MWCP for analysis. As such the water samples taken are sent to Dar es Salaam which as said earlier take a long time to get results.

So far the results received from both Dar es Salaam and MWCP laboratory show that in most of northern part of Morogoro Region water quality constitute more of saline content and lead to several wells being closed up or abandoned. In the same areas bacteriological quality shows that there is very little pollution, and the pH is almost normal, while the southern part has shown several signs of iron and manganese and users have been complaining of odour. There are very few samples with high saline contents, but the pH is very low and this has led to the use of PVC rising mains all over the southern part.

### 6.3 Recommendations

Planning for the country's development has reached a stage whereby it can be considered the level has been proportionally achieved. But implementation of the plans leaves much to be said. As from experience, a number of plans for the maintenance programmes have been laid down, but due to problems which occur in the implementation period or which were taken lightly in the planning or sometimes not even considered in the planning stage, the implementation has never been performed according to the plans. This has led programme to be incompleated or not attain its full implementation. Thus the recommendations which are going to be presented are not the only solutions to the problems but deemed, if carefully given full attention, to reduce the constraints or bottlenecks which hinder the implementation.

#### 6.3.1 Maintenance proposals

##### a) Maintenance investment

In establishing a viable maintenance system, it should be considered as investment which will be a sound effective system. This will not only protect the initial investment in well drilling and pump installation but will provide a basis that can be extremely useful for further village community development programmes.

##### b) Maintenance policy

There should be a maintenance policy for which decisions and long-term commitments can be implemented as planned, and this should stress the maintenance activities as priority. This can help to support the management and funding of maintenance system, as it has already been seen, maintenance is a demanding activity requiring the building and expansion capacities at various levels which needs careful planning.

c) Rate of expansion of pump installation

The maintenance organization should try to accommodate the rate of expansion of the pump installations and this could be taken as one main factor in the maintenance organization. There is always a danger of trying to expand the pump installation too quickly and forgetting the expansion possibilities of the maintenance system.

Hence the rate of expansion of the organization should be in parallel with the expansion of pump installation. Unfortunately it is not easy to train staff, to arrange for procurement of pumps, spare parts and materials and to establish a viable spare parts distribution network.

From experience it is not easy to train and educate people for their role in the maintenance systems, thus working continuously and starting from a zero base, could take a long time before the region could be able to absorb the massive hand pump programmes. This then creates a situation where the region is liable to settle for a very limited number of different hand pump models and to establish a method of financing. While at the same time a possibility of spare part distribution and local manufacturing capacity is sought.

With these, the maintenance system might develop gradually and sufficiently to be able to accommodate later expansion of hand pump programmes.

d) Pilot scale

In order to have a nationally standardized hand pump, it is advantageous to test two or three pump models, at pilot scale, for a period of two or more years prior to final selection of the pump and hence maintenance system to be adopted. However the general impression is such that it is difficult for the country to allow for such a system to develop in a phased manner. But given time and funds this could be achieved and would assist the country to select a possible right model of pump to be adopted nationally.

## e) Assignment of responsibility

The proper functioning of the maintenance system depends on both village community involvement and the government, and in this case it should be clear as to which maintenance tasks are assigned to village community and the government organization. The responsibility of each must be allocated with considerable degree of detail and it may be useful to specify the tasks as listed in f) schedule of maintenance of hand pumps. This allocation of responsibilities between the government organization and the village community might assist in achieving the goal of ensuring smooth maintenance of pumps as well as continuous operation and ultimately continuous supply of water.

## f) Pumps maintenance schedule

This maintenance schedule has been classified as daily, weekly, monthly and annually by Pacey (1980) and Shallow Wells (1979).

- |        |  |
|--------|--|
| Daily  | <ol style="list-style-type: none"> <li>1) Lock and unlock the pump (where locks are provided) at hours agreed by the village community.</li> <li>2) Clean the pump head and slab.</li> <li>3) Check the operation of the pump.</li> <li>4) Ensure that the pump and well are not being used as a working area and playing ground for children.</li> </ol>  |
| Weekly | <ol style="list-style-type: none"> <li>1) Thorough clean up the surrounding of the well.</li> <li>2) Oil or grease all hinge pins, bearings, spring and any other sliding parts, after checking that no rust has developed on them.</li> <li>3) Record any comments from the users about irregularities in working (e.g. tightness of parts, leaks from base pump and fall-off in water raised). Where possible these can be corrected.</li> </ol> |

- Monthly
- 1) If necessary make any adjustment as situation arises e.g. step plate and handle.
  - 2) Check that all nuts and bolts are tight and check that there is no evidence of loose connections in the pump rods.
  - 3) Check the symptoms of water at the valves noting any comment from the users about falling-off in raised water. If the pump fails to raise water when worked slowly (e.g. 10 strokes per minute) replace valves.
  - 4) Take water samples for quality analysis.
  - 5) Trim hedges and repair openings to make it tight.
  - 6) Instruct the users to use spill water to irrigate small vegetable farms around the well but at approximately 20 m away from the well.
  - 7) Carry out all weekly maintenance.

- Annually
- 1) Paint all exposed parts to prevent development of rust.
  - 2) Repair any cracked concrete on the slab and surrounding.
  - 3) Check wear at handle bearing and replace parts as necessary.
  - 4) Check plunger and foot valve, replace if found defective.
  - 5) Check pump rods and replace or re-connect and replace any defective lengths or connectors.
  - 6) Check pump head and replace or repair any defective part.
  - 7) Carry out all monthly maintenance tasks.

g) Maintenance development levels

In this aspect there seems to develop three levels of responsibility such that an effective maintenance system is achieved.

- Regional level development:

At regional level central workshops should be established for servicing and repair of pumps. The region should establish a factory which on receiving defective pumps, and where the need arises, modification could be done as well as trying to produce pumps using local materials (if available). Spares should be treated in the same manner. At this level the region should co-ordinate and monitor with districts as regards to the performance of the pumps and making analysis of the received data. Stores for keeping irreparable parts, spare parts and tools should be established.

- District level development:

The districts should try to establish small supplying centre for emergency cases as received from the village community. And a store to be established, in order to obey the order of supply line as discussed in section 4.2.4. The districts should keep records of all maintenance activities and then send them to the region for analysis, and through sharing responsibility, the district should do all major, emergency cases, and repairs where required. And they should make inspection trips to villages to check the performance of pumps and monitoring it with regional level.

- Village level development:

At district level pump attendants should be supplied with necessary tools for working, and keep them in their houses. Also for emergency cases, for minor repair they should be supplied with spare parts for parts needing frequent attention. On repair beyond their ability, should be reported immediately to the districts. Where necessary they should do all the daily and weekly maintenance tasks.

For well care-takers, it is recommended that those people, particularly women, living near the well, or if not, the ten-cell leaders, should be responsible for taking care of the well. In this regard, all the daily maintenance tasks should be shouldered by them. With each well having care-takers, will enable the pump attendants to perform their duties easily since some of the tasks are done by well care-takers.



### 6.3.2 Choice of a maintenance system

Having seen the existing maintenance systems of this region and some other selected regions, and after discussing them, it is considered the proper choice of the system should be a three level system where biasness is on village level maintenance, due to the fact that it is feasible, effective and cost reductive. However, some constraints still seem to exist as regards to the availability of equipment, tools and technology which need to be developed, but the reliability of such a system given careful consideration in planning and organization will be effective. The essential consideration in the selection of the maintenance should be:

- distance from central point
- accessibility to these areas with pumps
- density of pumps
- inspection and repair trips to be made.

It will become evident, later on, that when installation of pumps expands, the economies of scale will become more significant in that the first installations, the unit cost of maintenance will be relatively high but will decrease as the pump installations increase.

When planning for the maintenance system, the preparation should consider the following:

- Basic information collected from cards (carding system for equipment, tools or spare parts with necessary data e.g. technical and supplier, should have existed). There should be a collection and filing of all service manuals, instructions, drawings and leaflets for which data can be obtained. The analysis of all past breakdowns, repairs and replacement should be used as a basic information for planning.

- Follow-up of maintenance programme, this means information received from servicing cards and time schedule, observations made during operation or service and reports as received from maintenance teams.

#### 6.3.2.1 Requirements to motivate village efforts

Having chosen or recommended for a three level system of maintenance, and in order to make the village effort feasible, the following requirement should receive full emphasis:

- i) Village community participation should be emphasized and more on the maintaining and repairing of their own wells and pumps, with full responsibility to pump attendants and well care-takers.
- ii) Setting out an authorized dealer or organization to stock and sell the required spares to the village communities.

And this can be done in the following manner:

- a) Regional and District offices of Maji, to be stock centres whereas ward secretaries are distributors to the village communities.

OR

- b) By using existing chains of Regional Trading centres (RTC) which go down to division level. And then from division to village co-operative shops.

OR

- c) Establishment of workshop which will be under the Regional Authority, but being a separate entity with full responsibility of manufacturing and repairing spare parts and selling them to village co-operative shops. Initially assistance in establishment this

entity will be required and might be sought from donor agencies, but it should gradually improve its financial capabilities so that it can work from its own generated income.

If it is ensured that availability of spare parts and materials are at village level, the villagers will be motivated to do maintenance of their own wells and pumps.

### 6.3.3 Pump installation manuals

All pumps have specific installation requirements, ranging from simple to complicated ones. Even a relatively small weakness at the installation stage can greatly affect the performance of the pumps, which might lead to a total breakdown or increase in maintenance cost within a short period. In this way the pump manufacturers must, therefore, supplement their pump supplies with simple, easy to read and yet comprehensive installation manuals.

These manuals should be available for installation team, and it should not be presumed that, even though the team is technically qualified, will be aware of the different installation requirements for every design of pump. These manuals should detail step-by-step installation procedures and methods and would also serve as a guide for installation team to ensure that the installation of the pump is fully in accordance with specifications.

### 6.3.4 Funds for maintenance system

The required funds for maintenance will be determined by every decision on a component of a pump maintenance system for example the choice of pump to be used, its maintenance requirement and frequency, the type of organization undertaken and the number of personnel required. All these ultimately will influence the overall costs of the system and thus assist in budgeting required.

#### 6.3.4.1 Methods of funding

The various sources of financing will invariably influence the distribution costs. For the government to bear all maintenance costs, seems to or will be a real financial burden and it might lead to gradual deterioration of the system which eventually might collapse. Thus according to level of responsibility and sharing the cost, particularly shouldering it to village level, the government might get financial relief.

In this regard, the government should bear all fixed costs of maintenance organization and the village community to pay for the costs of spare parts and actual service charge of the pump by the pump attendants. Or the village communities may organize themselves to carry out simple maintenance tasks and minor repairs while the government is carrying out and financing major repairs. In this way the government should be able to collect service charges from the users and payment for spare parts and recycle these funds for the purchase of new supplies. But it should be noted that sometimes the handling of and accounting for such funds will pose a major administrative problem. Because it may not be possible to directly recycle revenue to meet the costs of spare part supplies in cases where the revenue has to be paid to the central government account.

#### 6.3.5 Manpower requirement

In this case it is not easy to specify (quantitatively) the requirement inputs of manpower because it will largely depend on the type of maintenance selected. However, the following provision should be made to obtain staff who could deal with:

- management, supervision and training
- general inspection
- preventive maintenance
- administration of stores
- vehicle maintenance.

And since maintenance is a labour intensive system where variety of skills for running of the organization is required, the personnel then required would comprise of:

- an engineer
- technicians
- masons
- administrators
- clerks
- drivers
- pump attendants.

It would be very useful if such a system would involve health educators who could take the responsibility of health education.

#### 6.3.6 Transportation requirement

It can be said that transportation largely contributes to the relatively high maintenance costs, and this is associated with the increase of fuel cost and vehicle spare parts. In this respect the transport vehicles should be as small as possible, but at the same time should be able to accommodate the rate of expansion of the programme, and if possible motorcycles and bicycles should have preferences to cars. These motorcycles and bicycles should be able to carry some materials e.g. pumps, pump rods, rising main etc., and this could be at village level.

At present it is not easy to enumerate precisely the requirement because the maintenance system seems to acquire a new turn. But as the expansion of the programme continues, provision of more transport seems to be required. This could be done through donor agencies who are willing and have keen interest in the upkeep of the maintenance of shallow wells in general.

### 6.3.7 Offices, stores and workshops

An essential part of any government-controlled maintenance organization is a system of offices, stores and workshops, and at these locations the government staff will have their base. Maintenance materials will be stored in stores, and repair can be done in the workshops. Generally these offices will fit into the organizational structure of the RWE and DWE's office, and it will be advantageous if the store will fit into the existing general store, and planning of spare parts distribution will depend on the source of supply and areas of demand. Where spares are issued it is often economical to collect the replaced items and recondition and then use them, rather than throwing them into the dumping areas. This could be done if the item is irreparable.

Normally staff house provision is an issue which receives very little attention and is not included in the project initiation. This can only be found where the project is undertaken by outside contractors. To reduce this problem the government should try to consider either provision of houses to the staff or include this in the capital investment of the project. However, if this is found to be costly, and if the staff is expected to carry out their tasks conscientiously, they might be given sufficient income to purchase or to rent their own accommodation or be provided with living quarters.

### 6.3.8 Maintenance costs

In the maintenance system, the following cost categories need to be considered:

#### Cost per pump

A Maintenance teams. In preparing cost estimate for the maintenance programme, the cost should also include the following:

- salaries and allowances for staff members
- depreciation of the equipment and vehicles
- maintenance of vehicles
- fuel and lubricant costs.

B Spare parts. This could be based on the analysis of collected data and indicated average.

C Village level pump attendants. The payment of their services could be met by village community, but the government should consider the training and material cost involved in this training programme.

By adding A, B and C and dividing by K (K in this case being number of pumps), the cost per pump per year can be estimated, which can help in the budgeting for the maintenance programme.

Thus maintenance cost expressed as a proportion of the investment cost of new pump installations will vary considerably depending on the type of maintenance system used, density of pump installations, the infrastructure, prices of fuel and spare parts and wages. As a rough guide, maintenance cost may be estimated in the range of 6 - 25 % of the capital investment of the well (Hofkes 1982).

#### Cost per capita

As discussed in section 6.2.3, the cost per capita seems to be relatively small, but as pumps are mostly used in poor areas, it may be quite difficult to raise the sums locally. The amount must be viewed in the context of local incomes from which a contribution towards the maintenance costs of pumps would be charged. This amount to the government may seem to be small and hence forming a negligible portion of the overall budget, but to a family it might form a relatively high proportion of his income. According to a publication of the World Bank, any water charges should not exceed a

maximum of 5 % of family income (Hofkes 1982). And as per section 6.2.3, the charges could be about 2 % of the family income which is relatively small. However, even where considerably less than this amount is required for pump maintenance, the mechanism to collect the money does not normally exist, except for funds which may be raised through other process. So to initiate this, there should be a mechanism through which the water charges may be collected and in the central government account there should be a separate vote for this.



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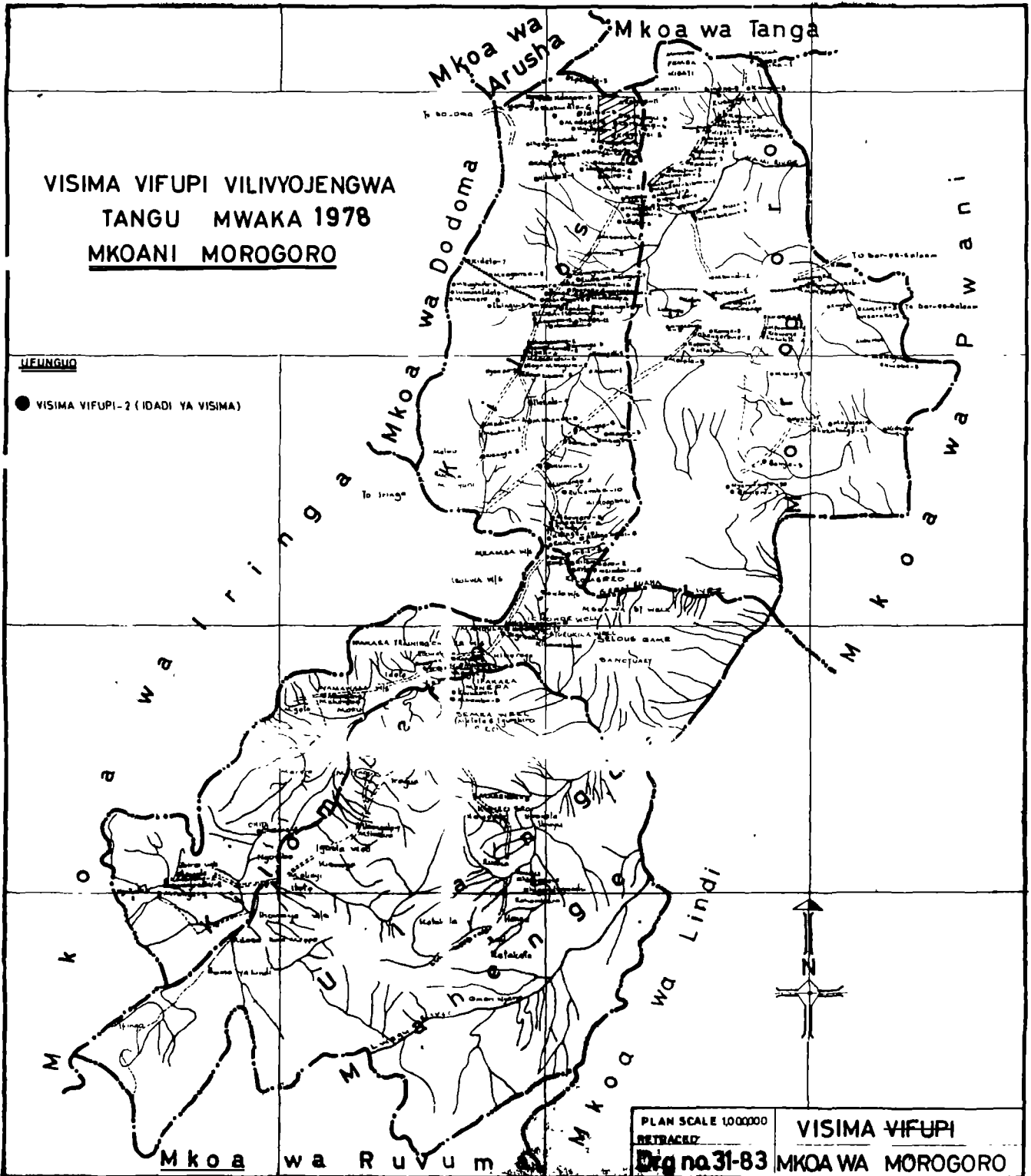
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**VISIMA VIFUPI VILIVYOJENGWA  
TANGU MWAKA 1978  
MKOANI MOROGORO**

**LIFUNGUO**

- VISIMA VIFUPI-2 (IDADI YA VISIMA)



PLAN SCALE 1000000  
RETRACED  
Fig no.31-83

**VISIMA VIFUPI**  
**MKOANI MOROGORO**

Kwa Fundi wa Visima Vidogo Vidogo,

K.K. Mhandisi wa Maji,  
 Wilaya.....*TA*.....  
 ..*S.H.I.A.N.S.A.*.....

TAARIFA YA KUHTAJI MSAADA KWA MAREKEBISHO.

Kuhusu kichwa cha barua hapo juu tunakuarifu kwamba tunahitaji msaada kwa marekebisho ya kisima kijijini kwetu.

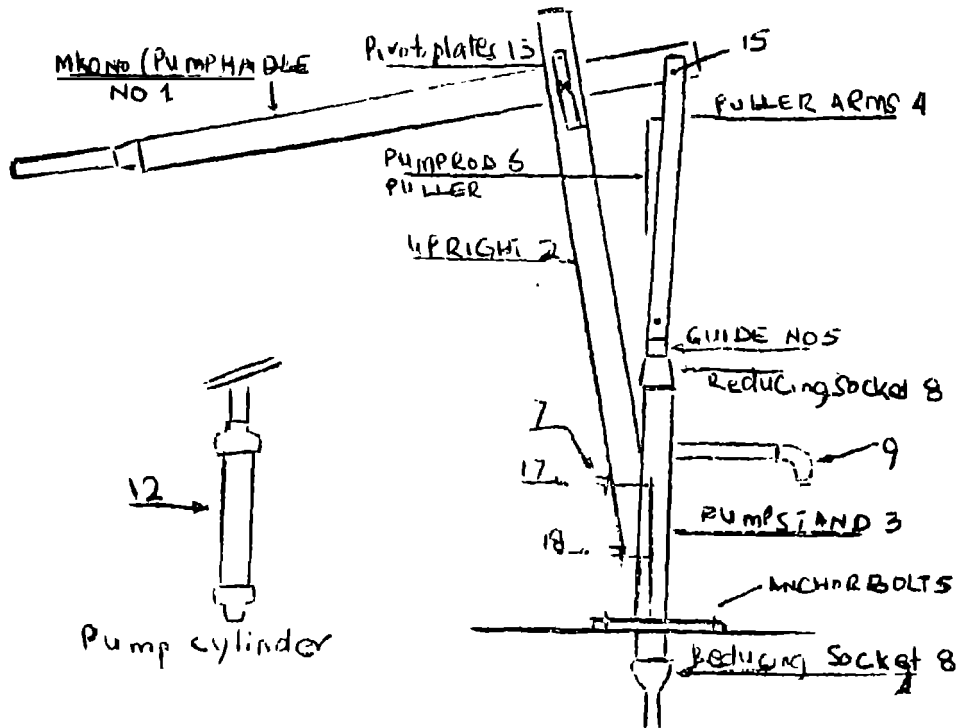
Jina la Kijiji.....*MWENSE SALAWE*.....

Jina la Mwangalizi.....*WILIAM SHIKIWA*.....

Namba ya Kisima.....*47/4r.32*.....

Kisima kimeharibika vipuli Nambari ...*8*.....

Maelezo zaidi...*Kisima lakidawi maji*.....  
*tunahitaji kwa msaada kwa*.....  
*marekebisho*.....



# HATI YA KUMILIKI KISIMA

CERTIFICATE OF WELL OWNERSHIP



Leo tarehe ..... Wanakijiji wa .....  
 Date ..... Village .....  
 Kata ya ..... Tarafa ya .....  
 Ward ..... Division .....  
 Wilaya ya .....  
 District

**Mmekabidhiwa kisima chenu kukitunza na kukiangalia**  
 You have been given responsibility over this well in order that you  
**mazingara yake kwa dhati ili kiendelee kuwahudumia**  
 may look after it and its surroundings properly so that it  
**kupata maji safi.**  
 will continue to serve you by giving you clean water.

**Maelezo ya kisima :**  
 Explanation of the well:

JINA LA MWANGALIZI WA KISIMA      DATE      JINA LA MWANGALIZI WA KISIMA      DATE

JINA LA MWANGALIZI WA KISIMA	DATE	JINA LA MWANGALIZI WA KISIMA	DATE

**Tumepokea kisima chetu kikiwa katika hali nzuri**  
 We have received our well in good condition

**Sahihi ya Mwenyekiti k.n.y. Kijiji :**  
 Signature of the chairmen on behalf of the village

.....

**Sahihi ya Katibu wa Kijiji :**  
 Signature of the Village Secretary :

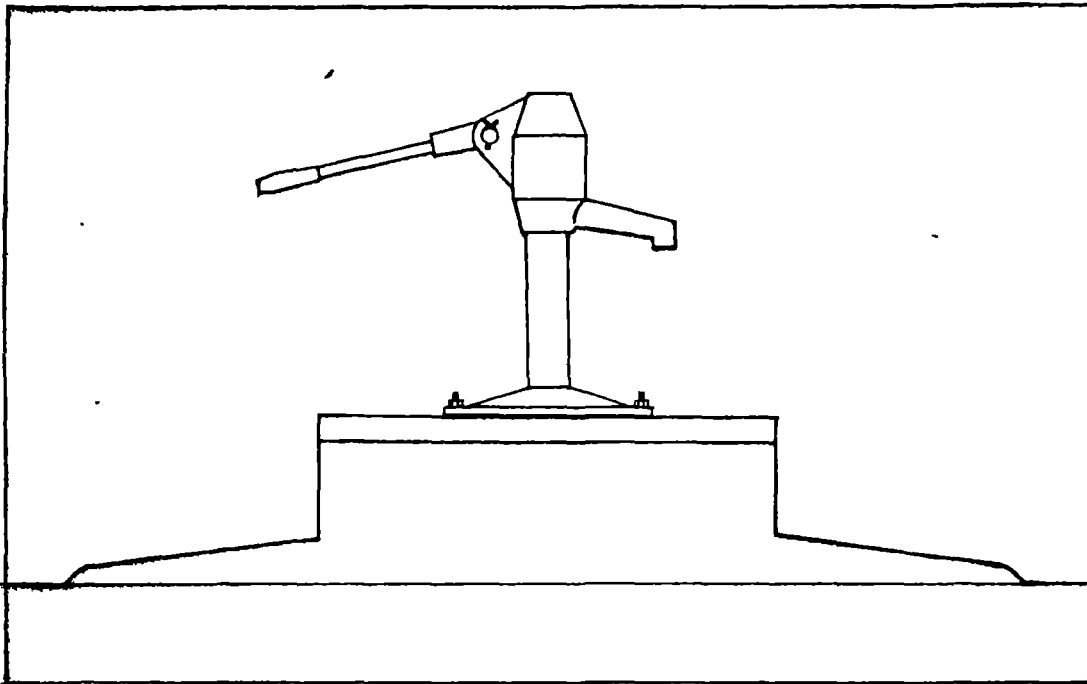
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**MKURUGENZI WA MAENDELEO WILAYA**  
**DISTRICT DEVELOPMENT DIRECTOR**

.....

Village request form  
Mtwara/Lindi Regions

RIPORTI MAALUMU YA UHARIBIKAJI WA MITAMBO



WILAYA ..... KIJJI .....  
 KATA ..... NAMBA YA KISIMA .....

TAREHE WAKATI MITAMBO ILIPOHARIBIKA / ..... 19..  
 SEHEMU GANI YA MITAMBO ILIYOHARIBIKA ( WEKA ALAMA YA X KWENYE PICHA HIYO  
 HAPU JUU. IKIWEZEKANA ELEZEA KWA KIREFU HAPA CHINI )

JINSI UBOVU UNAVYO - ONEKANA ( KWA MFANO )

- MITAMBO INAFANYAKAZI SAWASAWA LAKINI MAJI YANGOJEWU
- MITAMBO INAFANYAKAZI SAWASAWA LAKINI MAJI HAYATOKI
- MKONO WA MTAMBO HAUFANYI KAZI SAWASAWA
- LADHA YA MAJI IMEPUNGUWA
- MADHARA MENGINEYO ( ELEZEA )

.....  
 .....  
 .....  
 .....

JINA LA MWANGALIZI ..... TAREHE / ..... 19 ..

**FINN WATER SHALLOW WELL MAINTENANCE REPORT**

\_\_\_\_\_ District

Date \_\_\_\_/\_\_\_\_/19\_\_\_\_

Register No \_\_\_\_\_ Start \_\_\_\_\_ km

end \_\_\_\_\_ km

Driven \_\_\_\_\_ km

Camp at the start \_\_\_\_\_ village

Camp at the end \_\_\_\_\_ village

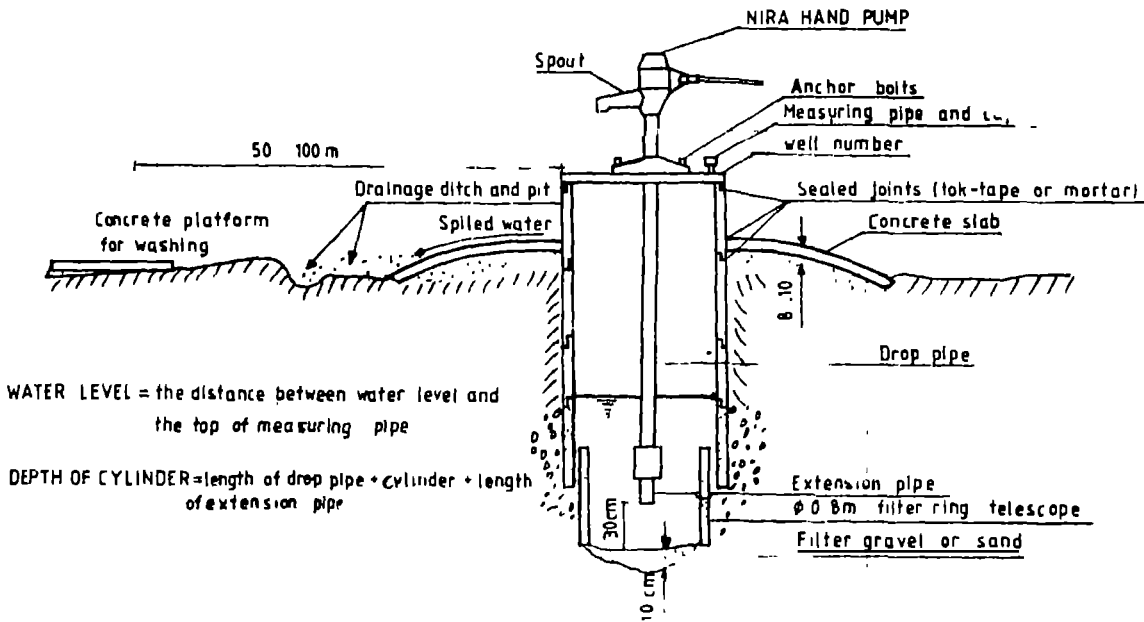
Maintenance supervisor \_\_\_\_\_

Village	Well No	Water level	Bottom	General impression of				Depth of cylinder	Remarks / action taken
				Well	Slab	Surround	Pump		



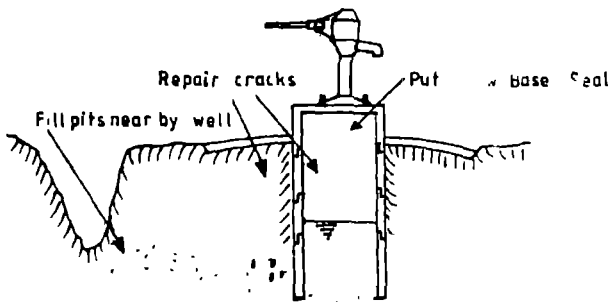
**ALWAYS CARRY OUT THE FOLLOWING MAINTENANCE ACTIVITIES:**

- 1 Contact the WELL ATTENDANT and VILLAGERS and ask about their well problems
- 2 Check the WELL NUMBER and repair it if it's unclear
- 3 Measure WATER LEVEL and BOTTOM, tighten the CAP with a spanner
- 4 Prevent surface water entering into the well  
REPAIR CRACKED COVER, RINGS and SLAB with concrete
- 5 Repair broken ANCHOR BOLTS
- 6 Check that the CONNECTION between COVER and WELL TOP is sealed with TOK-TAPE or cement mortar
- 7 CLEAN THE SLAB, DRAINAGE DITCH and PIT
- 8 Clean and DISINFECT the well if the water is POLLUTED
- 9 Remove EXCESS MUD from the BOTTOM and check that 10cm of FILTER GRAVEL is on the BOTTOM.
- 10 Grease the GREASING NIPPLE
- 11 Check that all PUMPTHREADS and NUTS are tight DON'T TIGHTEN TOO MUCH
- 12 Check that the SPOUT is directed to drainage ditch
- 13 PUMP (10, 20 strokes) until water flows from spout  
REPAIR THE PUMP if it's broken
- 14 ADVISE VILLAGERS HOW TO USE THEIR WELLS AND PUMP  
The well site is not children's play ground



MORTAR = 1 part CEMENT + 4 parts SAND + WATER

Well pollution and different ways to prevent...



**WELL DISINFECTION:**

- 1 Remove pump and cover
- 2 Measure WATER in the well
- 3 Pump all polluted water away in the well with mortar pump
- 4 Clean the well and remove excess mud
- 5 Pour CLORINE SOLUTION into the well.
- 6 Mix the chlorinated water in the well; wash the rings and all parts of well.
- 7 Close the cover and let chlorinated water effect 6 hours
- 8 Pump all the chlorinated water away and install the pump.

WELL CHECK FORM

MTC - 1/1

Checked by:.....

Date:.....

COMPLETION DATA						SURROUNDING													
VILLAGE	WELL NUMBER	MONTH COMPL'D	E.C. US/CM	W.L. (M)	T.W.D. (M)	HEDGES				OUNDING CLEAN		HOOD WORKS		WATER LOGGING					
						PLANTED		TRIM NEEDED		YES	NO	MUCH	NOT MUCH	INSIDE RIM		AROUND SLAB			
						YES	NO	YES	NO					YES	NO	YES	NO	YES	NO

Checked by:.....

Date:.....

WELL CHECK FORM

MTC 1/2

SURROUNDING				P U M P																			
DRAINAGE DITCH		END OF GUTTER ERRODED		GRASS GROWING AROUND		TYPE OF PUMP				WATER COMING		ACTION OF PUMP			STEP PLATE CRACKED		INNER TUBE GREASED		PUMP LEAKING				
CLEAN	ERRODED	YES	NO	YES	NO	YES	NO	KP	KP O/B	HP 80	HP 81	YES	NO	L	M	H	YES	NO	YES	NO	YES	NO	

O - Orange ) - Colour painted  
 B - Brown )



WELL CHECK FORM

MTC - 1/4

Checked by:.....

Date:.....

SLAB				S E A L								RISING MAIN (R.M.) PUMP RODS (P.R.)													
G U T T E R				T Y P E			C O N D I T I O N					T Y P E			G A L V A N I -		T Y P E		P U M P			G A L V A N I Z A T I O N			
C L E A N		C R A C K S		O F			G O O D		L E A K I N G			O F			Z A T I O N		O F		R O D S			O F			
Y E S	N O	Y E S	N O	R F	C B	R P	Y E S	N O	Y E S	N O	P . V . C .	G . S .	IS	R	O K	Y E S	O K	SS	ST	IS	R	O K	Y E S	N O	

HM = Rising Main GS = Galvanized Steel L = LIGHT  
 IS = LOOSE RF = ROOFING MATERIALS M = MEDIUM  
 R = RUSTED CB = CORRUGATED H = HEAVY  
 BR = BROKEN RP = ROPE  
 DP = DIRTY PACKED ST = STEEL  
 LK = LEAKING SS = STAINLESS STEEL



WELL CHECK FORM

MTC - 1/6

checked by:.....

date:.....

WATER QUALITY															OTHER DATA						
PISTON VALVES					FOOT VALVES					EC FB / CM	WATER SMELLING		COR SUR	IRON CONTENT		T.W.D. MEASUREMENT (M)	W.L. MEASUREMENT (M)	IN USE		FENE TRATION OF WATER	
YES	CONDITION				TYPE	CONDITION					YES	NO		YES	NO			YES	NO	YES	NO
PT	OK	PT	R	WR	BL	PT	OK	PT	R	WR					(M)	(M)	YES	NO	YES	NO	

PR = PUMP RODS  
 PO = POOR  
 WR = WORN  
 CR = CRACKED  
 BL = BALL  
 PT = PLAT  
 FT = FILTED







HAJI REGIONAL SHALLOW WELL PROGRAMME - MOROGORO

FORM - AGT/MTC/-2

Mji/ji		Nambaya <u>KIBIRA</u>	WL	M.CL	EC	JS/CM	TARUHE:
--------	--	--------------------------	----	------	----	-------	---------

1. Hali ya Kisima ilivyo:-

VIEWA VILIVYOTULIKA	UNIT	QTY.	UNIT PR.	AMOUNT TOTAL
<b>MIYA YA GARI      USAFIRI</b>				
	KUTOKA	MPAKA	JUMLA YA KH.	
<b>JUMLA YA GHARAMA YA H. TENGENEZO</b>				

2. Ubovu ulivoretikana:-

3. Hitengenezo yaliyofanyika:-

5. Hitengenezaji:-

<u>JINA</u>	<u>CHEO</u>	<u>SAHIHI</u>

6. Baada ya kujaza form hii haitisha hitengenezo na gharama nyuma ya Well Report Form.

MAJI REGIONAL SHALLOW WELLS PROGRAMME

WEEKLY REPORT FORM

MTC-3

WELL MAINTENANCE REPORT

Week from:..... To:.....

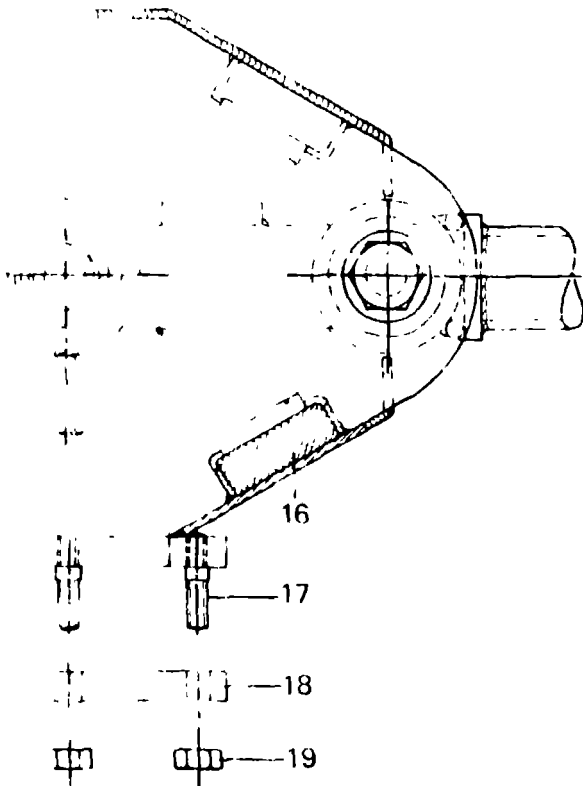
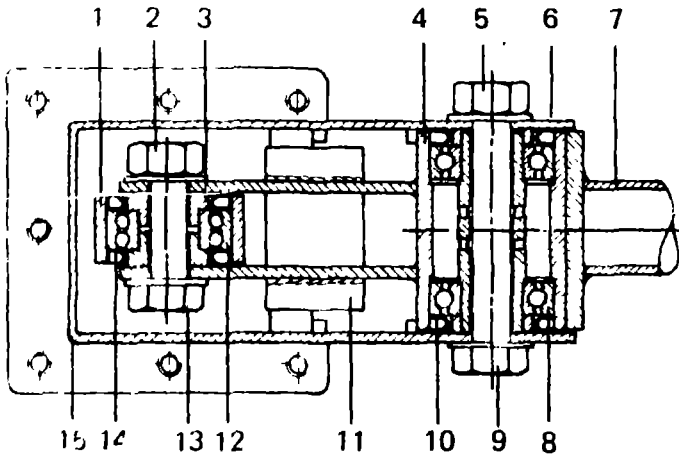
Repaired by:.....

Well No.	Village	Labour Maji	Labour D.P.	Car No.	KM/mls	Km/Day	Driver	Work Description	USED MAT	SURR	SLAB	PUMP	WL	EC

**STANDARD LIFT PUMPS SWN 80**

a PUMP HEAD SWN 80

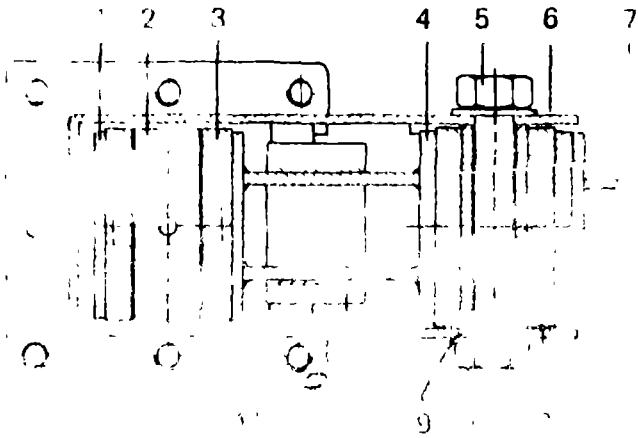
ball bearing



no.	description	number
1	rod and bearing	1
2	bolt M20	1
3	bush	2
4	bearing housing	1
5	bolt M20	1
6	washer M20	4
7	handle assembly	1
8	ball bearing	2
9	bolt M20 x 125	1
10	sealing	4
11	stroke limiter	2
12	ball bearing	2
13	bolt M20 x 75	1
14	sealing	2
15	pump head structure	1
16	rubber pads	2
17	stud M12	8
18	projector plate	1
19	nut M12	8

PUMP HEAD SWN 80

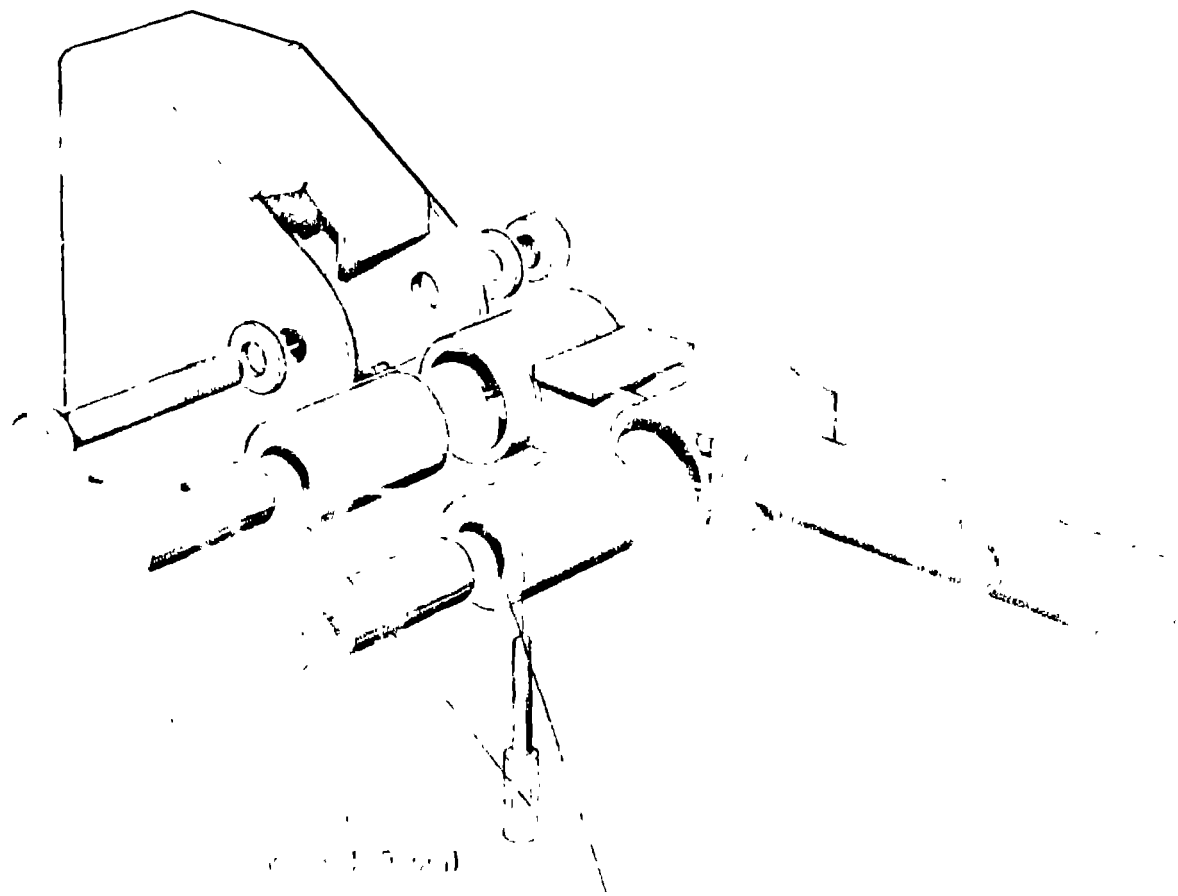
Bearing



no.	description	number
1	rotor and bearing	1
2	shaft	1
3	sleeve bearing	1
4	bearing housing	1
5	bolt M20	2
6	washer M20	2
7	handle assembly	1
8	bolt M20 x 125	1
9	main shaft	1
10	stroke limiter	1
11	pump head structure	1
12	rubber pads	2
13	stud M12	2
14	protector plate nut M12	1

PUMP HEAD BWN 80

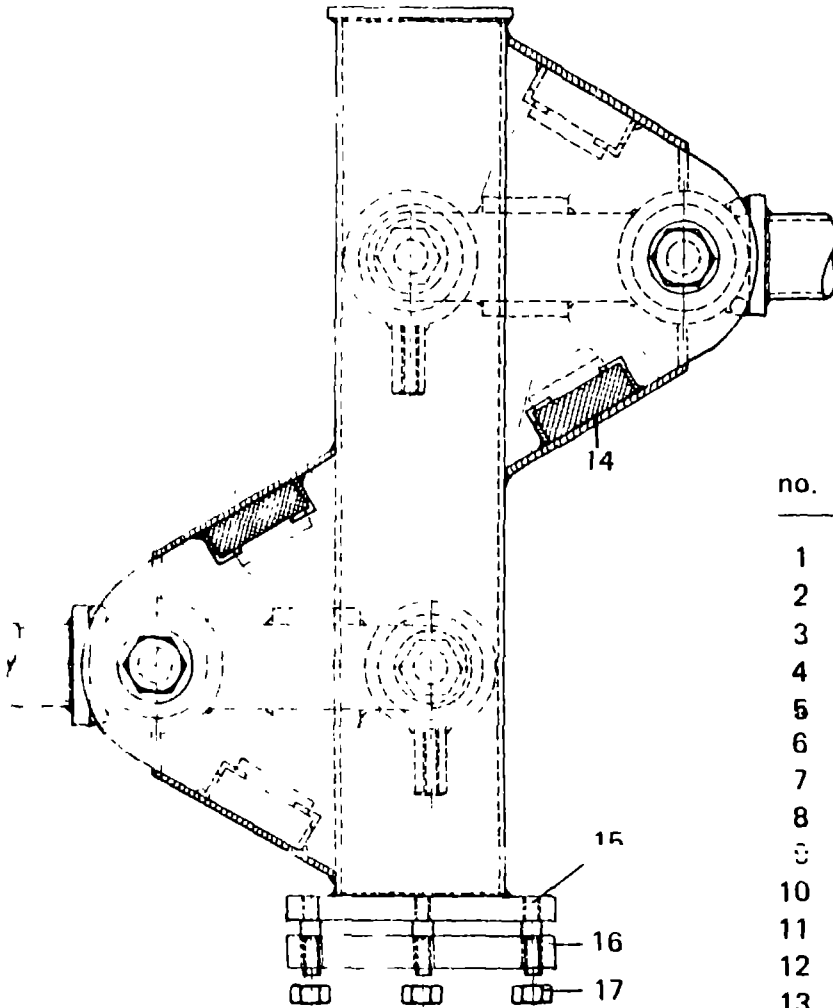
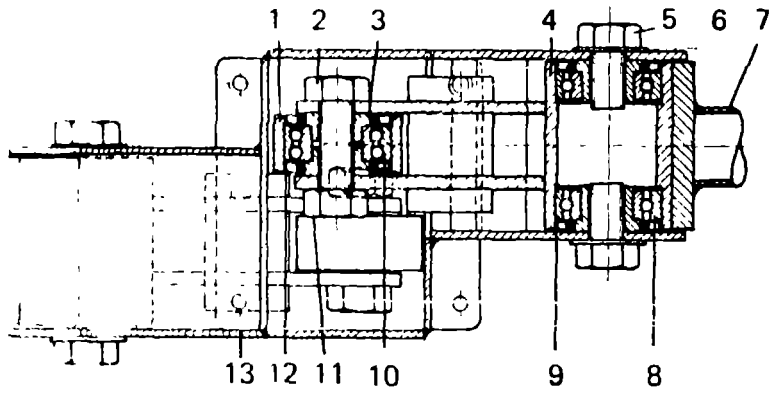
Exploded view of journal bearing



Polyacetal bushing  
to be fitted into the tree  
approx. 5 years

1000000  
1000000  
1000000

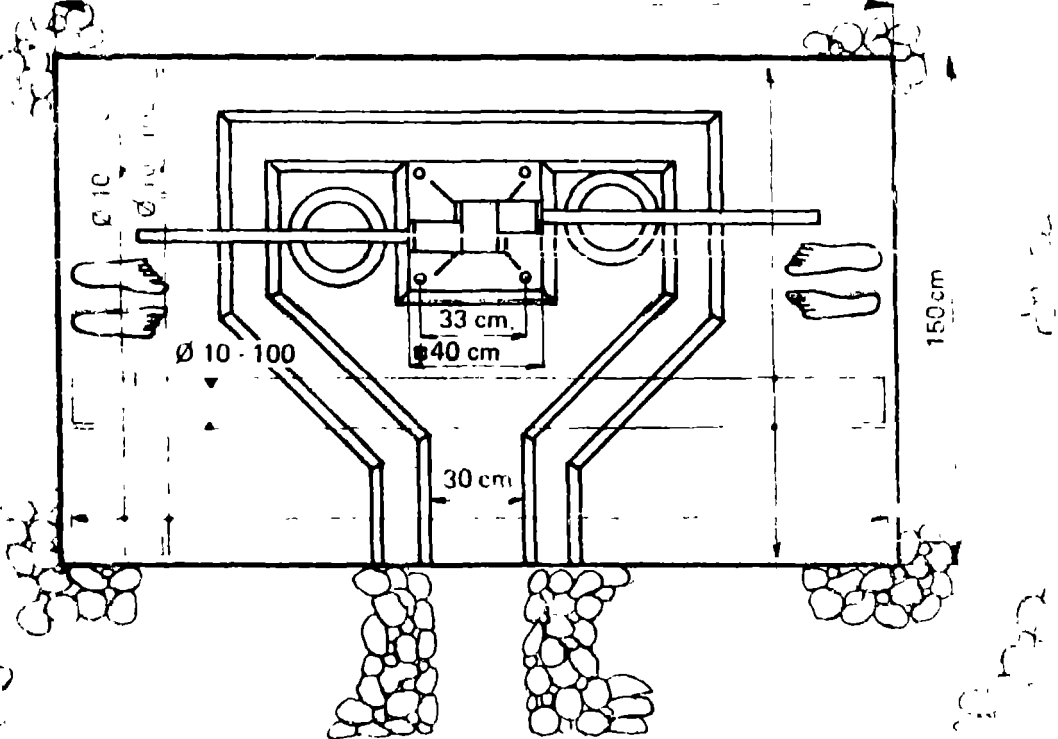
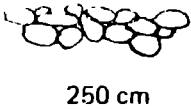
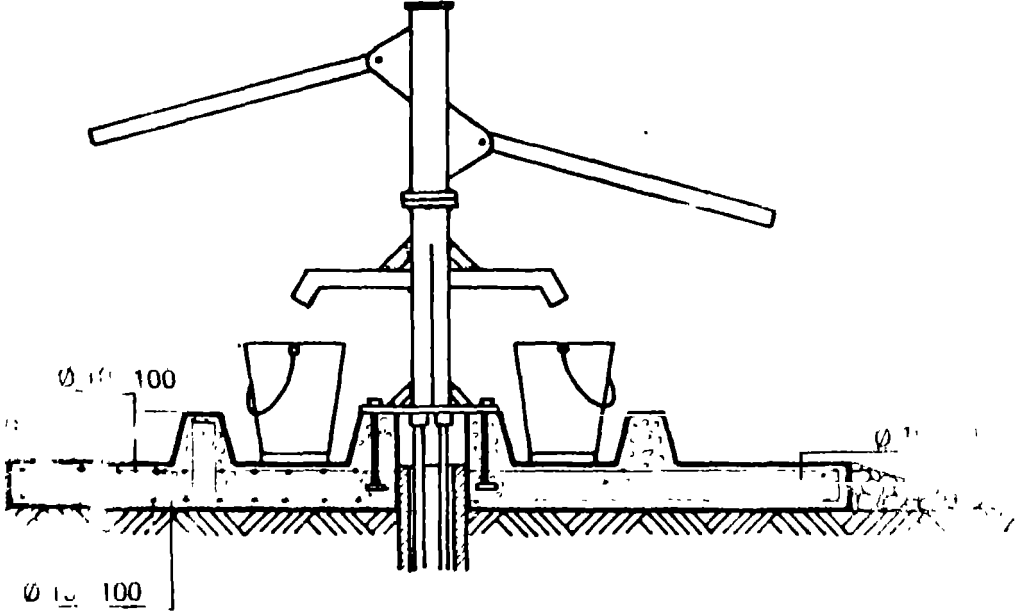
## PUMP HEAD SWN 80 DUPLEX



no.	description		
1	rod and bearing		
2	nut M20		
3	bush		
4	bearing housing		
5	belt M20	4	
6	washer M20		
7	handle assembly	2	
8	ball bearing		
9	sealing		
10	ball bearing		
11	nut M20		
12	sealing		
13	pump head structure		
14	rubber pads		
15	stud M12		
16	protector plate		
17	nut M12		

SWN 80 DUPLI EX ON SLAB

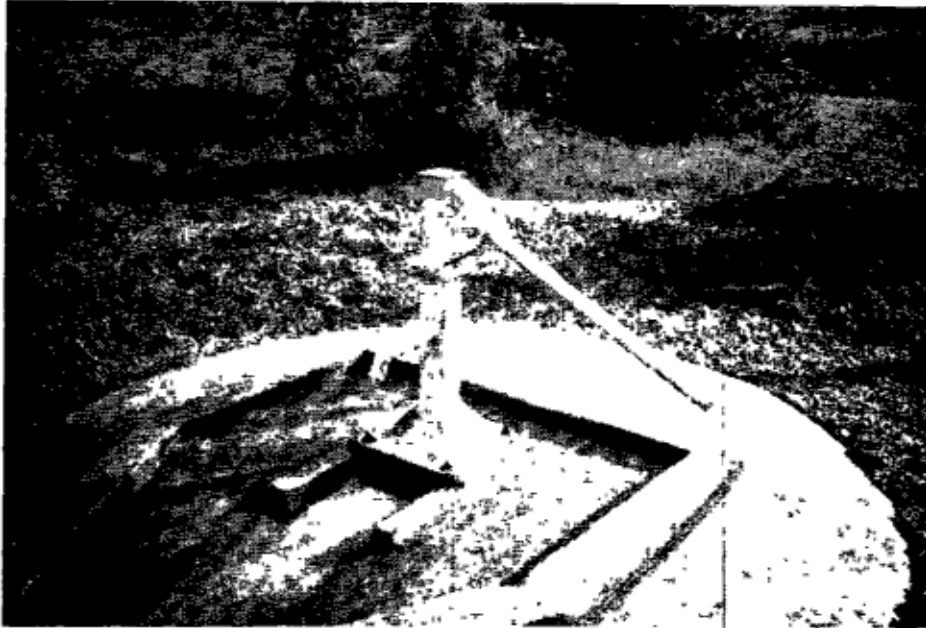
STRUCTURE FOR A DUPLEX PUMP CONSISTING OF A REINFORCED CONCRETE SLAB, A PUMP BASE WITH ANCHOR BOLTS AND A GUTTER



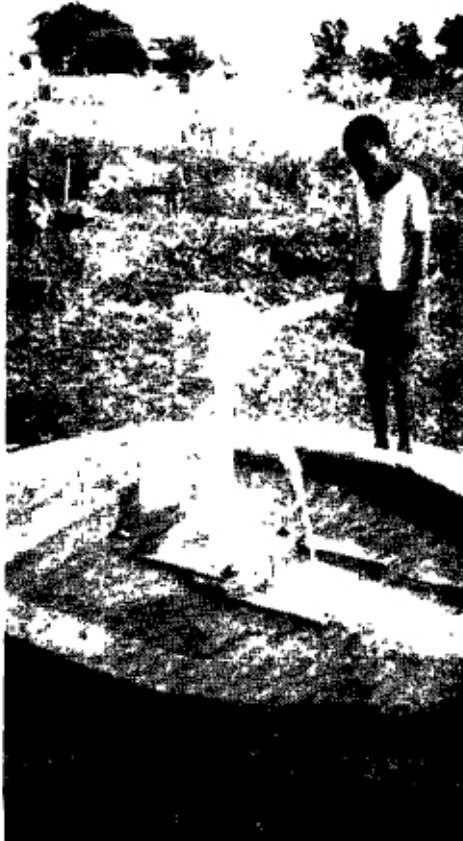


a) Different heads fixation on a SWN 80 pump house or stem.

*SWN 80 in standard construction Pumphead with life greased ball bearings  
Fitted with 50 mm diameter deep well cylinder, suitable to pump water from depths to 50 m*



b) The SWN 81 pump head on standard pump stand.

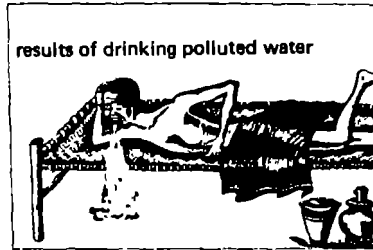


c) SWN 82, the same housing as the SWN 81, with journal bearings (instead of ball bearings).

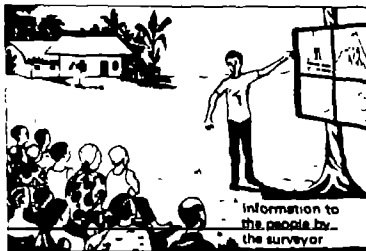




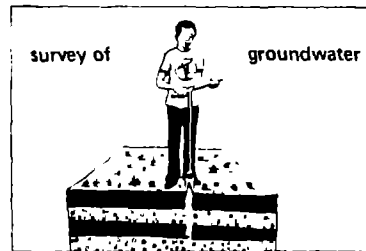
1



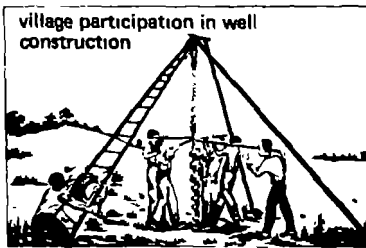
2



3



4



5



6



7



8

UNDERSTANDING AND IMPROVEMENT OF VILLAGE HYGIENE

Training/Job Manual for Trainers, Pump Caretakers,  
Village Water Committees and Village Health Staff  
(Kangaroo Pump Version)

NOTE TO THE USERS OF THIS BOOKLET

For whom is this book?

This book is for:

- the village pump caretakers and their trainers
- those members of the village water committee that  
are responsible for educating the pump users
- village schoolteachers and health workers

What is the purpose of this book?

The purpose of the book is:

- to make the pump caretakers, committee members and village functionaries understand the importance of good and sufficient water and better hygiene
- to give guidelines and educational material (flipcharts) for educating the other villagers on water and hygiene

### How to use the book yourself

- at each well, organize a meeting with the well users
- show each picture of this book and ask the questions given in the text
- do not give any answers yourself, but help the people to come up with their own answers and examples
- help your group to make decisions on how they will keep the well clean and improve their water use and hygiene
- If they give answers correctly, it will be easy for them to understand the use of clean water & keep it clean.
- If they fail, try to help them and emphasise on the subject concerned.

### How can others use the book?

Health workers can use it for:

- home visits and neighbourhood meetings
- visits with the village water committee to traditional and improved water sources and public latrines in the village
- discussions at the clinic

Schoolteachers can use it for:

- health education lessons in class
- taking the students out for practical lessons, e.g. inspecting school latrines, improved water sources and traditional sources (including those infested by bilharzia)



Je, haya maji ni safi na yanafaa kunywa ?

Discussion topic 1

DIRTY WATER BRINGS ILLNESS

Question: Water that is open (a river, waterhole, unprotected well) can become infected with dirt and worms. Can you give some examples of how this can happen? (see picture)

Discussion:

- People bathe themselves and wash clothes in the river or the well. That water is later drunk by other people
- People defecate near the open water. The rain washes the stools into the water. Excreta of cattle are also washed in. The stools can have worm eggs and germs. When this water is drunk the germs and worm eggs come into your body

Question:

- Is open water in your village used for drinking and making food?
- Is that water always boiled, even at planting and harvesting time?
- What diseases can you get from drinking dirty water?

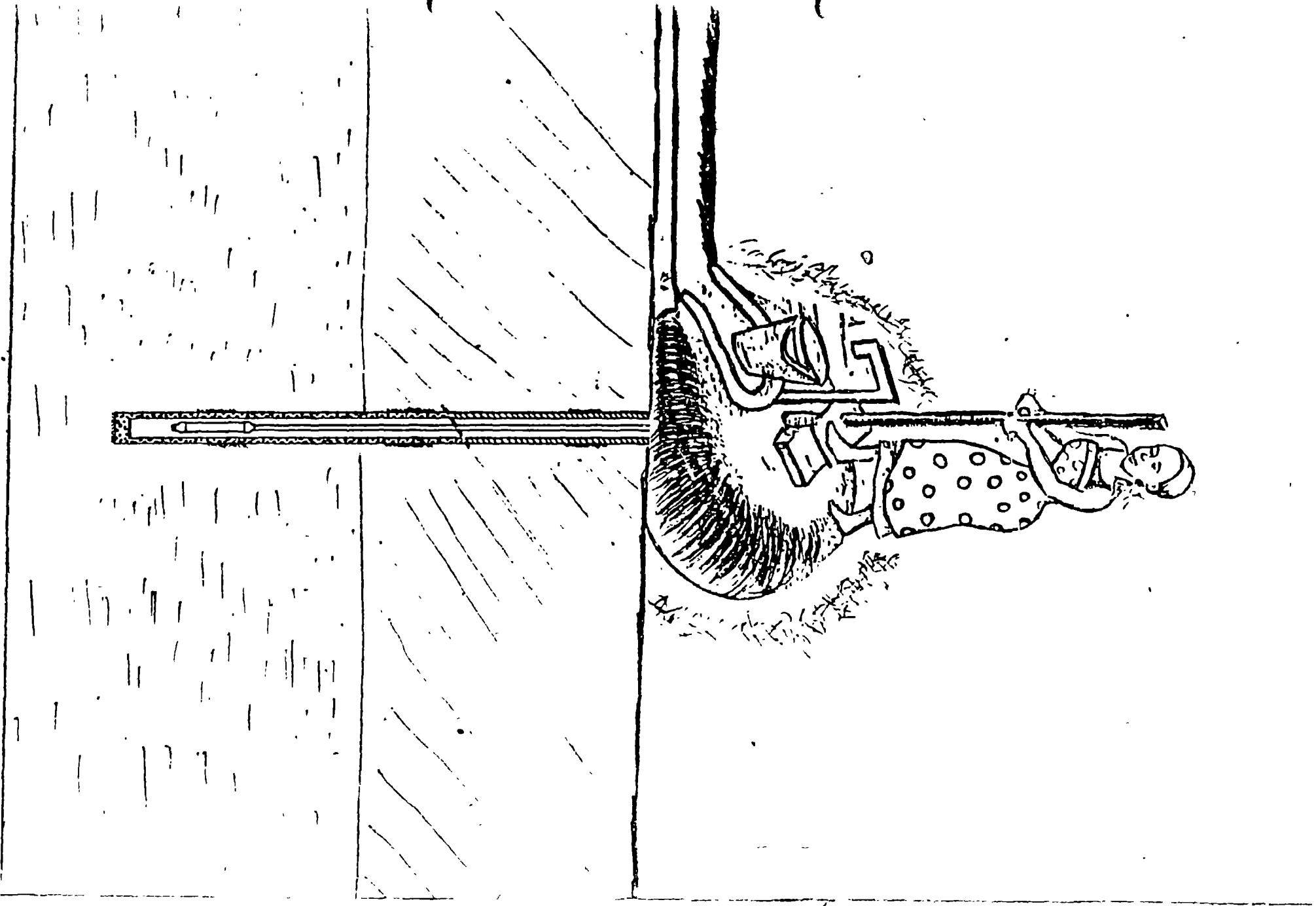
Answer: Cholera, typhoid, diarrhoea, dysentery, worms, jaundice

Question: How can drinking water bring these diseases to others?

Discussion:

- People who are ill with these diseases (even without knowing it) may defecate near water
- Their soiled clothes are washed in water
- This water is later used by other people for drinking and preparation of food

Conclusion: Which water in your village is unsafe? Will you still get your water from there?





A SAFE WATER SUPPLY IS GOOD FOR YOUR HEALTH

Question: Why is water from a pump safe to drink?

Discussion: Water from a pump comes from deep under the ground. There it cannot be contaminated by germs from stools, dirty clothes and people's bodies. (see picture)

Question: Will everyone in the village always use water from the pump to drink? Can you think of occasions when unsafe water will be used?

Discussion:

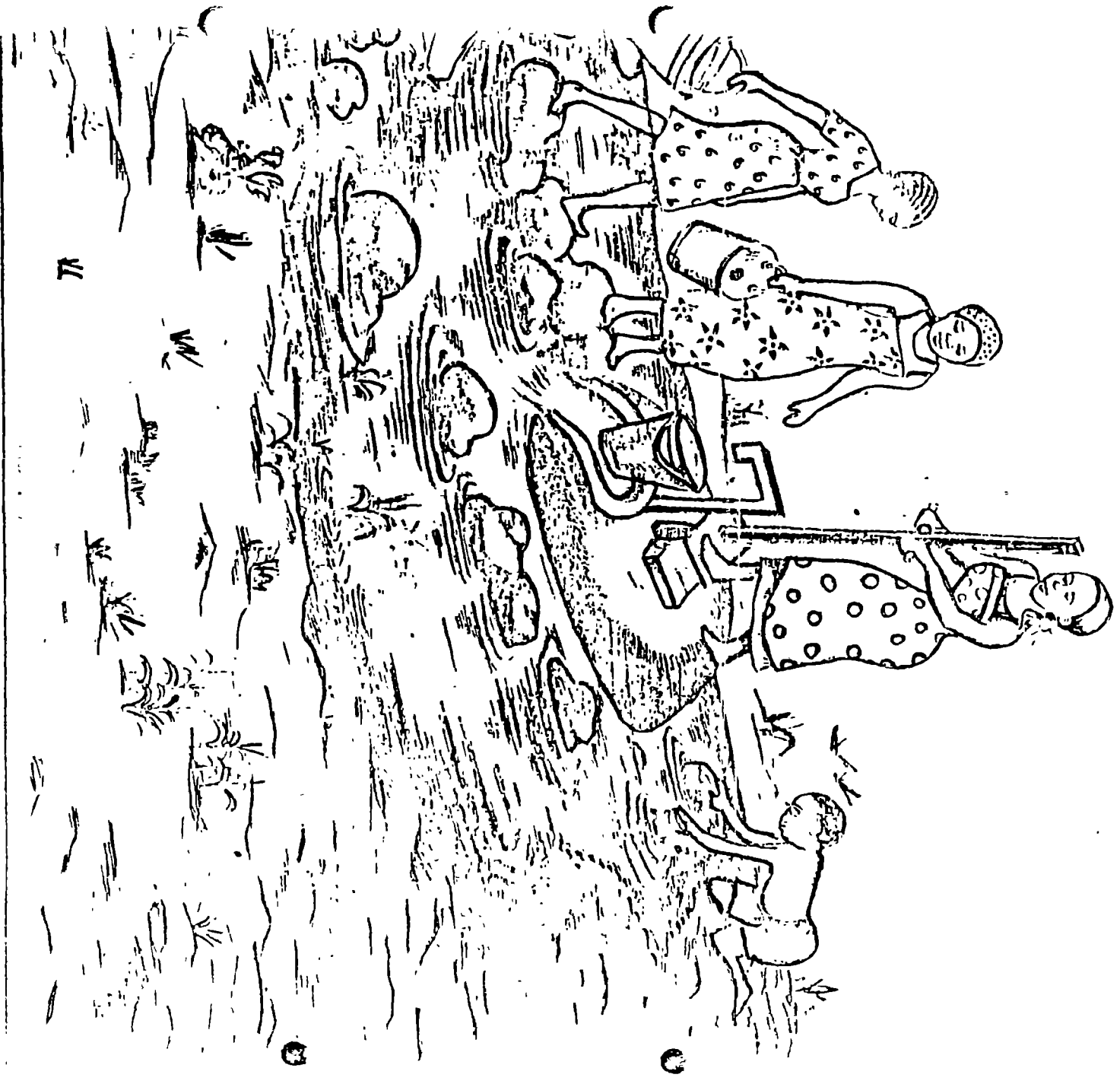
- The pump is farther than the nearest waterhole or the river
- There are queues at the pump
- The water tastes not as nice
- The pump is not working well
- Our children play in the river and drink from it

Question : How can we make sure that only safe water is drunk in our village?

Discussion:

- We can tell each other to stop using unsafe water
- We can make a village by-law on using only the pumps for safe water
- After some weeks we are used to a different water taste. We can also get your drinking water at another pump, if that tastes better

Conclusion: Water from a pump is safe because the well is closed and protected from dirt. The water has also been tested to make sure that it is safe to drink, even when it tastes a bit different. We should only use this water for all our drinking and cooking.



Je, haya maji ya kisimo hiki tado ni safi na yenza  
kunywa ? Vanaweza kufonywa nini ?

Discussion topic :

DOES THE SAFE WATER STAY SAFE?

Question: The water in the ground is protected against contamination by people and animals. What can happen when a lot of dirty water stands around the well?  
(see picture)

Discussion: The dirty water seeps into the soil and contaminates the clean water that is pumped up.

Question: What can happen when the well cover is cracked or opened?

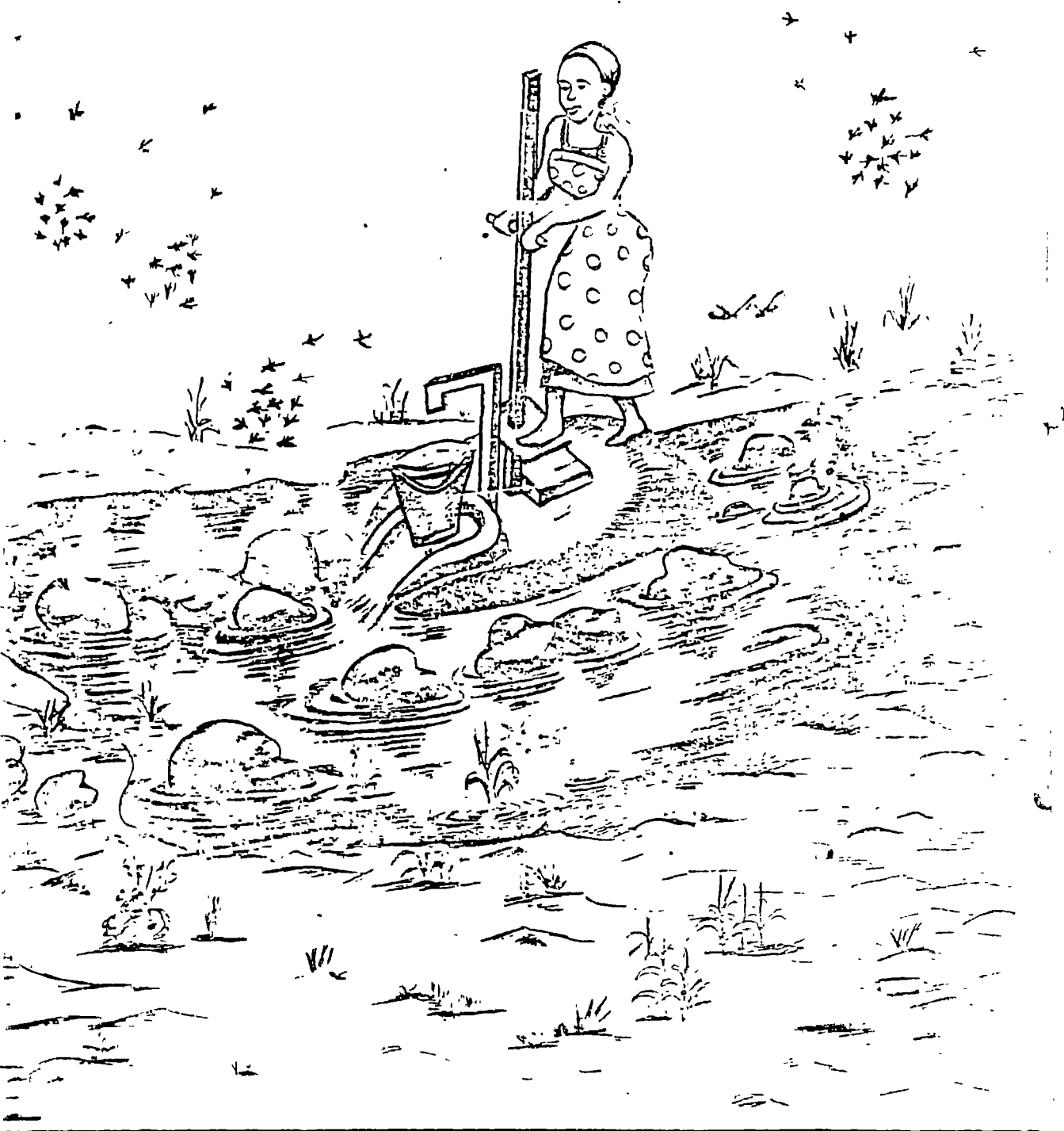
Discussion: Dirt and small animals (rats !) can fall in and pollute the clean water

Question: How can we prevent the clean water in our wells getting dirty ?

Discussion:

- Every user sees that the drain is clean and that there are no puddles around the well
- If there is water standing, a channel is dug to the field. The water can be used to grow vegetables
- Cattle are not allowed inside the well area. A hedge or fence protects the well
- Washing is only allowed when special provisions are made (drainage) at some distance from the well and no puddles and mud are formed
- Broken or cracked well covers are repaired by the village water committee and pump caretaker
- When a pump breaks down, the well is not opened but the broken pump parts replaced by good ones.

Conclusion: To keep the well water safe, the users keep the pump surroundings clean. The caretaker and water committee see that the wells are well-kept. A hedge is made to keep cattle away.



MOSQUITOES BREED IN STANDING WATER

Question: Why is it also bad to have stagnant water around the wells? (see picture)

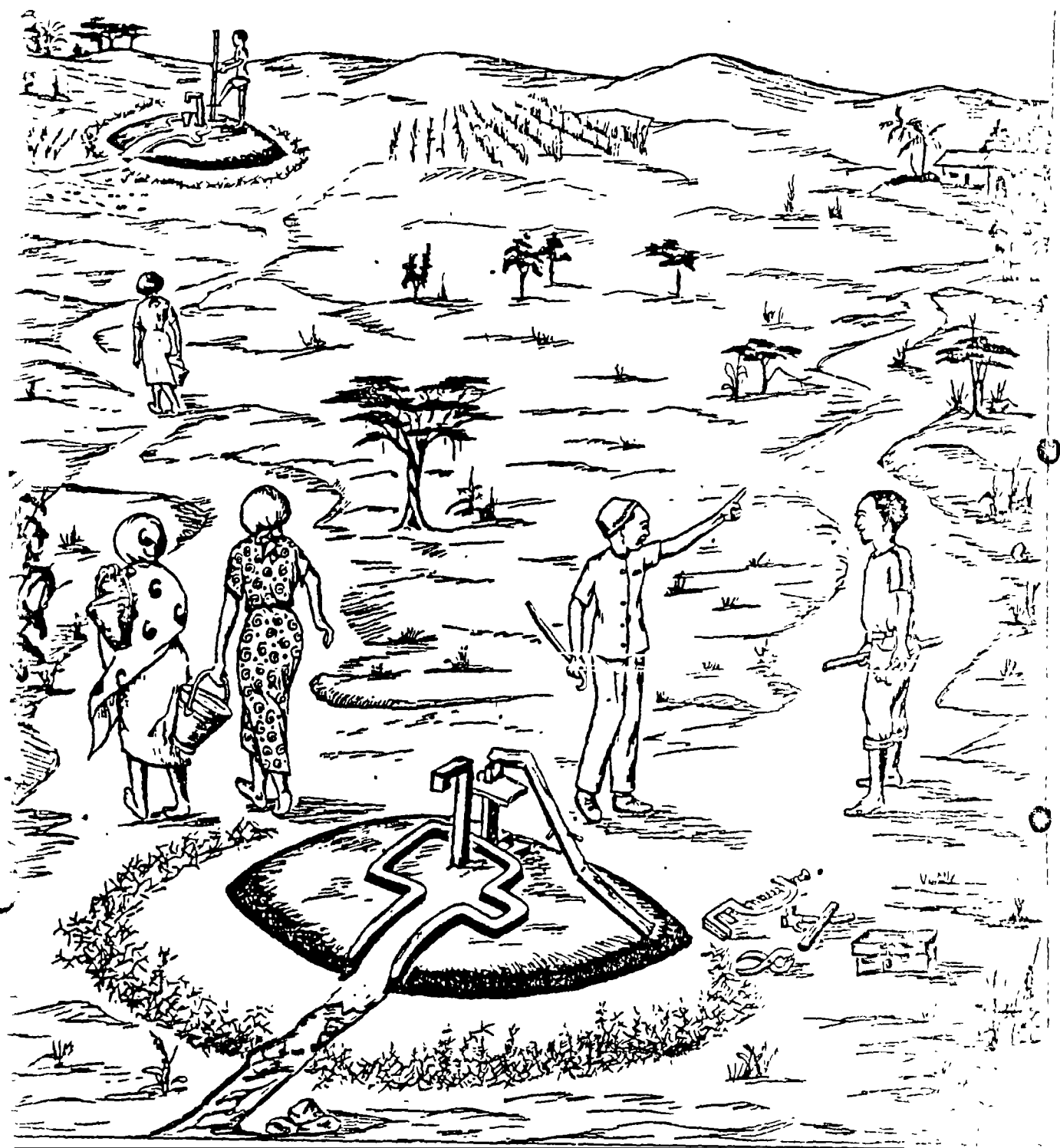
Discussion: Mosquitoes breed in standing water. They can transfer malaria, elephantiasis and other diseases from a sick person to a healthy person.

Question: Where can water collect in our village?

Discussion :

- Around the wells (puddles)
- Rainwater puddles in the compounds and village roads
- Old tins, calabashes, ditches, hollow trees and plants (vidimbwi) near the houses in which rainwater collects
- Rainwater storage drums or tanks that are not covered
- Puddles outside bathing places

Conclusion: To limit as much as possible the places where mosquitoes breed there must be no puddles around the well, no old tins, uncovered water containers and ditches around the houses. Where possible, standing water should be drained, and drainage channels made along the village roads



Tunaweza kufanya nini pampu ikivunjika ? Je, kuna mahala  
pengine tunaweza kupata maji mpaka pampu hii  
itakapotengenezwa ?

PUMP FAILURE AND VILLAGE HEALTH

Question: ○ The village was for some time used to having good (drinking) water from the pumps. Now one of the pumps breaks down. The users do not go to another pump, but go back to dirty water. Their stomachs are used to clean water. What will happen?

Discussion: When your stomach is first used to safe water and then get dirty water you can easily become ill.

Question: What can we do to protect our health when a pump breaks down? (see picture)

Discussion:

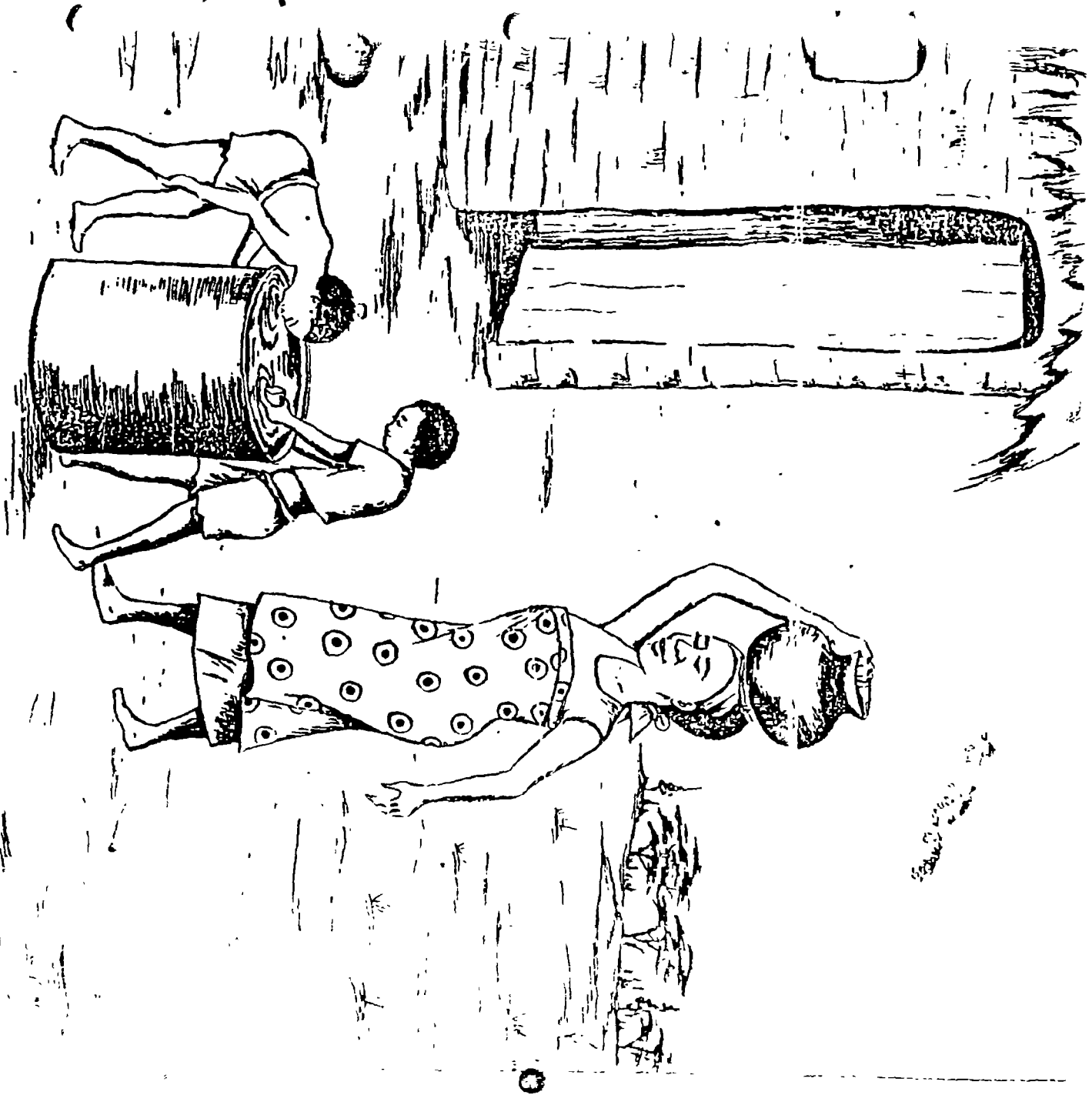
- We go to the other pumps to get our drinking water
- We warn the pump caretaker as soon as we find that there is a problem with the pump
- We do not open the well but try to get it repaired quickly, with the help of the caretaker and the village water sub committee
- If the caretaker cannot repair it we seek help from outside the village

Question: How can users check their pumps?

Demonstration:

- Feel if the pump is firm on its base
- See if there are any loose parts (nuts, bolts, handle)
- Report to VCT if pump or parts are loose
- Wash hands, rinse bucket and empty in gutter before filling the vessel
- Clean gutter and well surrounds when necessary
- Do not allow children to play with the pump

Conclusion We must operate the pump in the right way to keep it functioning. When there are problems we warn the caretaker. When the pump breaks down we use another or boil our drinking water when it comes from an unsafe source. We ask the village water committee for a quick repair.



Je, maji safi yanaweza kuwa machafu unapoyagusa kwa vidole vyako ?



WATER COLLECTION AND STORAGE

Question: The water from the pump is clean and safe for people's health. But this water may not stay clean once it is taken from the well. How can it become dirty during collection and storage? (see picture)

Discussion:

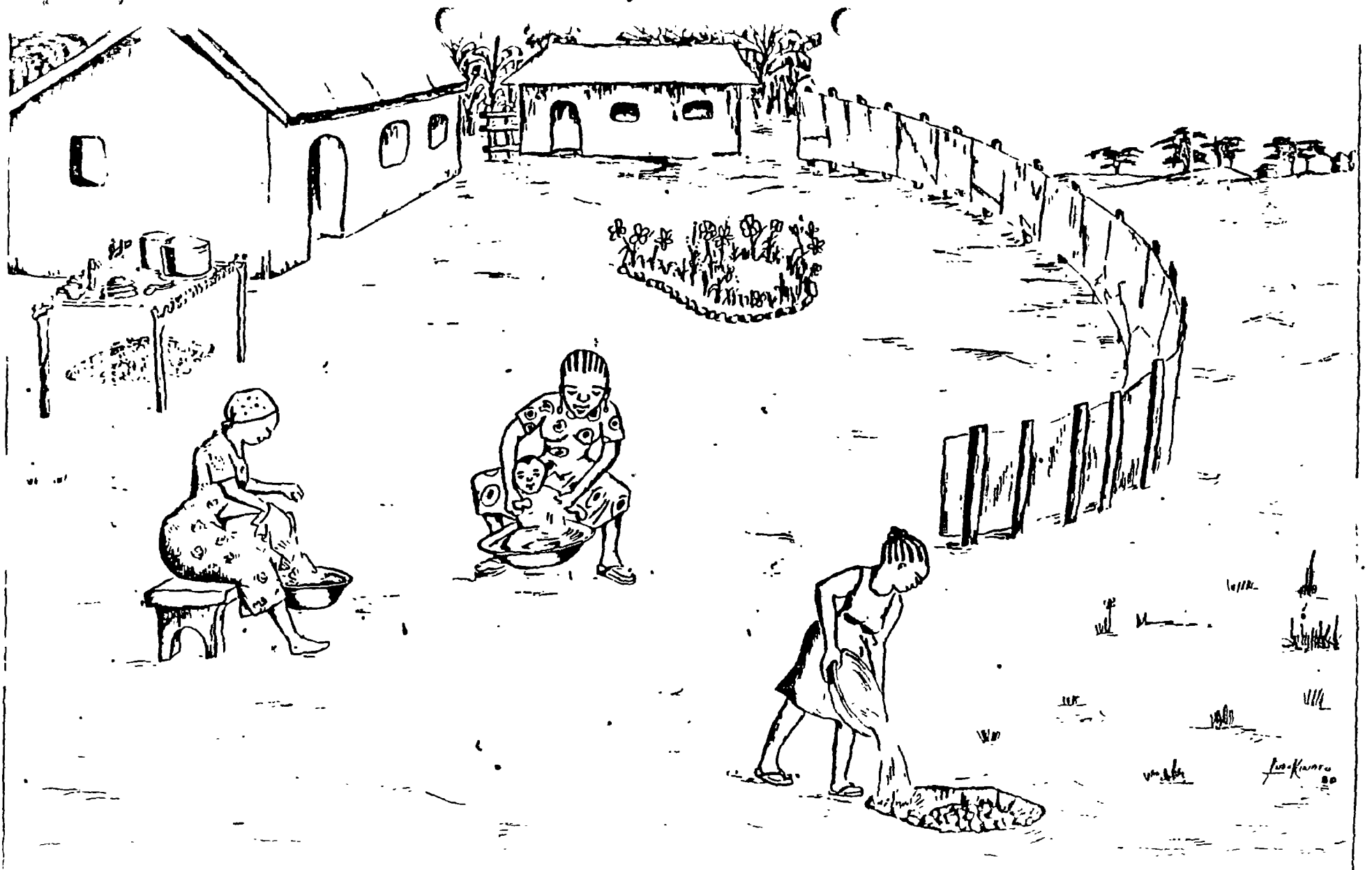
- People collect water in unwashed buckets
- They put leaves and twigs on top of the vessels to prevent spillage during their trip home. The leaves may be unclean
- Drinking water is stored in dirty or open pot
- The water in the collection vessel or storage pot is touched with dirty hands

Question: What can we do to make sure that the clean well water is not contaminated during collection and storage?

Discussion:

- Wash hands and rinse bucket before filling
- Put a clean cover on top of vessel against spillage
- Do not touch drinking water with hands or mouth
- Cover the storage pot with a firm cover
- Use a long-handled dipper (e.g. made from a calabash or old tin) to take water from the pot
- Clean storage pot often
- Teach everyone in the household how to take water from the storage pot in the right way. Explain to the children why they should not put their hands or drinking cups in the water.

Conclusion: To keep our clean water clean we wash our hands and buckets. We store our <sup>drinking</sup> water in a clean, covered pot. We use a long handled dipper to take water from the pot. We teach our children how to collect and take water. We discuss this with our neighbours and other well users.



WAZOZIMU  
WAZOZIMU  
WAZOZIMU

Wazozimu kuoga mara kwa mara hwezeshwa na upatikanaji, mzuri wa maji.

Discussion topic 7

USE MORE WATER FOR WASHING AND BATHING

Question: What diseases can you get when you do not use water often to wash your hands, clothes and food utensils, to wash your children (especially their hands and eyes) and to wash your own face and body ?

Discussion:

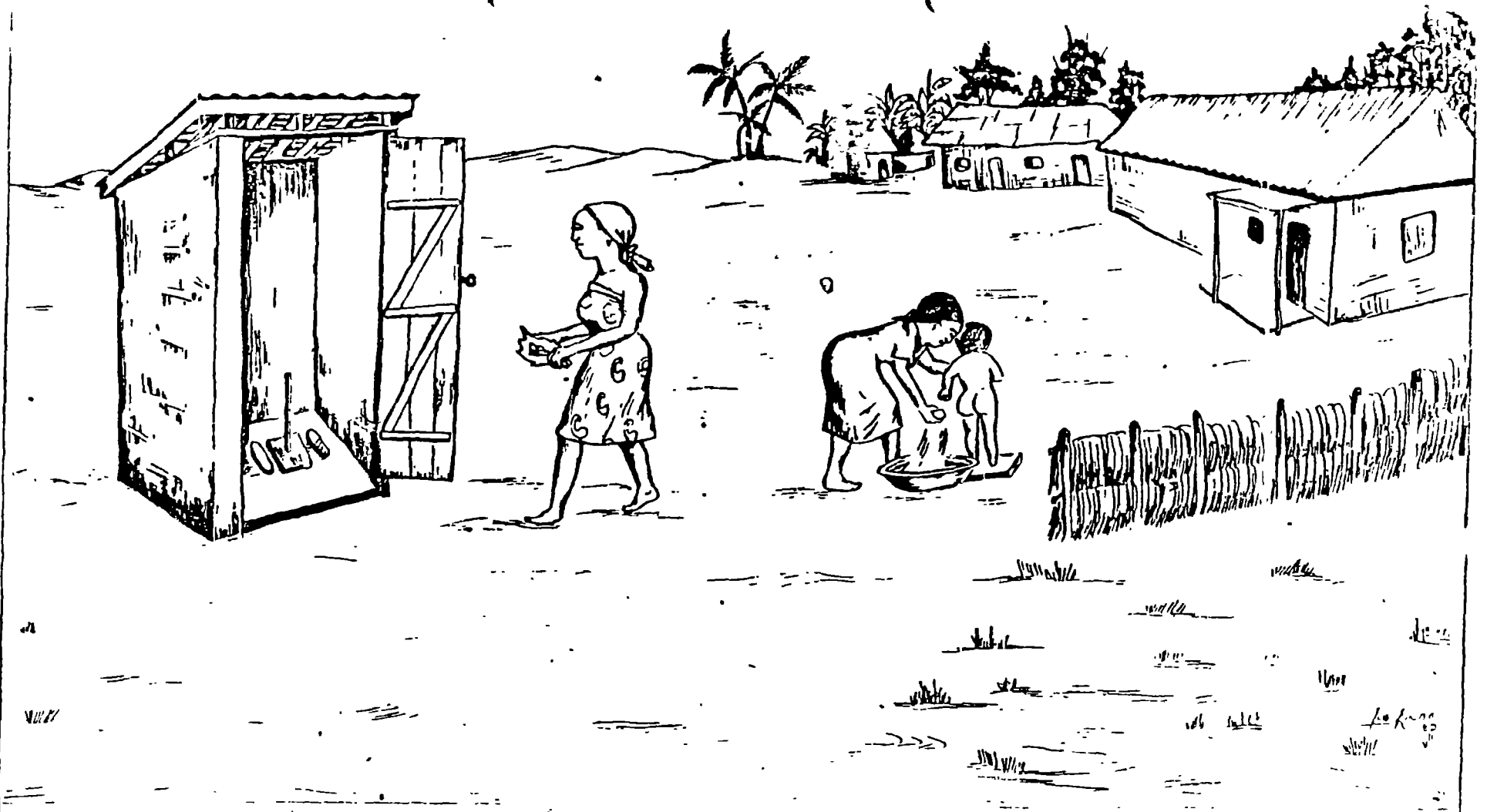
- Stomach diseases, when food is prepared or eaten with unwashed hands or dirty utensils
- Eye diseases, because in the dry season eyes that are not washed regularly get infected by dust and flies. When eyes are infected, bathe them frequently with salt water (as salt as tears)
- Skin diseases (scabies) and louse-borne fever, passed on by <sup>tiny</sup>bugs sitting on the skin and in clothes and bedclothes. In case of infection, scrub the skin with a brush and wash clothes and bedclothes frequently.

Question: What can we do to reduce the risk of these diseases ? (see picture)

Discussion:

- Wash our hands more frequently, if possible with soap
- Wash the hands, face and body of our children often
- Wash our kitchen utensils every day and dry them on a frame in the sun (see picture)
- Wash our clothes and bedclothes more often and dry them in the sun
- Discuss with the village water committee and well project if we can make a washing slab at one of the wells

Conclusion: For a better health it is important that we use more water for regular washing of ourselves and our children (especially our hands and eyes), our clothes, bedclothes and kitchen utensils.



Kwa watoto wadogo wasioweza kutumia choo au shimo, 'upa kinyesi chooni na isafishe mikono kwa sabuni.

A CLEAN LATRINE ALSO MEANS HEALTH

Question: When people drink water with tiny bits of excreta, they get stomach diseases (diarrhoea, cholera, typhoid, worms etc.) But there are other ways in which you can accidentally get a bit of excreta in your mouth. Can you think of an example?

Discussion:

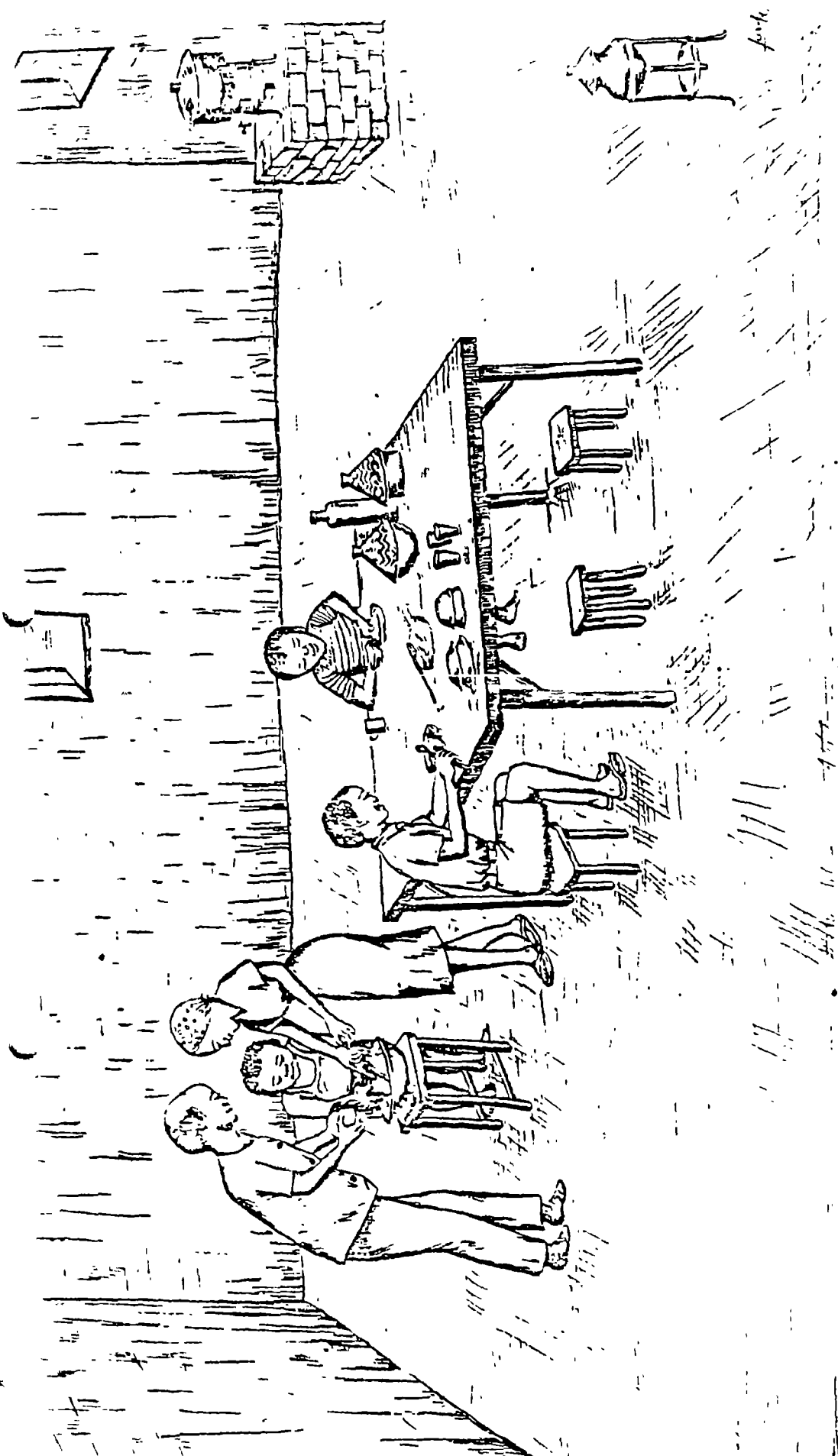
- The latrine at home or in school is dirty. Flies sit on the dirt and then sit on food
- Hands are not washed after toilet use. Food is prepared or eaten with soiled hands
- Young children crawl in a compound where stools are lying. They touch the stools and then suck their fingers
- Stools are lying uncovered in village. Flies sit on them and then on food
- People defecate under fruit trees. Fruit falls down and is picked up and eaten raw without washing.

Question: What can we do to avoid all risks of swallowing tiny bits of excreta ?

Discussion:

- Never leave stools in the open (not children's stools)
- Keep our latrines clean and use long-handled fly cover over the hole (see picture)
- Put a pot with water and if possible soap in or near our latrine for handwashing
- Teach our children to use a latrine and wash hands
- See that there are enough and clean latrines in school (with handwashing facility)
- Make a by-law forbidding uncovered human excreta in the village, around wells, bus stop etc.

Conclusion: To keep healthy, we must not only drink safe water but also avoid swallowing tiny bits of excreta in other ways, such as through soiled hands, flies and soiled food



Familia yote inaweza kujingwa na kuugua, milimo michafu, maji machafu na mainzi kwenye choko.

Discussion topic 9

GOOD HANDWASHING IS IMPORTANT

Question: Why is it so important to wash hands, if possible with soap?

Discussion: Soiled hands can pollute water and food. When this is eaten or drunk you can get ill. Small children also often suck their fingers and thus swallow germs.

Question: When is handwashing important?

Discussion:

- When collecting drinking water
- After toilet use (children also) at home and elsewhere
- After cleansing the bottoms of babies and young children
- Before preparing food
- Before eating food

Conclusion: Frequent handwashing (with soap if possible) by adults and children is important to reduce the risk that germs and eggs of worms living in human excreta are accidentally digested.



Masahau kwamba  
 watoto mara nyingi  
 watumii choo.  
 Iyeyi mara  
 mengine huweza  
 kwa na mayai ya  
 minyoo.  
 Iyai hayo  
 anguliwa ardhini  
 kutoa minyoo  
 michanga.

Minyoo michanga  
 huweza kuingia  
 kwa watu  
 wengine kupitia  
 kwenye visigino  
 vya miguu.

Minyoo haiwezi  
 kuingia mwitini ikiwa  
 kila mmoja anaye  
 kanda mbili.  
 Pia tunaweza  
 kuwafundisha  
 watoto wetu  
 kunya kwenye  
 snimo ikiwa  
 hakuna choo.



HOOKWORM

Question: Do people in the village have hookworm?  
How can you get this disease?

Discussion: Somebody with hookworm excretes in a shady place (e.g. behind a bush) The hookworm eggs in his stool come out and live for some time in or on the soil. Adults and children who pass that place on bare feet can get the worms in their feet, especially when the ground is wet. Once in the body, the worms start laying eggs that come out again in the stools.

Question: What can you do to stop hookworm infections? (see picture)

Discussion:

- Have no uncovered stools lying around in the village , around the wells, at the bus stop etc.
- Use latrines when possible
- Otherwise (e.g. when working in the field) bury stools in a deep hole
- Wear sandals or shoes, esp. when ground is wet
- Get treatment when you have hookworms and be extra careful not to leave any uncovered stools

Conclusion: If everyone in the village (adults and children) uses latrines or buries their stool deeply when in the field there would be no more hookworm in the village.

kwenye maji au karibu yake



Wakati mtu mwenye kichocho anapokoja au kunya kwenye maji yaliyosimama au karibu yake, mayai ya minyoo wa kichocho huingia kwenye maji.

Mayai hayo huanguliwa kwenye konokono. Minyoo michanga hutoka na kuingia kwenye maji.

Minyoo michanga huingia kwa watu wengine kupitia kwenye ngozi wakati wanapooga au kutembea kwenye maji.

BILHARZIA

Question: Does the village have a bilharzia problem?  
How do people get this disease? (see picture)

Discussion: People who have bilharzia have worms in their urine or stool. When this urine or stool gets into water the eggs of the worms also get into the water. These eggs enter snails and grow into worms. The worms leave the snails and enter other people who bathe or stand in this water through their skin. These people then also get bilharzia.

Question: What can we do to stop the disease from spreading to other people?

Discussion:

- Nobody should defecate or urinate near or in open water
- If water in or near the village is known to be infested with bilharzia, people should know that it is dangerous to bathe, wash and swim in this water
- If possible, other safe places for bathing and washing should be arranged (e.g. a washing slab and bathing facility at a well, maintained by the women's group)
- People suspecting that they have bilharzia (blood in urine or stool) should go to a clinic

Conclusion: Nobody should urinate or defecate in or near water, as bilharzia is spread in that way.



Huyu mtoto amekunywa  
maji machafu kutoka  
mtoni au dimbwini.  
Sasa anaharisha .  
Mdomo wake  
umekauka .  
Ngozi yake  
ikiinuliwa hubakia .  
Imekunjamana .

Mama yake  
anampa  
dawa .

Amechemsha vika na  
sita vya maji kwa  
dakika kumi,  
akaweka huko  
chumvi kidogo na  
sukari kiganja kimoja .  
Anafunika maji ya  
kunywa .  
Pia maji huchotwa tu  
kwa kutumia kata .

HOW TO TREAT CHILD DIARRHOEA

**Introduction:** Even when you are careful, people can still get diarrhoea. This is especially dangerous for young children, because their body is small and can dry out quickly when they have diarrhoea and/or vomit a lot. When they dry out, their skin wrinkles like a fruit left in the sun. Their eyes become hollow. They become apathetic and may die before you can get treatment.

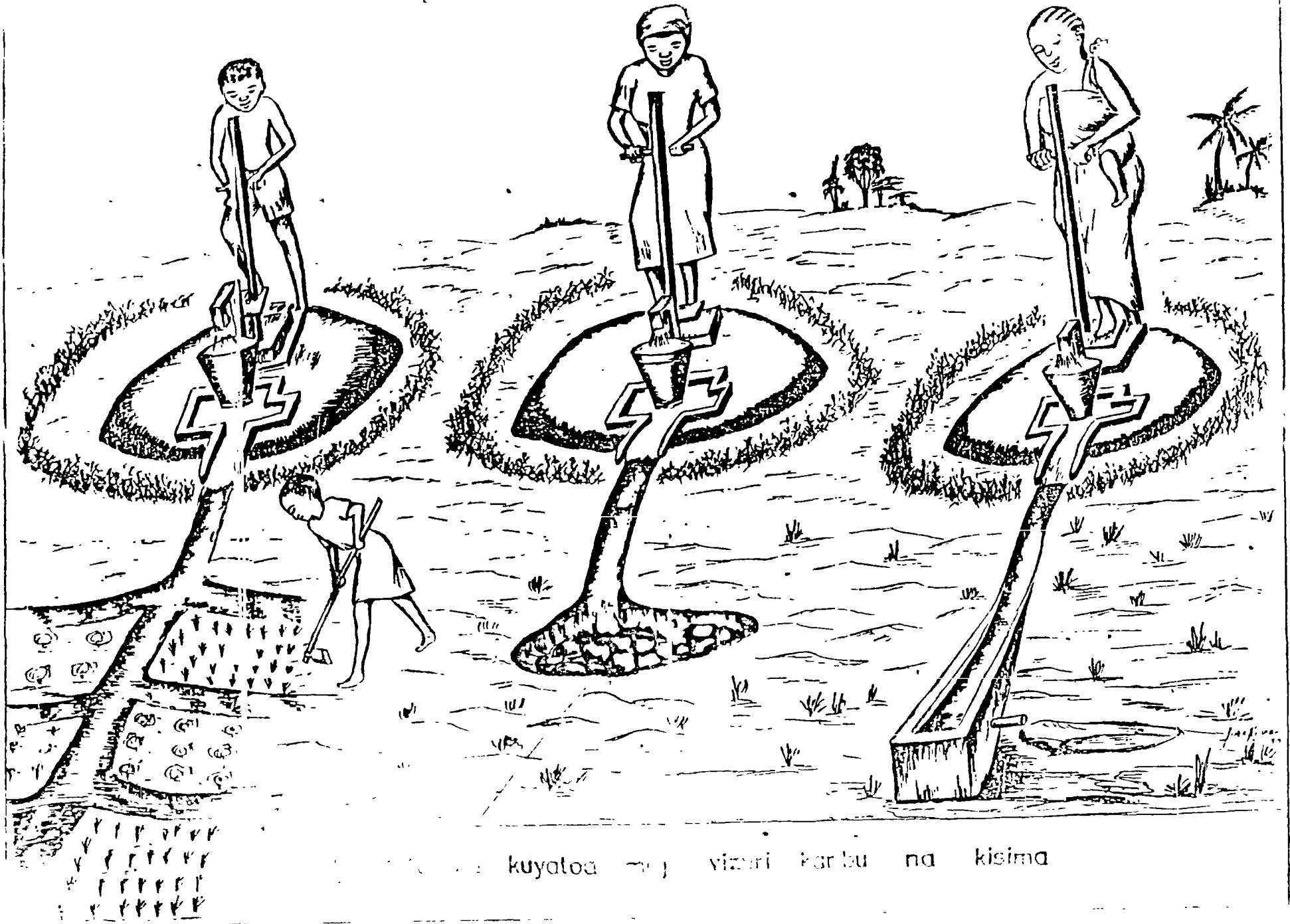
**Question:** What can you yourself do when the child has diarrhoea?

**Answer:** As soon as the diarrhoea starts,

1. put one handful of sugar (one tablespoon) and a pinch of salt (one teaspoon) in one litre<sup>1)</sup> of water
2. start giving the child the liquid
3. boil the rest of the liquid and let it cool down
4. Let the child drink as much as possible, as often as possible, but at least every hour
5. Take the child to the dispensary when its condition does not improve.

**Conclusion:** For a young child diarrhoea can be dangerous because the normal body water drains out quickly. The child therefore needs a lot of water, sugar and salt to replace the lost water and gain energy quickly.

1) One beerbottle can contain half a litre.



kuyatoa maji vizuri karibu na kisima

Discussion topic 13

PRODUCTIVE USES OF WATER

Question: What other uses can the village make of their water supply? (see picture)

- Discussion:
- Households who have a well on their private land can use the drainage water to grow vegetables or fruits. In exchange the village government can demand that they keep the well site clean and look after the pump.
  - At wells sited on public land the school, a youth club or women's group can organize a vegetable garden. The profits can be used to finance pump maintenance and group activities
  - Another possibility is a seedbed for fruit-, timber- and firewood trees at the end of the drain. When the young trees are mature enough, they can be planted in people's gardens or a village plantation.
  - The well water can be used to make bricks and clay tiles for a village building project

Conclusion: To benefit as much as possible from an improved water supply, the village can look into possibilities for small-scale productive uses of the water, such as dry season gardening and brick making.





Rural Water Supply: Population Served by - 1983

DISTRICT	POPULATION	SURFACE PUMPED (SW+P)	BORHOLE PULPED (BH+P)	GRAVITY	SHALLOW WELLS (SW+HP)	TOTAL	
Morogoro Rural	380371	34532	63480	58789	88622	245423	65%
Kilosa	285844	22911	43486	22234	141881	230512	81%
Kilombero	117086	15800	5680	35994	19958	77432	66%
Ulanga	107659	26659	-	1580	29094	57333	53%
Total	890960	99902	112646	118597	279555	610700	68%
					31% 46% 71%		
Urban Town							
Morogoro	102700	35945	-	46215	-	82160	
Kilosa	26580	9300	6645	-	5315	82160	
Ifakara	41460	-	20730	-	4145	24875	
Mahenge	22890	-	-	-	-	14880	
	193630	45245	27375		9460	143175	
Grand Total	1084590	145147	140021	179692	289015	753875	

Foot Note:

31% represents contribution of shallow wells compared to other supplies ( out of total population )

46% shows amount of population served with shallow wells ( out of served population )

71% represents percentage of underground water extracted as shallow wells. ( out of served population )

- This table is extracted from Mpango wa Maendeleo wa Mkoa - Morogoro



