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Community Water Supply and Sanitation

Guide for Organising

HANDPUMP MAINTENANCE SYSTEMS

July 1983

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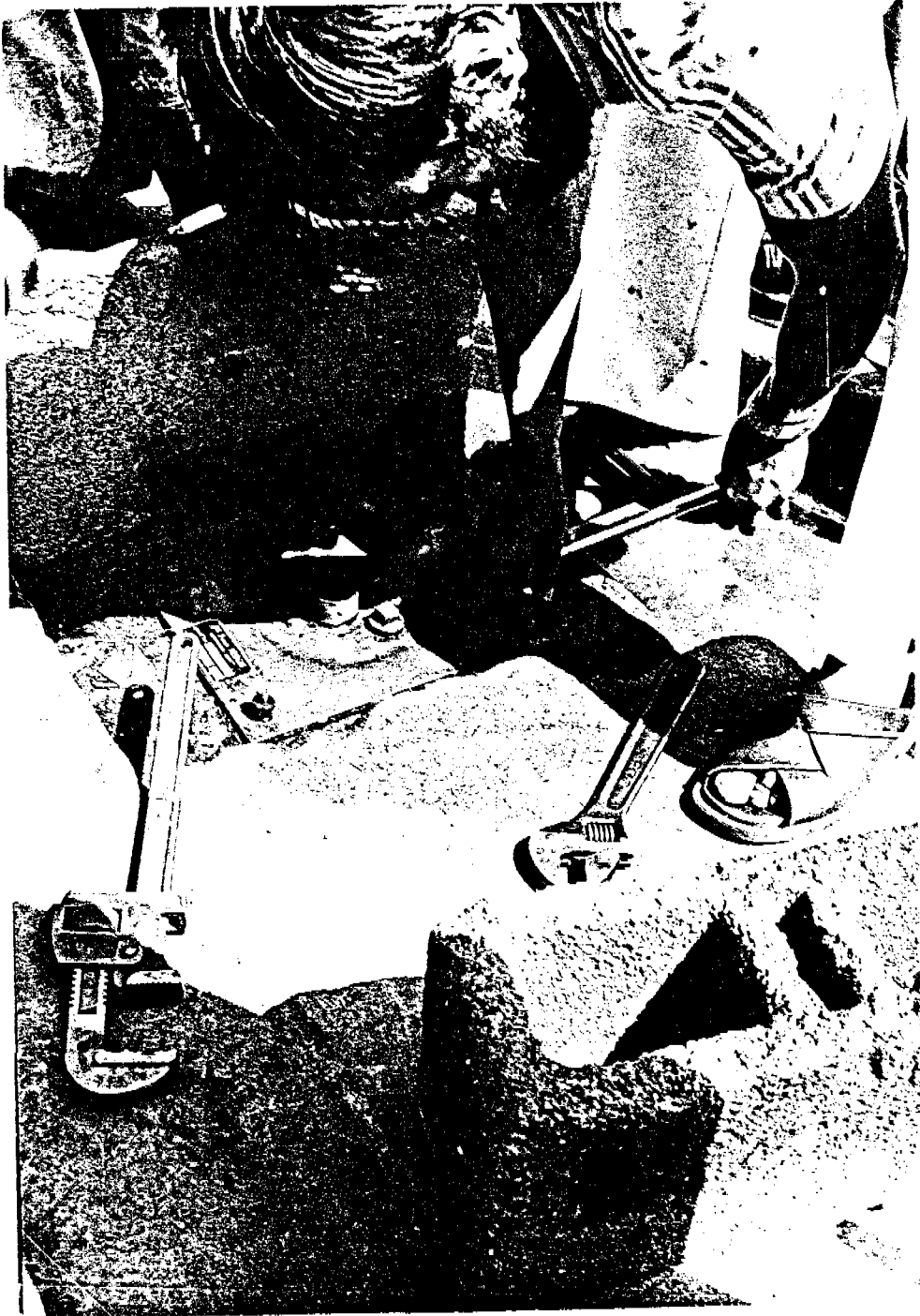
PREFACE

Although appreciable progress is being made, in many developing countries, with regard to well drilling and handpump installation for rural water supply, the same is unfortunately not true of the maintenance of the pumps once they are installed. The wells and pumps are intended to cater for one of the basic needs, perhaps the first need of the village communities: safe drinking water. Yet handpumps breakdown by the thousands, in some countries even by the ten thousands, and remain unrepaired for long periods of time because adequate maintenance is lacking. Concentrated efforts are needed to improve this situation. Wise pump design may prevent many difficulties, but regular and proper maintenance is the key to reliable pump performance.

A central principle in any handpump water supply project should be that in the selection of pumps full consideration is given to the maintenance requirements, and the needed skills, tools and spare parts. Just as the technical design of the pump should be cost-effective and suited to the conditions, so should the maintenance requirements be financially and technically feasible.

This guide is directed to officials and chief officers in government departments and water supply organizations, who are responsible for organizing the maintenance of handpumps in rural areas. It draws on the approaches followed, and experience obtained in the rural water supply programmes of a number of countries in Asia and Africa, each very different from the others, yet sharing the same goal: bringing an acceptable water supply to their rural population, and using handpump installation as an important means in that effort.

The purpose of the present guide is to provide guidelines for organising handpump maintenance systems. It brings together practical methods, arrangements and organisational set-ups, and the actual experience obtained with them.



1. INTRODUCTION

Data published by WHO and other international agencies shows that an estimated 1800 million people in developing countries will need to be provided with an adequate supply of safe water during the period 1981-1990, in order to meet the goals set for the International Drinking Water Supply and Sanitation Decade. The majority of this number comprise of people living in rural areas.

Massive capital investments will be required to bring safe drinking water to the rural areas of developing countries. A document prepared by WHO, in collaboration with the World Bank, states that in order to achieve acceptable coverage for all rural populations by the year 1990, the required investment rate would have to be four times the 1971-1975 average level of investment, and sustained up to 1990.

These estimates clearly indicate the need for low-cost water supply technology such as handpumps. While it may be financially feasible to tap groundwater using motor-driven pumps (diesel engines, electric motors, etc.) in some areas, it is certain that handpumps will play a major role in the provision of rural water supply in many more countries.

In areas where groundwater is readily available at moderate depth, constructing a number of wells with handpumps is by far the cheapest means of providing an adequate supply of safe water. Groundwater, in contrast to surface water, generally needs little or no treatment to render it safe.

The effective use of handpumps is essential to the success of many rural water supply programmes. Proper selection and further improvement of handpumps is important, but the need to provide for adequate maintenance of the pumps, once they are installed, is particularly crucial and urgent.

The Current Situation

Experience shows that the use of handpumps in rural water supply meets with serious problems of inadequate design, poor quality of manufacture, lack of durability, poor maintenance practice, and weak maintenance organisation generally. Failure rates over 50% within two years after installation of the pumps have been reported. The problems have a world-wide dimension, as they are encountered in most countries where handpumps are used on a large-scale.

Handpumps are used under a wide variety of conditions. They may serve on shallow or deep wells, with many or few users. Their use may range from almost continuous to infrequent, and maintenance from adequate to none whatsoever. Numerous handpump models, from many different manufacturers are on the market. Frequently, the pumps are imported from distant countries on the basis of very limited information.

Estimates of the worldwide requirements for handpumps are necessarily crude due to lack of sufficiently detailed data. However, a reasonable estimate indicates that handpumps are presently the source of drinking water for some 250 to 400 million people. Rural water supply programmes envisaged by developing countries to meet the targets set for the International Drinking Water Supply and Sanitation Decade would provide an additional 500 to 800 million people with a hand pump water supply. In the same period, handpumps currently serving some 150 to 250 million people would require replacement. Population growth would probably result in an additional 200 million people requiring a handpump water supply by 1990.

The Basic Issue

The financial burden on developing countries' governments from the maintenance costs of handpumps is rapidly increasing in those countries where rural water supply has been, and continues to be, undertaken as a social service. It appears that at least the direct costs of maintenance must be born by the beneficiaries, or handpumps will be going out of service almost at the same rate as they are being installed.

There probably are no fixed rules to determine whether a governmental or community type of maintenance system, or whichever balance of both systems, is the right choice. The point that must be stressed is simply that one

should be clear from the outset about the kind of maintenance system which is to be used in a rural water supply programme. To plan for governmental maintenance, and then find that it is provided only on a patchy or occasional basis is to invite failure.

The development of a successful handpump programme requires coordinated and planned activity at all stages of implementation. Ideally speaking, therefore, such planning should cover all stages, from well drilling, community education, selection and installation of handpumps, on through proper maintenance.

Thus, two things are necessary:

- 1) Select or develop pumps that can be operated and maintained efficiently at local level, and ensure that they are properly installed;
- 2) Organise a maintenance system, and train local staff for it, to provide the necessary back-up service and supply of spare parts.

If no way can be found to provide for the maintenance of existing handpump installations, it would probably be better to postpone major new handpump installation projects. Instead, attention would have to be focussed on the rehabilitation and maintenance of existing handpump water supplies, at the same time exploring ways to meet the maintenance costs.



2. ANALYSIS OF MAINTENANCE PROBLEMS 1)

2.1 General

This study concentrates on maintenance²⁾ systems for handpumps fitted on covered (or "protected") dug wells or tubewells installed for community water supply purposes.

To keep a single handpump in operating condition, is not so difficult if it is lavished with care and qualified maintenance attention. In contrast, it is extremely difficult to keep a large number of handpumps continually operating, particularly when these pumps are widely distributed in difficult terrain, in a country with a low level of development and having relatively few people with technical training and management experience.

It is essential that any handpump design for large-scale use, in a rural water supply programme, should fully allow for the local operational and maintenance capabilities. The establishment of a central (governmental) maintenance structure should not be expected to resolve all the problems of inoperative pumps. Central units can be of great importance to provide back-up service to local pump caretakers, but they must supplement local capabilities, and not seek to substitute for them.

2.2 Organisational Deficiencies

One reason why maintenance of handpumps is neglected and not provided for, is that the community or organisation which is responsible - or is made responsible - for maintenance, frequently is another one than the organization that is responsible for the drilling of water wells and the installation of the pumps. Too often, without any real justification, it is assumed that the local community will somehow maintain the handpump.

1) Problems of maintenance are not restricted to the poorest countries alone. OPEC countries have frequently pointed out that they are also developing countries, with one, fast diminishing resource. Water supply development in those countries has the serious difficulty of the lack of sufficient indigenous personnel.

2) Generally, maintenance means to nurse, to develop, to keep up, etc.; and technically it means to keep up an installation on proper working conditions.

Generally, the well drilling activity will be separate from the pump installation and maintenance programme. Drilling work has its own set of objectives and priorities which are seldom in keeping with the timing and organisation of the pump installation and maintenance. Obviously, the pump installation team should coordinate its programme with the drilling operation, so that the pumps will be installed as soon as possible after completion of the well.

Water supply organisations frequently tend to restrict their planning to drilling and installation activity only, to the exclusion of other aspects. Especially adequate staffing for maintenance back-up, and spare parts provision are neglected. 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.

2.3 Bias towards New Construction and Installation

It is not uncommon to find that attention is mainly or exclusively focussed on the construction of new wells, and new installation of pumps. Frequently, no provision is made for the maintenance of the pumps. In fact, maintenance is one of the most neglected aspects of water supply installations, and the number of inoperative pumps is remaining discouragingly high.

International and bilateral agencies frequently offer funds for new construction but are not so 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 adequate provision for the maintenance of the existing ones. It happens therefore, that new handpump installation is sometimes used to replace existing pumps which could have been rehabilitated at much lower cost.

In many countries there are considerable problems caused by lack of funds and manpower for maintenance tasks, and inadequate procedures for reporting and repairing pumps that have broken down. Non-operating pumps deteriorate very quickly as people tend to damage them when they do not deliver the desired water. An entire rural water supply programme then will run the risk of becoming a failure.

2.4 Financial Constraints

A national handpump programme requires a long term commitment to handpump maintenance and the provision of spare parts. Regardless of whether the funds come from national or external sources, the relationship between new installation and maintenance exists, and should be considered from the start. Neglecting the need for maintenance implies risking the investments made in the programme partly or totally.

But many, if not most governments of developing countries have only a very limited or non-existent budget for meeting the maintenance costs of installed handpumps. Resources required for maintenance are frequently underestimated in project proposals for rural water supply, and it is not unusual for budget authorities to make further reductions of the requests when it comes to actual allocations.

The cost of maintaining handpumps can be quite substantial, and there are situations (e.g. long distance between pumps) where any attempt at centralized maintenance, however modest, would incur prohibitive costs. The key point for the government or central water supply agency is to avoid an accumulation of recurrent costs which cannot be financed within the regular budget. The degree of centralization in the maintenance system has a great influence on the costs that are to be met from the government budget.

2.5 Impact of Poor-quality Handpumps

The effectiveness of any handpump maintenance system can be marred by the installation of poor-quality handpumps. A handpump with inherent manufacturing defects will not be economically to maintain, and any savings effected in the initial cost of the handpump are likely to be more than offset by heavy maintenance costs.

In view of the urgency of providing safe drinking water to rural areas in developing countries, and the limited supply of top-quality, heavy-duty community handpumps, water programmes sometimes make the mistake of relaxing quality requirements. This results in the use of hundreds of non-standardised, poor-quality pumps, and this will first strain and, then, probably break the maintenance system.

Handpumps should always be procured through firms which apply recognised specification standards as well as quality control procedures in the manufacture of their pumps. To ensure that handpumps acquired for rural water supply programmes are actually of satisfactory quality, it is advisable that the goods be inspected by a specialised agency prior to despatch from the manufacturer.

Few handpump programmes have meticulously insisted on standardisation and quality control of their supplies, and this in turn has considerably contributed to the poor maintenance record.

2.6 Absence of Preventive Maintenance*

In practice, preventive maintenance of water supply systems is very rare, and the organisations that are responsible for maintenance merely send out repair teams when breakdown occurs. This is regrettable, because considerable economic savings can be achieved when preventive maintenance is provided in stead of repair after breakdown.

For example, a country may have some 20,000 handpump water supplies, representing an average investment of US \$ 2,500 each. If only 60% of the systems are functioning, then 8,000 pumps are out of operation at any given time. Should an improved maintenance system result in the proper and continuous functioning of 4,000 out of these 8,000 pumps this would be equivalent to recovering a capital investment of US \$ 10 million!

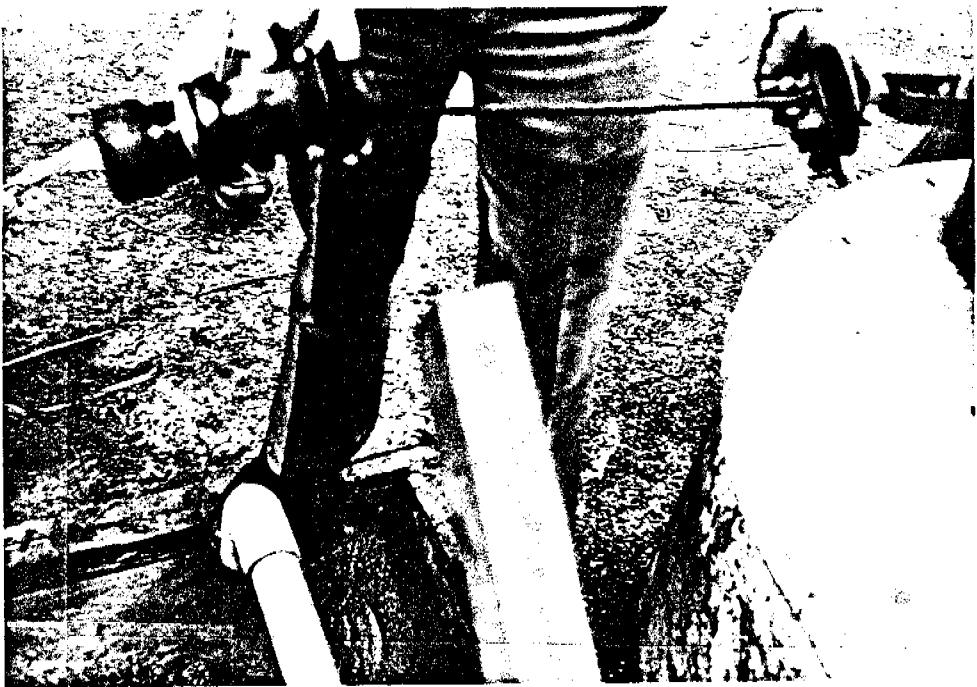
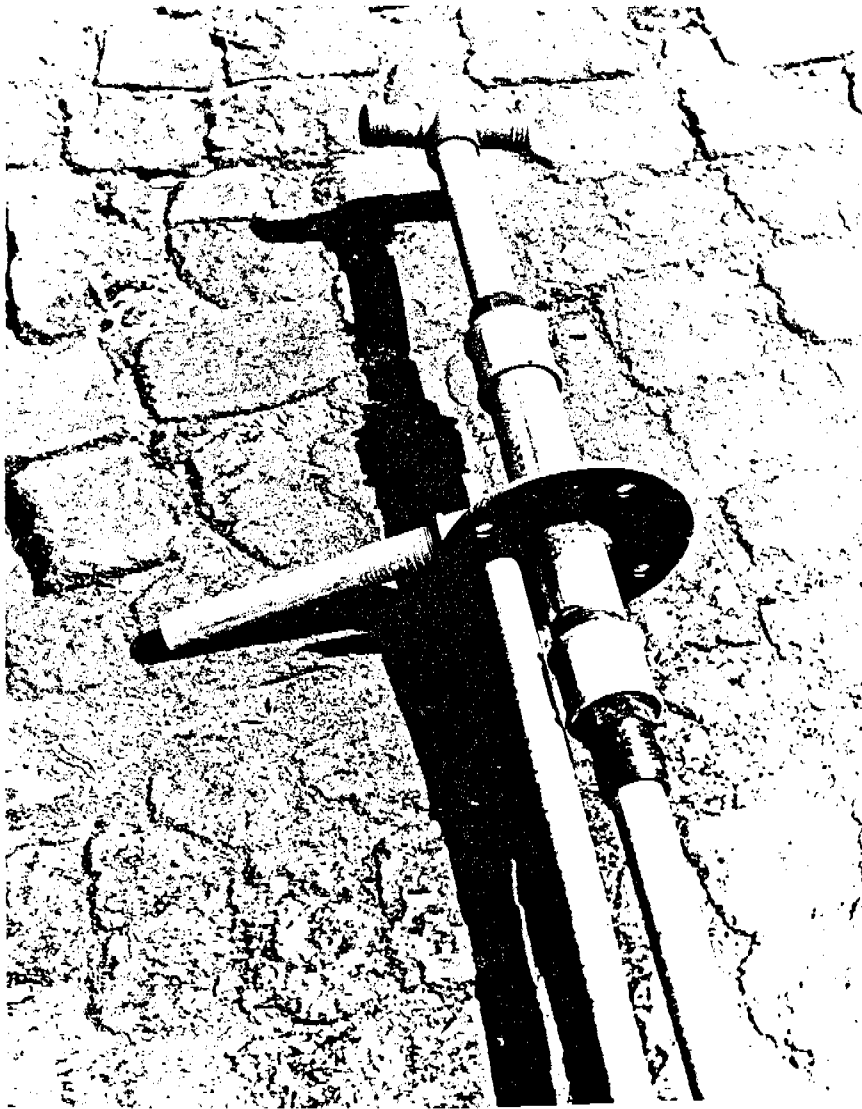
* Preventive maintenance involves regular maintenance carried out to keep handpumps in satisfactory condition by providing scheduled inspection, and correction of minor failures before they occur or develop into major problems. Lubrication, fitting of new parts and overhauls are made at regular, pre-determined intervals.

2.7 Negative Psychological Impact

In areas where handpump water supplies are vital, the introduction of a well and pump to a village community frequently is a major event. To obtain the maximum benefit, health educational activities are increasingly organized to accompany the event. This involves information on health benefits, and explaining the reasons why safe water should be used for drinking, cooking and personal hygiene.

Once a water supply is provided, it is important to ensure that the community continues to rely upon it. Thus, it is essential that the pump be continuously kept operating. If it breaks down, and remains inoperative for long periods of time due to a poor maintenance, people will return to their traditional water sources and the opportunities for improving the attitude towards safe water supply will be lost, probably for years. Furthermore, where the handpump water supply was installed with contributions from the community, they may view its failure as evidence that their contribution has been wasted.

The psychological impact of inoperative pumps consequently is very negative. The news of a pump's breakdown is likely to spread to neighbouring communities. Confidence in the handpump programme will be undermined, and this will make it much more difficult to implement the programme.



3. HANDPUMP MAINTENANCE SYSTEMS

3.1 General

To organise a maintenance system for handpumps is not an easy task. It calls for setting up an organisation with the necessary personnel, equipment and materials, to do the maintenance job required at the time it needs doing. The following questions need to be considered, when organising a maintenance system:

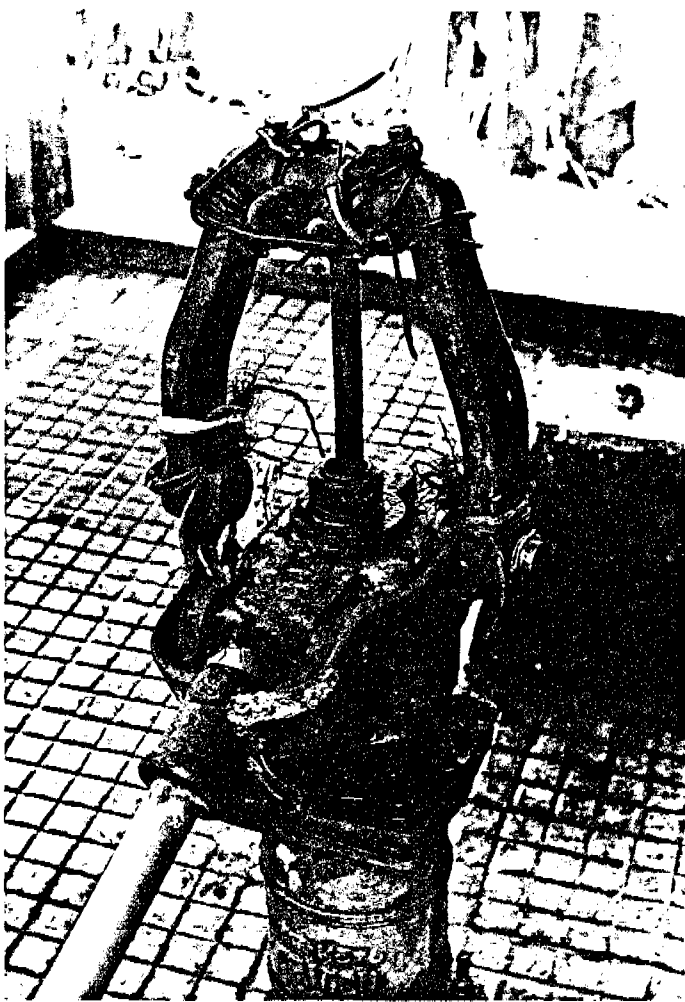
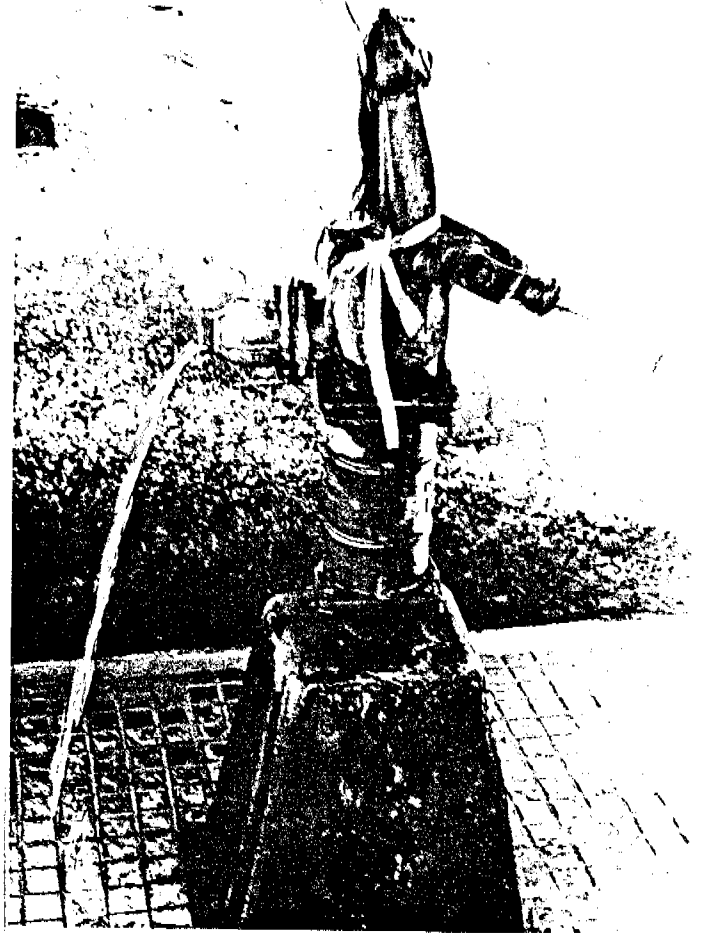
- Where is the work to be done? On site? In a workshop?
- Who should do the work? The level of technical expertise and the number of needed personnel.
- When should it be done?

Several, different approaches have been applied with the aim of keeping large numbers of handpumps operating. Broadly speaking, these fall into the categories of:

- a) centrally-organised maintenance;
- b) village-level maintenance;
- c) private maintenance;
- d) varying combinations of these types of maintenance system.

Most handpump maintenance systems can be characterized as one-tier, two-tier or three-tier systems. An example of a one-tier system is where all maintenance tasks are the responsibility of a central organization, or where they are undertaken entirely by the community. In the two-tier system, maintenance is shared between the central agency and the local communities. In the three-tier system, the intermediate level of government (e.g. province; district) assumes a specific part of the maintenance duties.

In the two-tier and three-tier systems the local community, or a resident working on a voluntary basis or as a government employee, assumes responsibility for basic village-level handpump caretaking, maintenance and failure reporting. Routine maintenance work includes lubrication, bolt tightening and minor repairs of the handpump, as well as the replacement of the piston cup seals ("leathers) on shallow well handpumps. Where villagers deal with only the basic maintenance tasks, it is necessary for a technical support team to visit the pump at regular intervals (e.g. every three months) for a thorough servicing of the handpump.



Sometimes, an attempt is made to allow for very little or no maintenance at all, by using very robust handpumps which are not likely to need any servicing or repair for a long time. This always is a fallacy. An example can perhaps serve to illustrate the inherent implications of not providing for maintenance, even where it concerns simple and robust devices.

The ox-drawn farm implements used widely in Africa are often viewed as needing no maintenance at all. They are strongly made of steel and rarely break. But with use, the optimum shape of tines and ploughshares is gradually lost. Angles and edges are distorted by wear and sometimes by bending. The result is that more and more effort is needed by the oxen to draw the implements through the soil, and in the end the work becomes very inefficient.

The key argument in this study is that, for a pump installation programme to be effective, clear choices need be made as to which maintenance tasks are to be taken up by the local community, and which will be the responsibility of the government water supply agency. That is, the choice of "zero maintenance" is not a real option! The "zero maintenance" concept is often used as a claim to justify a high-priced handpump. While it is true that well-designed, heavy-duty pumps require less repair, they really do need a certain amount of maintenance. Cleaning and servicing will be necessary, and the users should still be educated in the proper use of the pump, and the care for the cleanliness of the platform and well surrounds.

Increasingly, we see that the local community, through a resident working on a voluntary basis or paid by the government, is required to assume responsibility for the basic village-level maintenance duties and the reporting of breakdowns. This routine maintenance work includes lubrication, bolt tightening and minor repairs. A mobile maintenance team operating from the district centre is then needed for back up support to provide major maintenance work and the regular servicing of each handpump installation.

As the functioning of a maintenance system in this way, in more and more cases, will depend on both the local community and the government agency, it is absolutely essential that it is clear which maintenance tasks are assigned to the local community and which will be provided by the central maintenance organization. The responsibilities of each must be allocated with a considerable degree of detail.

A handpump programme without a parallel maintenance system is incomplete. Maintenance is a tangible requirement, and the question should not be whether or not to have maintenance but how it should be organised.

3.2 Centrally-Organised Maintenance

Where the government assumes all responsibility for maintenance, it would have to arrange for the procurement and distribution of spare parts, provide staff, equipment and transportation, meet training requirements, establish workshops, ensure installation quality, carry out major handpump repairs, and when necessary replace handpumps or renovate them. Apart from these tasks, it would have to extend its infrastructure to the community level to communicate the safe drinking water concept to the village communities, to instruct villagers in the use and care of the handpump, and most importantly, undertake responsibility for failure reporting. However, no amount of maintenance infrastructure at other levels can substitute for pump caretaking and break-down reporting at the village level.

There are several ways the government might organise these duties. A special government agency may be established which would be responsible for the maintenance of all handpumps installed by the government. It may have offices at the lowest level at which the government can maintain such units.

One advantage of the government taking all responsibility for handpump maintenance would be that there will be no doubt where the responsibility rests. This is particularly relevant, where more than one organization is involved in installation and maintenance of the pumps. Especially where one central organization would handle both handpump installation and maintenance, the value of proper installation will be recognized in terms of reduced maintenance costs.

Obviously, the costs involved for all the maintenance and repair tasks would be substantial for one agency to bear, as would be the requirements of professional skill and capacity. The centrally-organised type of maintenance system always will incur high, and frequently even prohibitive costs to the government*.

* For example, in Tanzania the estimated costs of such a maintenance system would amount to TAS 1,000-1,500 (about US \$ 130-200) per year, per pump.

Sometimes, the government establishes a technical organisation which is responsible for a group of utilities or basic amenities such as water supply pumps, roads, power, housing construction and other services which may conveniently be grouped together. However, when a number of activities which are not connected with handpump maintenance are grouped under a government regional or district office, there is always the disadvantage that the other demands will probably overshadow the requirements for handpump maintenance. The road construction programme, for example, could easily take precedence over the maintenance of handpumps.

Experience has shown that whilst centrally organized agencies may be effective in the initial stages of a handpump programme, they do not grow commensurate with the expansion of the programme. Often, after some time, they become understaffed, undermotivated, and physically incapable of meeting the monitoring and logistical requirements of the maintenance programme. In the absence of detailed and continuous data collection, the planning (including budgetary implications) tends to become unrealistic and inadequate, and the maintenance structure will gradually begin to disintegrate. Furthermore, such agencies often do not have units at the village level, and consequently no first hand information on the actual working condition of the handpumps.

What will happen in practice with a handpump on a covered (or "protected") well, that the distant government agency may regard as too small an item for a technician to be sent many kilometres just for routine servicing. The pump will be used by the people for as long as it works, but when the inevitable happens and the pump breaks down, the cover of the well will be opened and buckets will be let down to draw water. This negates the very purpose for which the pump was installed, that of sealing the well against contamination from the surface, in order to safeguard the quality of the water.

3.3 Village-Level Maintenance

Needed is a pump design that allows the removal of connecting rods, piston, foot valve and rising main through the pump head. Lifting the pump cover provides easy access to the connecting rods which are anchored to the pump handle. Light-weight below-ground components of pump allow elimination of hoisting gear and open up the possibility of village-level maintenance.

This type of maintenance system is dependent on the availability of below-ground pump components that can be maintained by pump attendants at the village-level. Eventually, the village pump caretaker using only one or a few spanners, should be able to withdraw worn or damaged below-ground pump parts and replace them with new parts obtainable from a spare parts distribution system.

Although the present stage of handpump technology and community capabilities usually do not allow for full village-level maintenance, it is simply necessary that handpump programmes should eventually move towards such a system. Maintenance at the village level needs to be made possible by improved pump design and more intensive and specific training of the local pump caretakers. Until such time as this system proves viable in practice, it is essential that all current maintenance systems stimulate community involvement and capacities, so that greater participation at the community level over a phased period will become possible.

Community involvement in the maintenance of handpumps may not only result in better care and upkeep of the pump, but also may help stimulate related activities such as health education and the proper use of water for hygiene. Water can provide an entry point for a number of related activities for rural community development, if community participation is encouraged from the outset.

A certain amount of spontaneous community involvement will exist in all cases, in varying degrees. During the introduction of the handpump programme to the community at the well drilling stage, the community is already involved through the donation of land for the handpump site, the provision of food and lodging to the drilling crew, and work assistance by local labour. Drilling activity in a village will generate a natural degree of interest, and since drilling and installation activity may require several days during which the team members stay in the village, this would provide an excellent opportunity for informal communication on the importance of safe water for health. This basis will later be useful for establishing an organised community involvement in the up-keep and maintenance of the handpump as well as for introducing health education activities.

An important consideration is the extent of existing community organisation. The chances of effective village-level maintenance are small where the

community structure is not strong enough to provide the requirements of handpump maintenance. These include:

- awareness of the importance of safe drinking water;
- purchase and storage of spare parts;
- technical skills;
- funds and the collection thereof.

For even a minimal degree of community participation in handpump maintenance, the community attitude and interest in safe drinking water is a decisive factor. Where the well and handpump are provided without adequate introduction and communication on the value of such installation, the safe water supply will be seen as something provided by the government without request or consultation. Frequently, under such conditions the community will expect the government to also maintain the pump.

Awareness of the importance of safe drinking water should not be expected to exist at the village level. Rural populations often are unaware of the relationship between their traditional, polluted water sources and the incidence of water-borne and water-related disease. Thus, there is a very real need for health education which should aim at developing awareness of the relationship between water and health. Encouraging communities in the use of safe drinking water is not a simple task; it entails changing traditional beliefs, and introducing new attitudes. It will require a concerted and integrated approach..

One great advantage of a determined policy of encouraging village-level maintenance of handpumps is that it can bring out local initiative and reduce the burden of maintenance costs on the government. Government resources may then be channeled to new well construction and handpump installation. This approach completely depends on the people's attitude towards the pumps. Where the well and handpump are seen as something the government has given without any request or consultation, the local people will normally expect the government to maintain the pump. However, where the village community does see the handpump as something that was achieved with full local cooperation, they may feel it is theirs.

The village-level handpump maintenance system should, in most cases include a government agency responsible for installing the handpumps and for major

repairs, but the regular maintenance and minor repairs would be fully at the village level.

It should be recognized that a village-level maintenance system based entirely on local resources and only supported by governmental backup service is very likely to fail in the early stage of development. As soon as the handpump breaks down, the villagers would probably revert to their traditional water sources, or would open up the well on which the handpump has been installed. In most developing countries it is not reasonable to expect small rural communities to fully maintain their handpump as envisaged in the maintenance system as it should eventually developed. Frequently, the direct result of such a system will be a large number of handpumps out of operation, and the resources used in well construction and handpump installation will be wasted. In the early stages when people are not yet accustomed to using well water, and not yet appreciate the benefits of their new water supply, the first breakdown of the pump may provide a convenient excuse for the users to return to their traditional, polluted water sources.

This conclusion is illustrated and confirmed by a project in Ghana where the use of pumps on covered wells was deliberately rejected because it was felt that in practice the pumps would not be maintained. Open wells were chosen, and it was tried by various measures to reduce the health hazards associated with the use of buckets. The best approach, in this circumstances, would be to gradually upgrade the technical capabilities of the local people urging them to support replacing the buckets by a handpump as soon as they consider for themselves that they could cope with the maintenance requirements of the pump.

In the initial stages, a mechanic from the government-organised backup service should be looking after a given number of handpumps. His job would be to check the technical condition of the pump, to carry out repairs to the above-ground-assembly, and to call in the district maintenance team of the government water supply agency, for the major repairs. This technical support, in the initial years, leading up to eventual village-level handpump maintenance, would fulfil an essential role.

The overall costs of a village-level handpump maintenance system will probably be no less than under other systems. However, the cost to the government will be substantially reduced.

3.4 Private Maintenance

Quite frequently, no formal government organization exists for the maintenance of handpumps, nor is there a village-level system. Where the pumps are financed exclusively from private sources this may be acceptable. The owners of the well and handpumps are likely to have sufficient financial resources to purchase spare parts from commercial suppliers who have an incentive to ensure that the needed spare parts are on sale. Furthermore, privately owned handpumps are usually not so intensively used, and the direct involvement of the owner will probably ensure greater care than is normal for a handpump used by a community.

3.5 Key Considerations

Organising handpump maintenance, i.e. establishing a viable maintenance system, should be viewed as an investment - and a sound investment indeed! A handpump maintenance system, if working effectively, not only protects the initial investment in well drilling and pump installation, it also provides a basis that can be extremely useful for further community development programmes.

Investment in maintenance, therefore, also is investment in institutional development. A handpump maintenance system should be considered in this broad sense.

The development of a handpump maintenance system requires policy decisions and long-term commitment to implement it as planned, stressing maintenance as a priority activity. This is necessary in order to support the management and funding of a maintenance system. Maintenance is a demanding activity requiring the building up of capacities at various levels, and this needs careful planning.

When organising a handpump maintenance system, an important factor is the rate of expansion of the handpump installation programme. There always is the danger of trying to expand too quickly. It takes years to train staff, to arrange for procurement of pumps and spare parts, and to establish a spare parts distribution network. Most difficult of all, is the requirement to educate and train the people for their role in the maintenance system. Working continuously and starting from a zero base it could take as long as

five to ten years before a country otherwise suitable for handpump water supply systems is able to absorb a massive handpump programme. During this period the water supply agency should settle for a very limited number of different handpump models, and the maintenance organization and method of financing should be established. The spare part distribution and local manufacturing capacity of pumps would be built up. In this way, the maintenance system would develop gradually and sufficiently to be able to accommodate later expansion of the handpump programme.

This is not always easy to achieve. The New No.6 pump used in Bangladesh, for instance, had a design problem in that four bolts were used in the headcover where three bolts would be much better. Maintenance crews reported this time and again to the government department concerned. But, what should be done? Should the head cover be re-designed, and be replaced on the 500,000 pumps that were already installed? Who would pay the costs of such an enormous operation? Another example is the slot cover on the "New No.6" pump which could have been eliminated by using one extra pivot point, and a brash bush.

Some tasks need to be performed so frequently that the only practicable solution is to undertake them at the village-level; these include the greasing of hinge-pins and sliding parts, and a daily cleaning of the well-head and platform. Other maintenance tasks suitable for a pump caretaker at the village level, are those which do not require any special equipment (except spanners of the relevant size); for example, adjustments to the stuffing box. In deep wells, changing the pump leathers involves lifting and unscrewing a very long length of pump rod, which is perhaps best left until a technician is present to help. On shallow wells, however, a trained villager could do the job. Every detail needs to be thought out like this. It is the only way to arrive at a clear allocation of responsibilities between visiting maintenance technicians and the village pump caretaker(s).

It would be advantageous to test two or three alternative systems of handpump maintenance on a pilot scale for a period of two or more years, prior to the final selection of the system to be used nationally. However, the general situation is such that few countries can allow their handpump maintenance system to develop in such a phased manner.

There are several social-cultural reasons which may cause handpump maintenance systems to fail:

- (1) The new handpump water supply was forced upon the local population; and they did not really want it. They may fear that their own priority (e.g. a primary school) will be postponed indefinitely. Blaming the handpump for this, they may refuse to maintain it.
- (2) The new handpump will also be neglected, or even rejected when the existing water resources are regarded as holy, a hafir built by a well-known religious man, or a holy river or stream.
- (3) People do not understand the importance of a safe water supply for their health. For them, the important water quality standard is clarity and absence of colour, taste and odour. Bacteriological contamination is not recognized as important. Thus, the handpump water supply may be rejected and not maintained when the water from it is salty or tastes bitter.
- (4) People may resent the change in social life brought about the new water supply, i.e. the shortened walking distance to the new water points that are nearer to the houses than the old source. The washing of clothes at the village pond or on the river, is often appreciated by the women as an opportunity to exchange news and gossip, and they may not like that to change.

Parallel to the establishment of the handpump maintenance system, a health education programme should be carried out to make people more aware of the health implications of safe water supply, and the importance of keeping livestock a reasonable distance from the pump.

In some countries, local health promoters work in the project area, as handpump water supplies are installed. They criss-cross the dirt trails of the project area on motorbikes, promoting the use of safe water in those villages with installed handpumps and contacting other communities to convince them of the benefits of a safe handpump water supply.

3.6 Maintenance Requirements of Handpumps

The common claim by manufacturers that their handpump will last for 15-20 years under "normal operating conditions" is a far too simplistic guideline to be of much value in the maintenance of pumps. Each pump has a number of

components. Several of these components will probably last many years with little or no maintenance. Others have a more limited life span because of wear or vulnerability. As with any mechanical device, a handpump has wearing parts which have to be replaced periodically more or less in relation to the intensity of use. Thus, when we speak of the maintenance requirements of a pump, we are not referring only to the most rugged and longest lasting component, we are actually assessing each component of the pump separately. A typical handpump maintenance schedule is given in Table 1.

One aspect which is frequently overlooked is that regardless of the type of handpump used, some basic form of maintenance organization is always required. Therefore, a high-priced pump cannot totally eliminate the need for maintenance. Another aspect is that high-priced spare parts, and although they may not have to be replaced often, the cost is high when it does happen. Thus, over the pump's life span the total costs of spare parts for such a pump may be considerably more than for lower-priced pumps, even though fewer are required.

The most common cause of handpump breakdowns is wear of the leather cups in the cylinder. This is much commoner than failures of the top-end parts. In deep-well pumps, it is also a more serious problem than faults in the top-end mechanism, because changing the pump piston seals entails hauling the riser pipe, pump rod and cylinder to the surface. This is often beyond the capability of a technician working by himself. Even where villagers provide help, maintenance work on a deep-well pump remains a difficult job to undertake.

The next most significant cause of pump failure is trouble with the valves in the cylinder. Repair and maintenance again require hauling the riser pipe, pump rod and cylinder out of the well. Ball valves are normally more trouble-free than flapper valves, but they suffer from the defect that pounding of the ball may deform the metal seat on which it rests. Experience shows that poppet valves with rubber cushions are often more effective in the long run.

Table 1. Typical Maintenance Schedule for Handpumps

After: Pacey (1976)

-
- daily: - lock and unlock the pump at hours agreed by the village.
 - clean the well-head.
- weekly: - thorough clean-up of pump, well-head and surroundings.
 - oil or grease all hinge pins, bearings, and sliding parts,
 after checking that no rust has developed on them.
 - record any comments from users about irregularities in
 working (tightness of parts, leaks from stuffing box,
 fall-off in water raised). Correct these when possible.
- monthly: - if necessary, adjust the stuffing box or gland. Usually
 this is done by tightening the packing nut. This should not
 be too tight there should be a slight leak when the adjustment
 is correct.
 - check that all nuts and bolts are tight, and check that there
 is no evidence of loose connections on the pump rods
 - check for symptoms of wear at the leathers, noting any
 comments from users about any falling off in the water
 raised. If the pump fails to raise water when worked slowly
 (e.g., at 10 strokes per minute), replace the leathers.
 - carry out all weekly maintenance tasks.
- annually: - paint all exposed parts to prevent development of rust.
 - repair any cracked concrete in the well-head and surrounds.
 - check wear at handle bearings and replace parts as necessary.
 - check plunger valve and foot valve; replace if found leaking.
 - check the pump rod and replace any defective lengths or
 connectors.
 - replace packing at the stuffing box or gland.
 - carry out all monthly maintenance tasks.
-

Village pumps are often used very intensively, and the table recommends a correspondingly high level of maintenance. In some instances, this would lead to pumps being over-maintained, but this is obviously preferable to the present state of total neglect of maintenance, as found in many areas. The frequency of maintenance could be adjusted for lightly used pumps.

3.7 Selecting a Maintenance System

Basically, the proper choice of system should be village-level maintenance, because of feasibility, effectiveness and cost. However, at present both the equipment and the technology for this type of maintenance system still need to be developed. Although field trials and research are undertaken to

develop village-level maintenance systems, it will still take years before it will become fully mature and effective. The variety of pumps already installed in many countries, forms a serious problem and constraint which will be hard to overcome.

An important factor is the scope of the handpump programme, both in terms of number of handpumps as well as the geographical area covered. In selecting a maintenance system, factors such as distance, accessibility and density of handpumps, and the necessary frequency of inspection and repair, are essential considerations. The importance of pump density should not be overlooked when planning the the maintenance system. At some stage it may be possible to change from central, and thus, distant stockpiling of spare parts, to local stocks to be distributed with low-cost transportation means.

The unit costs of maintenance are mainly dependent on the type of handpump and the density of the pump sites. When planning a maintenance system, it is important to take into account that as the system expands, economies of scale will become more significant. When the first handpumps are installed, unit maintenance costs will be relatively high. But, as the pumps increase in number, unit costs will be reduced. The travel distances between the pumps generally will become smaller, and spare parts may be stockpiled more nearby.

4. FINANCING HANDPUMP MAINTENANCE COSTS

4.1 General

An important factor for the viability of any maintenance system for handpump water supplies, is how the maintenance costs are met.

In many instances communities in rural areas rely, sometimes too easily, on subsidies from the government to finance the maintenance of their handpump water supply.

The financial arrangement for meeting maintenance costs will reflect the government policies and commitment and any arrangements made under a joint plan of action with international organizations and/or bilateral aid agencies.

It is firmly believed that no matter how poor a community may be, some water charges can and should be collected from the consumers. It has been said that the day when people start to receive water free of charge from a handpump water supply marks the beginning of the downfall of the supply.

4.2 Methods of Financing Maintenance Costs

The way the costs of maintenance services and spare parts are financed, greatly influences the distribution of the costs over the various sources of finance:.

(1) Government pays:

Where the government pays all costs of maintenance and spare parts, the maintenance organization must extend down to the village level. It is quite possible for a villager to be employed by the government as the pump caretaker for each pump installed, but this will further add to the financial burden on the government.

(2) Government subsidises:

Under this method, the government will be financing the fixed costs of the maintenance organization, and the local communities will have to pay the cost of the spare parts, and perhaps also a service charge for the actual maintenance work on their pump. Or the communities may organise themselves to carry out the simple maintenance tasks and minor

repairs, with the government carrying out and financing the major repairs. The government organization, in this system, must be able to collect service charges and payment for spare parts, and recycle these funds for the purchase of new supplies of spare parts.

Sometimes, the handling of, and accounting for, such funds will present a major administrative problem. It may not even be possible to directly recycle revenue to meet the costs of spare part supplies, in cases where revenue has to be paid into the general government account.

(3) The community pays all costs:

In this case the people may either pay the full charge for the maintenance service provided by the government organization, or all costs of hiring local technicians to carry out maintenance and repair tasks. With this financing method the maintenance of the pump is completely the responsibility of the community.

Of interest is another option for the financing of handpump maintenance costs, which was also considered in Upper Volta. This would be that the costs of handpump maintenance would be financed by a surtax on beer and alcohol; in Upper Volta, and perhaps in many other countries, these are regarded as a luxury.

Yet another approach is used in the Volta Noir Region in Upper Volta, where a water well drilling and handpump installation project is underway with bilateral assistance from the Netherlands. Here, each family in the villages served by the project, contributes 50.000 CFA per year towards the maintenance of the handpump. This amount is more or less equal to the annual expenses they used to have for rope and buckets. It covers the costs of: (a) spare parts; (b) a skilled technician coming from the district centre for the occasional major maintenance tasks or repairs; and (c) the village's contribution to the operating costs of the regional unit of the national water supply agency.

4.3 Maintenance Inputs

4.3.1 Manpower

Depending upon the scope and size of the handpump programme, provision should be made to obtain staff who can deal with:

- management, supervision; training;
- general inspection;
- installation;
- preventive maintenance;
- repairs and overhauling of pumps;
- administration of stores and spare parts;
- vehicle maintenance.

Since handpump maintenance is labour intensive, and seldom a one-man job, the variety of skills is needed for the running of a maintenance organisation. Manpower would comprise of engineers, administrators, clerks, mechanics, drivers, helpers, masons, health educators, and of course, the pump caretakers.

In a government-organised handpump maintenance system, the number of people directly employed will depend on the extent to which local communities share in the maintenance activities. Another important factor is the total number and density of pumps in an area. No firm conclusions on manpower needs are possible but the ratios found in India, Bangladesh, and Tanzania provide some insight (Table 2).

Table 2. Typical Ratios of Staff Employed for Handpump Maintenance

Staff level	<u>Tanzania</u>		<u>Bangladesh</u>	<u>India</u>
	(a)	(b)		
Executive level and above	30	5	1	1
Middle level	60	10	9	18
Lower level	130	75	50	160
	<u>220</u>	<u>90</u>	<u>60</u>	<u>180</u>

(a) Centralised maintenance system

(b) De-centralised maintenance system, with village communities taking responsibility for simple, daily maintenance tasks and minor repairs.

Clerical and administrative posts required in the maintenance organization are not shown in Table 2. In addition, other units of government may have to be strengthened in order to cope with the additional workload of the handpump maintenance programme.

4.3.2 Transportation

Some of the most important costs of handpump maintenance do not pertain to the handpumps themselves, but to the maintenance costs associated with the trucks, motorcycles and manpower required to inspect, service and repair defective pumps.

The number and types of vehicles required by a government maintenance organization will largely depend on the topography of the country and its transport infrastructure such as roads and railways. In most countries, the most common transport will be by road. Senior staff of the maintenance organization would require vans or cars, possibly with four-wheel drive. For transport of the necessary equipment and maintenance materials, pickups or trucks may be required. In remote and difficult terrain (such as parts of Nepal), where roads do not exist, the maintenance organization may even require animals for transport purposes. All transport units themselves require maintenance, and the handpump maintenance organizations will have to make provision for the upkeep of its vehicle fleet. The cost of maintaining the vehicle fleet and the write-off of vehicles quite often form a substantial part of the overall maintenance costs of handpumps.

4.3.3 Equipment

The maintenance organization will require equipment for routine maintenance tasks, and for making repairs. The equipment needed includes wrenches, lifting gear, screwdrivers, hammers, hack saws, and whatever other tools and equipment needed for the particular handpumps in use. The handpump caretaker may be provided with a very basic set of tools to carry out the simplest kinds of maintenance, such as bolt tightening and the replacement of the piston cups (in the case of shallow wellpumps). The pump caretaker may also receive a supply of grease for regular lubrication of the pump's moving parts. However, in some instances, such general issue of materials may not be effective. Provision of tools and materials to pump caretakers obviously form part of the overall maintenance costs.

4.3.4 Housing

In a government-organised maintenance system, staff frequently claim living accommodation and, dependent on local custom, it may be necessary to construct housing for these people. This is mentioned here because, in estimating the capital investment for a government maintenance system it may be necessary to allow for construction of staff housing. For the lowest level of staff who will be in the largest numbers, housing would probably not be considered the government's duty. However, if they are expected to carry out their tasks conscientiously, they must either be given sufficient income to purchase or to rent their own accommodation or else they must be provided with living quarters. In some countries, the provision of staff quarters has been found the most appropriate arrangement.

4.3.5 Offices, Stores, and Workshops

An essential part of any government-controlled maintenance organization is a system of offices, stores, and workshops. At these locations the government staff will have their base. Maintenance materials will be stored there and any repair on pumps, vehicles and equipment carried out. Generally these offices and workshops will fit into the organizational structure of the government with a head office, and regional or district offices. Lower down the chain of operation, as work concentrates more on the actual maintenance tasks, combining offices and stores will usually be advantageous. The planning of a spare parts distribution system will be dependent on the sources of supply and areas of demand. In places where spare parts are issued, it is often economical to also collect the replaced items. These can be sold as scrap or perhaps they can be reconditioned.

From the records, as available, an analysis should be made of frequency of replacements of the different parts of a handpump used in a handpump programme. This will provide the necessary basis for ordering (e.g. once or twice per year) the needed supply of spare parts.

4.4 Record Keeping

The need for proper record keeping as a basis for handpump maintenance cannot be over-emphasized. Only from such records, is it possible to determine the required frequency of servicing the handpumps, the time the maintenance jobs take, the actual performance and reliability of the various components of the pumps and which spare parts should be stocked in what quantities.

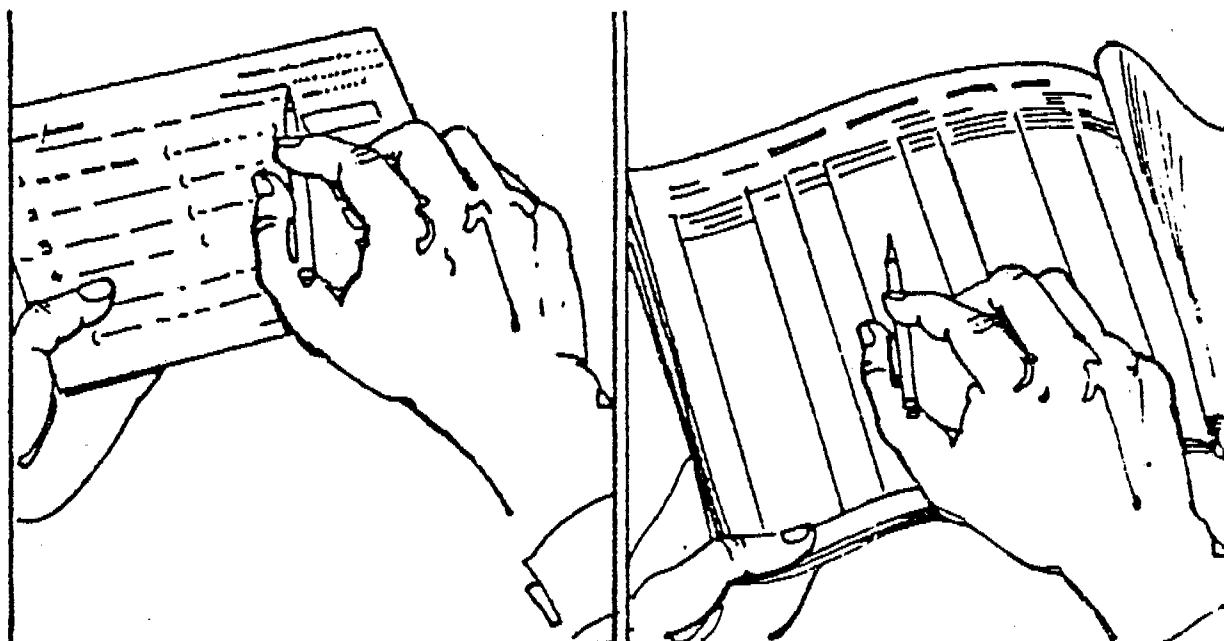


Fig. 1. Maintenance requires functioning record keeping routines.

Maintenance records are mostly kept on cards, one for each piece of equipment. On these cards should be kept a record of regular lubrication, inspection, cleaning, replacement of worn parts and other data of importance. The data for the next regular servicing of the pumps should be noted.

4.5 Maintenance Cost Data

Actual handpump maintenance costs, obviously, are very much dependent on a) number of handpump installations and the distances they are apart; b) prices of fuel, spare parts; and c) durability of the pumps. Actual cost data for maintenance of handpumps are hard to come by. This is due to a variety of reasons.

Firstly, it is a question of time. If properly installed in the first place, handpumps usually require little maintenance during the first years of their life.

Secondly, due to the scattered location of handpump installations in any individual country, it initially does not seem necessary to set up an organization specifically for their maintenance. Thus, when maintenance or are repairs required, these may be carried out by a government agency or private organization without any specific charges. Therefore, it is not very well possible to make an analysis of average maintenance costs of such handpump water supplies.

While it is true there is a dearth of actual maintenance cost data, some are available.

For the India Mk II handpump, an official source quotes maintenance costs at Rs 350 (US \$ 35) per annum.

A typical cost estimate of handpump maintenance is given in Table 3.

In a recent survey of two villages in Upper Volta, the feasibility of a financial contribution from the villagers in the costs of maintaining a new handpump water supply were investigated. The study method used, was to relate the actual expenses for the ropes and buckets used to lift water from existing open wells, to estimated family income, and to compute these costs per person (Table 4).

As the water supply situation in the village of Boare was very inadequate, the people were found willing to pay an extra charge of 60 CFA per person. Moreover, they would be prepared to provide assistance in the construction work needed to improve their handpump water supply. Apparently, it is possible to obtain some contribution from the users for meeting maintenance costs, provided the new water supply is regarded by the people as much better than their existing water sources, and does not cost more than their current expenses for water.

A sample comparative cost analysis of handpumps is shown in Table 5.

Table 3

Typical Cost Estimate of Handpump Maintenance

(Allahabad District,
Uttar Pradesh, India)

Store keepers	4 Nos	Rs 5,580/- per annum,	Rs 22,320/-
Pump Mechanics	8 Nos	Rs 4,872/- per annum,	Rs 38,976/-
Helper to Mechanic	12 Nos	Rs 4,632/- per annum,	Rs 55,584/-
Watchman	4 Nos	Rs 4,032/- per annum,	Rs 18,528/-
Part-time sweeper	4 Nos	Rs 600/- per annum,	Rs 2,400/-
Jeep Driver	1 Nos	Rs 4,896/- per annum,	Rs 4,896/-
TA for staff Rs 300/- per Tehsil	1x4x100x12		Rs 14,400/-
Running of vehicles ¹⁾			
a. for motor cycle average running 30 km/per day/ Tehsil (one liter petrol for 30 km running	1x4x1lit.x365	Rs 6.50 per lit.	Rs 9,490/-
b. jeep for inspection once every forth nightly approximate running 200 km per per trip	1x4x2x200x12x1	Rs 750/- per lit.	Rs 20,800/-
Office	1x4 office	Rs 750/per year	Rs 3,000/-
Spare parts for mainte- nance of handpump	711 Nos.	Rs 20 per HP	Rs 42,200/-
Total Maintenance Costs			Rs 363,682/-
Total Population Served	125,000		
Annual Per Capita Maintenance Costs		Rs 3,00 (approx)	

* Jeep and motorcycle used for supervision purposes not included.

Table 4

Expenses for Ropes and Buckets in two villages in Upper Volta.

number of persons per family	village of BOARE population: 1130		village of ZIZIN population: 369	
	expenditure per person	% of estimated total expenses	expenditure per person	% of estimated total expenses
less than 6	342 CFA	9.5 %	162 CFA	2.9 %
between 6 and 10	185 CFA	5.2 %	164 CFA	3.0 %
more than 10	140 CFA	3.9 %	145 CFA	2.6 %
average family	192 CFA	5.4 %	155 CFA	2.8 %

* the higher costs in Boare village are due to the greater depth of the well
 ** the village of Zizin is more wealthy
 100 CFA = US\$ 0.40

Sample Comparative Cost Analysis of Handpumps*

	<u>Pump A</u>	<u>Pump B</u>	<u>Pump C</u>
1. Initial capital costs	\$ 300	\$ 600	\$ 700
2. Economic Life	6 years	10 years	11 years
3. Replacement of vital parts involving lump-sum costs	\$ 100 on the 2nd and 4th year	\$ 120 on the 3rd 6th and 9th year	\$ 150 on the 4th and 8th year
4. Annual Maintenance	\$ 100	\$ 80	\$ 60
5. Discount Rate	10%	10%	10%
<u>Present Worth of Costs</u>	\$ 1,319	\$ 1,339	\$ 1,249
<u>Annual Equivalent</u>	\$ 203	\$ 206	\$ 192

* The following assumptions have been made:

- (1) The replacements of the pump or its major parts are done by the same type initially used or in other words the pump technology remains unchanged.
- (2) Cost analysis has been done on the basis of constant price (i.e. value of money in the initial year of installation remains unchanged) and not in current price or in other words general inflation has not been taken into consideration.
- (3) Market prices of different inputs are used in the cost analysis.

The costs of maintaining handpumps are dependent on conditions that are specific for each area. Costs may thus vary substantially, ranging from US \$ 5 to US \$ 250 and more per year per handpump. Higher pump density would normally bring costs in the \$ 30 to \$ 80 per year range, and for a lower density it would be probably somewhat higher but usually not more than \$ 80 per handpump. Based on 100 persons served by a well, and in many cases this figure is double or more, per capita maintenance costs are thus in the range of \$ 0.30 to \$ 2.50 per year.

The amounts mentioned may not seem large but as handpumps are mostly used in (very) poor areas, it may be quite difficult to raise such sums locally. The amounts must be viewed in the context of the local incomes from which a contribution towards the maintenance costs of the handpump would be charged. Perhaps they seem negligible but, in fact, may form a large percentage of family income in a rural area.

4.6 Budgeting for Maintenance

4.6.1 Per Capita

As indicated earlier, the costs of maintaining handpumps are dependent on conditions that are specific for each area. Costs may thus vary substantially, ranging from US \$ 5 to US \$ 150 per year per handpump. Higher pump density would normally brings costs in the \$ 10 to \$ 30 per year range, and for a lower density it would be probably somewhat higher but usually not more than \$ 80 per handpump. Based on 100 persons served by a well, and in many cases this figure is double or more, per capita maintenance costs are thus in the range of \$ 0.1 to \$ 1 per year.

These may not seem large amounts but as handpumps are mostly used in (very) poor areas, it may be quite difficult to raise such sums locally. The amounts must be viewed in the context of the local incomes from which a contribution towards the maintenance costs of a handpump would be charged. In a government-financed maintenance system, the amounts involved may form a negligible portion of the overall budget; but the same amounts may form a large percentage of family income in a rural area.

According to a publication of the World Bank*, any charges for water should not exceed 5 percent of family cash income. 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 raised through the general taxation process. There may be a case for government taxation to cover all or part of the cost of handpump maintenance, but it is also not unreasonable to expect the village community to pay for spare parts, where the government already pays for the distribution of spare parts and major repairs.

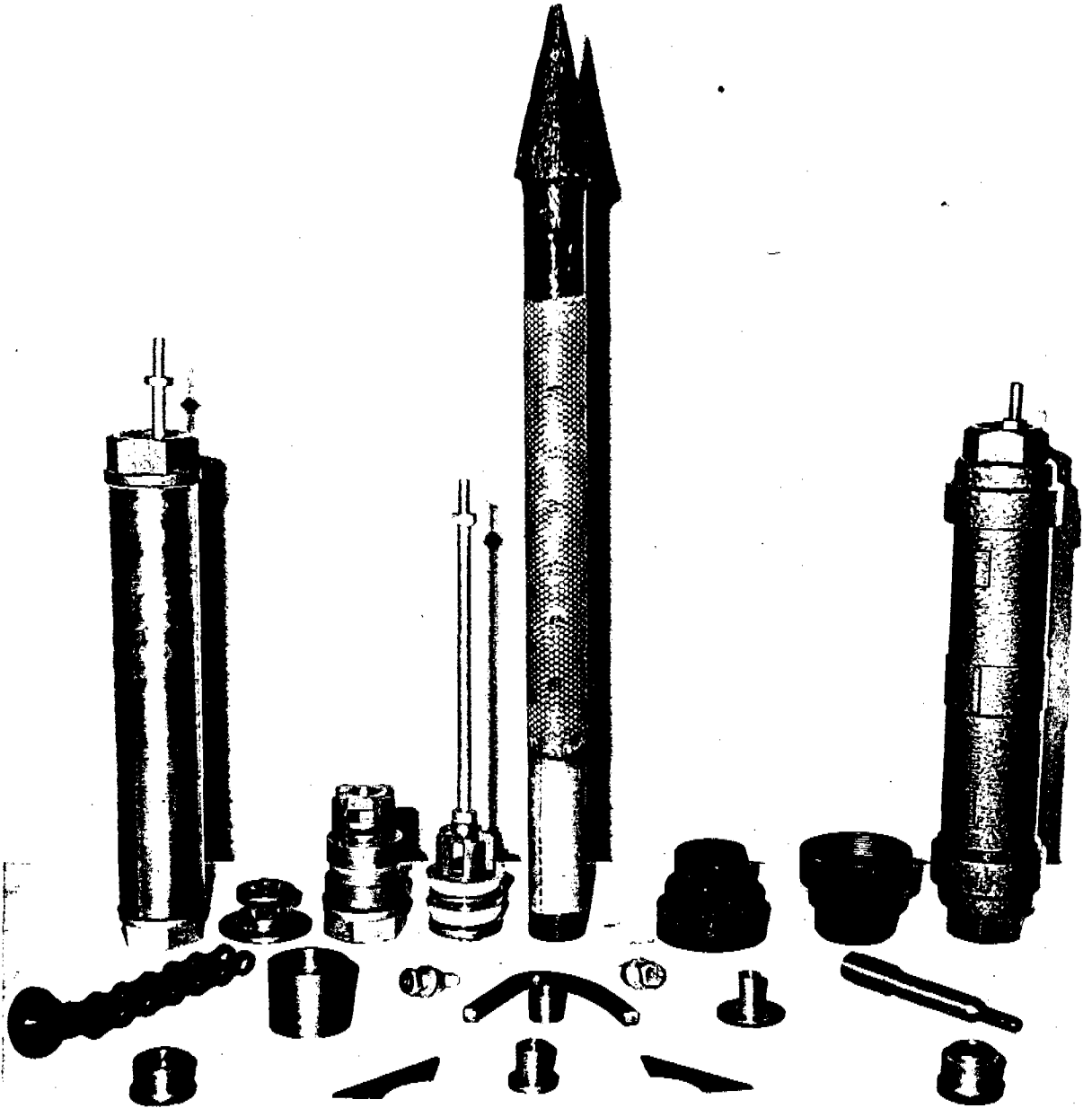
4.6.2 Per Unit

The maintenance costs expressed as a proportion of the investment cost of new handpump installations, will vary considerably depending on the type of maintenance system used, density of handpump installations, the country's infrastructure, prices of fuel and spare parts, wage level and a host of other factors, such as the quality and durability of the pumps. As a rough guide, maintenance costs may be estimated in the range of 6 to 25% of the initial cost of the pump, per year.

4.6.3 Replacement Costs

The pumps must be replaced eventually so the initial cost of installation is not the end of the financial commitment. Thus, it is necessary to consider the eventual cost of replacement or rehabilitation of the pump. The well usually costs several times as much as the pump, and replacement of the well also to be considered. It is almost always a matter that has to be handled by the government. The technical skills and capital requirements will be much greater than what the village community can normally provide. In most cases, the replacement of a well has to be financed by the government from general revenue, if possible with some contribution by the village. Attempts to get the village to repay the full cost of the well over a number of years are likely to fail because once the government has installed the well, any threatening that it will be removed or closed is not very realistic, and unreasonable.

* Village Water Supply: Economics and Policy in the Developing World. World Bank Research Publication. Johns Hopkins University Press, Baltimore, 1976.



5 HANDPUMP MAINTENANCE ORGANISATION

The following are a set of typical job description composing a handpump maintenance organisation, as used in India.

Job Description of District Maintenance Team

- Maintain the handpumps in the assigned area (covering about 500 handpumps). This concerns both preventive maintenance and repairs on any broken down handpump.
- Provide technical assistance, as required, to the Block Maintenance Mechanic, to repair any handpump in his area.
- Respond without delay to complaint cards received from the village-level handpump caretaker (i.e. within one week of receiving the request).
- Explain to villagers why the handpump is installed, and that the handpump is a safe drinking water source, which will improve the villagers' health.
- Demonstrate to villagers how to use the pump correctly. Explain that, when the pump is used in this way, it will give long service.
- Recondition at the district level workshop the various handpump components, e.g. by rethreading/cutting of pipes and rods. Particularly, recondition the cylinder. This material will be reused as exchange items.
- Maintain in perfect condition their vehicle, i.e.:
 - change oil regularly
 - clean air and oil filters every week
 - attend to any vehicle repair required.

Job Description of Block Maintenance Mechanic

- Visit each and every handpump in his area once a month on a regular schedule.
- Carry out a routine check on every pump by operating it. ensure that all nuts and bolts are tight, that the inside of the pump head assembly is clean, that the handle is not shaky, etc.
- Carry out the necessary repairs to the pump assembly above the ground, including minor masonry repairs to cracks in the platform and remove rusty patches on the pump body and apply some anti-rust paint coating.
- Ensure that the area around the handpump is clean and free from refuse.
- Ensure that the excess water is channelled to a soak-pit or garden, and that the drainage channel allows the free flow of water.
- To maintain a log on each pump in which condition of the pump and repairs carried out are recorded.

- Maintain a daily movement register to record his schedule of visits.
- Report the need for major repairs to the District Maintenance Team without delay.
- Submit monthly report to District Engineer about movements/visits and repairs carried out, spare parts used, and condition of tools.

Job Description of Village Pump Caretaker

Daily

- See that the villagers operate the handpump properly so that it will have a long life.
- See that excess water is channelled into a garden or soakage pit.
- Keep the area around the handpump clean and free of refuse.
- If the handpump breaks down, report it to the District Maintenance Officer.
- Maintain the handpump log book.
- Explain to villagers that water from a handpump is better for their health than water from a pond, river, or open-well.

Weekly

- Check axle-bolt. Make sure lock-nut is tight.
- Check flange bolts fastening water chamber to pedestal and make sure they are tight.
- Make sure handpump is firm on its base.
- Clean out trash from drain hole below inspection cover.

Criteria for Selection of Handpump Caretakers

- Preferred age: 17-25 years.
- Preferably someone with technical ability e.g. motor mechanic, cycle shop technician.
- Should be literate.
- Should be user of the pump.

6. CASE STUDIES

6.1. Bangladesh

Previously, in Bangladesh a government-organised handpump maintenance system existed that operated as follows. The government purchased spare parts in bulk and collected them into central stores. Spares were then distributed according to allocation, to stores at the district and subdivisional level. At the next lower level, the thana (or "police district"), maintenance mechanics were employed each having responsibility for maintaining about 200 hand pumps. They collected spare parts from the subdivisional stores and bicycled out to the villages to maintain and repair hand pumps. In this system there was no payment by the people for the spare parts.

The maintenance mechanics were, in theory, responsible for routine preventive maintenance. However, their role frequently reverted to that of repair men, traveling to a broken hand pump when informed by the local people. The hand pump used was one that required frequent maintenance, the maintenance costs were paid by the government. Thus, there was one maintenance organization for the whole country. Involvement of the people was minimal, except in the initial selection of the well site and the appointment of a caretaker who was nominally responsible for the well.

Bangladesh's record for hand pump maintenance is not worse than for many other countries. However, 25% of pumps usually were out of order at any one time, and this must be considered too high a failure rate. Moreover, the government was required to pay for the entire cost of hand pump maintenance. For 500,000 hand pumps installed and an annual maintenance cost per hand pump of US\$ 5 (US\$ 3 in spare parts, and US\$ 2 in operating costs), the total annual expenditure on hand pump maintenance would rise to US\$ 2,5 million. To pay only US \$ 2,5 million for hand pumps serving almost 40 million people may not look excessive, but in a country with a gross national product of only US\$ 2,000 million (1978), it is very difficult to make US\$ 2 million available. Recognizing that the maintenance costs would certainly increase further as more pumps would be installed, it was found necessary to transfer at least part of the cost of handpump maintenance from the government to the people.

The following modifications were made to the maintenance system to make it possible to charge the people for part of the costs. The government would continue to purchase from local sources (and, where necessary, to import) all spare parts. These would be stored centrally by the government's public health engineering department. From the central stores, spare parts would be distributed to government stores at the subdivisional level. The government would further establish small new stores at the thana level, an additional 350 stores, throughout the country. For each store at the thana level there would be a government sub-assistant engineer supervising a group of government-employed maintenance men. At the next lower level, the union level, each union would appoint a union-employed maintenance man who would be paid a small salary by the union and would have the duty of maintaining all hand pumps in the union area. The cost of the spare parts required in the union, would be paid from the union budget. The necessary funds could be raised by local taxation or by directly charging for the spare parts.

The new system would operate as follows. The government would obtain new supplies of spare parts and sends them to the thana stores. The union maintenance man would service the hand pumps in the union, installing any necessary spare parts. He purchases spare parts from the thana stores. Each hand pump is placed under the direct charge of a pump caretaker. The caretaker is generally a responsible person living close to the pump. He or she will receive some training with regard to the proper care of the hand pump and some health education training. It is not so easy to offer the pump caretaker an incentive to carry out his duties properly, and there have been cases where a caretaker was not prevented from exploiting his position. Part of his duties is to keep the area around the hand pump clean, and to carry out the minor routine maintenance. He is also expected to keep a record of the visits of the union maintenance man, and in the event of pump break down, he has to inform the union mechanic. The government employed-maintenance men at thana level are expected to carry out the major repairs.

This new system was first tested on a pilot scale and it was planned to be introduced with some modifications for the entire country during a period of several years.

The thana stores maintenance system does not raise capital for the eventual replacement of the well. It is not exactly known what the life of the new wells using PVC pipes and PVC well screens will be, but a useful life of between 10 and 15 years was expected. Recent information seems to indicate that the useful life of the wells has been over estimated. It is, thus, necessary to reserve in the order of US\$ 10 per year to provide for the eventual replacement of the well and pump.

WELLS INSPECTION AND EVALUATION REPORT

Form RWS/05

1. IDENTIFICATION Village : _____ Sub-Division : _____ Union : _____ District : _____ Thana : _____		3. CARETAKER Name : _____ Profession : _____
2. PUMP Date of Installation : _____	Water Discharge Rate _____ Depth (Well) _____	
4. QUALITY OF SITE (a) Distance of UNICEF/DPHE Well from : - Caretaker's house _____ ft. - a Cluster of houses _____ ft. - a Tubewell (excl. private) _____ ft. - a Latrine _____ ft. - Standing water around _____ ft. (b) Platform. Completed ? Yes <input type="checkbox"/> No <input type="checkbox"/> Intact ? <input type="checkbox"/> Broken ? <input type="checkbox"/> (c) Well- -subject to flooding ⁽¹⁾ ? Yes <input type="checkbox"/> No <input type="checkbox"/> -installed on low ground ? Yes <input type="checkbox"/> No <input type="checkbox"/> (d) Slope- -Sufficient slope to drain away water from Platform- Yes <input type="checkbox"/> No <input type="checkbox"/> and around well- Yes <input type="checkbox"/> No <input type="checkbox"/>	5. USE AND USERS (a) Population of the Village _____ (b) Population of a cluster of houses where well installed _____ (c) Population using this well _____ (d) Population uses this well for Drinking <input type="checkbox"/> Bathing <input type="checkbox"/> Washing <input type="checkbox"/> Other <input type="checkbox"/> (3) (e) Population uses _____ for Drinking _____ for Bathing _____ for Washing _____ for other need	
7. MAINTENANCE a. Pump ⁽²⁾ Lubricated ? Yes <input type="checkbox"/> No <input type="checkbox"/> b. Spare readily available ? Yes <input type="checkbox"/> No <input type="checkbox"/> c. PHE Mechanic last attended the pump : Month _____ d. No. of time pump repaired _____		6. WATER QUALITY Iron content : _____ Chloride content : _____ Water Taste : _____ Odor : _____ e. Pump ever repaired by Caretaker ? Yes <input type="checkbox"/> No <input type="checkbox"/> Villager ? Yes <input type="checkbox"/> No <input type="checkbox"/> f. Platform maintenance Satisfactory ? <input type="checkbox"/> Poor ? <input type="checkbox"/> None ? <input type="checkbox"/>
t. Well accepted ? Yes <input type="checkbox"/> No <input type="checkbox"/> If not, give reason : _____		
WES Field Technician Name : _____ Signature : _____ Date : _____		(1) Situation which will warrant pouring floodwater into the well (pipe). (2) Piston, pins, nuts, and bolts. (3) Tubewell water, ring well water, pond water, or any other type of water for mentioned purposes.
Contractor : _____		Work Order No : _____ Date : _____

SEA per
7.4.7c

Fig. 5.1. Wells Inspection and Evaluation Report used in Bangladesh

6.2. INDIA

Previously, in India the government used to construct wells and install handpumps, without any special arrangements for maintenance and repair of the pumps. The advantage of this approach is that the government can standardise equipment and ensure a satisfactory well construction and the use of suitable handpumps. The great disadvantage was that the government did not develop an organization to carry out the routine maintenance. There being no organization, the government did also not have the opportunity to promote health education through an established pump maintenance network. This maintenance system or rather the lack of it generally produced poor results. With pump maintenance completely left to the local communities, as many as 80% of the pumps were inoperative within two years after installation.

Considerable efforts have been made to produce a better handpump (which has resulted in the India Mark II deepwell pump), and to provide for its proper functioning through improved maintenance. A new maintenance system was developed (the "Three-tier system), and first used in the State of Tamil Nadu*. This system has been successful in reducing the number of inoperative handpumps. The Three-tier Maintenance System provides for maintenance attention at village, block and district level.

At Village level

A responsible person, who usually resides close to the handpump, is approached with the general consent of the village residents. He or she may either be an artisan, a literate farmer, or a social worker. He is given a two-day orientation course on the importance of a safe drinking water

* Until August 1976, all handpumps whether installed by the state government or by the panchayat unions, were formally under the maintenance of the village panchayat concerned. Due to the limited financial resources of the village panchayats and the non-availability of skilled mechanics in the rural areas, there was no proper maintenance of the pumps. A very high portion was, in fact, out of order. The government, by order dated 3 August 1976, entrusted the responsibility for the maintenance of the handpumps to the Tamil Nadu Water Supply and Drainage Board.

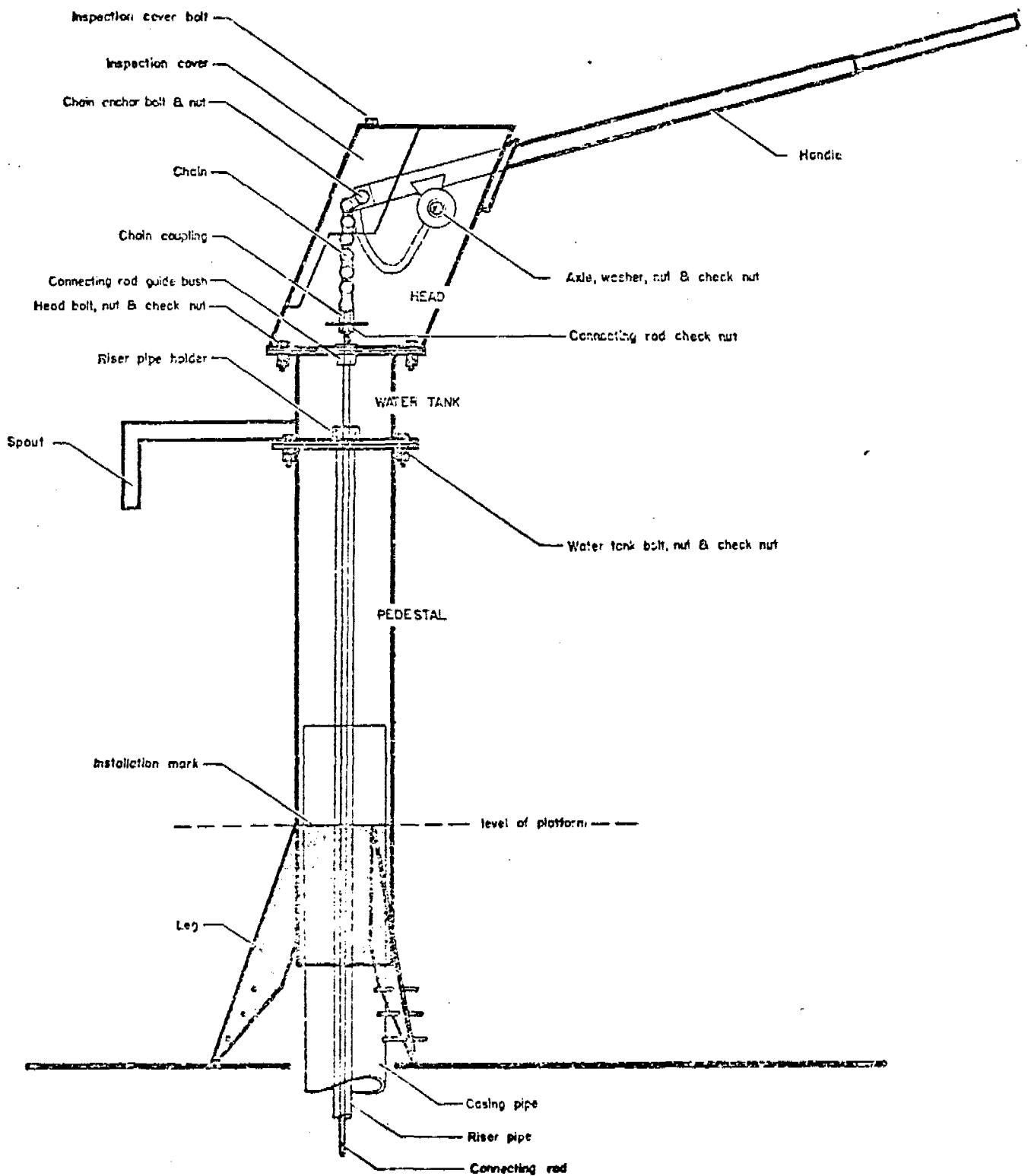


Fig. 5.2. India-Mark II deepwell handpump.

supply, the mechanism of the handpump, and the failures that might occur to the pump. He is trained to attend to minor repairs, and is supplied with the basic tools necessary. He is also provided with pre-stamped and -addressed postcards, which list, in the regional language, the possible problems that might arise. When such a breakdown occurs, the caretaker will indicate on two postcards the type of repairs needed, and will post one to the block-level fitter and the other to the district Tamil Nadu Water Supply and Drainage Board mobile team.

The function of the caretaker includes:

- attending to minor handpump repairs;
- educating the community on how to protect the water supply;
- sending information to the block-level fitter and district mobile team whenever there is a breakdown in the handpump.

At Block level

One fitter is appointed at the block level for every 100 handpumps, under the administrative control of the Block Development Officer and the technical supervision of the Tamil Nadu Water Supply and Drainage Board.

The fitter works out of the block headquarters if the block has 100 or more pumps, his base is situated in the block which has the largest number of handpumps to be attended to.

Upon receipt of a request from a caretaker, the fitter will proceed to the village and attend to repairs, if the problem is located in the top-end mechanism.

At District level

In the case of a major repair, it is the district-level team which will proceed to the village immediately upon receipt of the card. If there is a large number of repairs to be carried out, the help of the assistant engineer at the Tamil Nadu Water Board is sought.

From experience, it has been discovered that one mobile team cannot effectively cover 1000 handpumps, and the Tamil Nadu Water Supply and Drainage Board has therefore recommended one mobile team for every 500 handpumps.

TAMILNADU WATER SUPPLY & DRAINAGE BOARD

Hand pump Maintenance Record

VILLAGE

PANCHAYAT

UNION

DISTRICT

PUMP No:

DEPTH OF BORE:

WATER LEVEL:

DATE OF INSTALLATION:

DETAILS OF REPAIRS	DATE OF REPAIR	DATE OF INTI-MATI-ON	NAME OF MACHANIC	REPAIR ATTEN-DED DATE	DETAILS OF REPAIRS ATTENDED	DETAILS OF SPARE USED	REMARKS

Fig. 5.3. Handpump Maintenance Record Card used in State of Tamil Nadu (India).

The objective of the maintenance system for the handpumps is to attend to any repair within a week. Any expenditures incurred in the process are shared by the government and the local bodies concerned.

Comments on Three-tier Maintenance System

The first tier of the new maintenance system - the village pump caretaker - is crucial to the success of the whole system. Unless the maintenance staff at the Block and District level is informed promptly when a handpump breaks down, repairs will be delayed and the maintenance system will not function as intended. Training courses for pump caretakers were, initially, organised in one block of each district, with UNICEF assistance. One follow-up camp was then conducted per block by the District Development Officers concerned with the assistance of the Tamil Nadu Water Supply and Drainage Board. After three months, the caretakers were given a refresher course during which caretakers for newly installed handpumps and substitutes for any drop-outs were trained.

The village pump caretaker is a volunteer and receives no payment from the government but his position usually carries some prestige and he may receive a small fee from the local community. Maintenance duties are divided between the caretaker in the village, the inspector-mechanic at block level, and the mobile maintenance team at district level.

The cost of maintenance is mainly born by the government, but through the pump caretaker the community is involved in the care of its pump. As part of his training, the hand pump caretaker is informed of the importance of good hygiene and of a safe drinking water supply. It is the intention that he or she will become a health education promotor in his village. The mobile team will use an exchange system for pump servicing. This means that instead of carrying out repairs on the spot at the well site, they will fit a new or reconditioned pump and take the old pump to the workshop for servicing and repair. This process speeds up the work of the mobile team, ensures that the handpump they leave is in good condition and it allows repair work to be carried out in the workshop.

TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD.

HAND PUMP CARETAKER'S ACTIVITIES REPORT.

Village/Habitation
 Panchayat
 Union
 District

Hand Pump No.
 Depth of borewell
 Static water level
 Date of Installation
 of hand pump

NAME OF CARE TAKER:

50

Serial Number.	Description of repairs	Date of breakdown	Date on which information card posted.	Name and address who attended to repairs.	Date of attending to Repairs	Details of repairs attended to	Details of Spare parts changed if any.	Remarks.
1.	2.	3.	4.	5.	6.	7.	8.	9.

Fig. 5.4

தமிழ்நாடு குடிநீர் வடிகால் வாரியம்
பழுது பார்ப்போர் செயற்குறிப்பு

Form-C.

Fig. 5.5

கிராமம்

ஊராட்சி

ஒன்றியம்

மாவட்டம் தென்னாற்காடு

கைப்பம்பு எண் :

கைப்பம்பின் அமைப்பும் :

வழங்கியவரின் பெயரும் :

கைப்பம்பு பொருத்தப்பட்ட நாள் :

வரிசை எண்	பழுது அறிவிக்கப்பட்ட நாள் அல்லது பார்வையிட்ட நாள்	பழுது சரி பாக்கப்பட்ட நாள்	யாரால் பழுது பாக்கப்பட்டது	பழுதுகளின் தன்மை	கைப்பம்பில் மாற்றப்பட்ட பகுதிகளின் விவரம்.	குறிப்பு
51						

Fig. 5.6. Handpump Maintenance Record as used in Tamil Nadu (India)

TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD.

HAND PUMP FITTERS ACTIVITIES REPORT.

VILLAGE
 PANCHAYAT
 UNION
 DISTRICT

HAND PUMP NO..
 TYPE OF HAND PUMP
 NAME OF AGENCY SUPPLIED
 THE PUMP
 DATE OF INSTALLATION

NAME OF FITTER

Sl.No.	Date of receipt of Information Card/ Date of Inspection.	Date of repairs attended to.	Repairs attended by whom.	Nature of Repairs.	Details of spare parts changed if any

TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD.

HAND PUMP FITTERS ACTIVITIES REPORT.

VILLAGE
 PANCHAYAT
 UNION
 DISTRICT

HAND PUMP NO..
 TYPE OF HAND PUMP
 NAME OF AGENCY SUPPLIED
 THE PUMP
 DATE OF INSTALLATION

NAME OF FITTER

Sl.No.	Date of receipt of Information Card/ Date of Inspection.	Date of repairs attended to.	Repairs attended by whom.	Nature of Repairs.	Details of spare parts changed if any

Fig. 5.7. Handpump Maintenance Record Card used in State of Tamil Nadu (India)

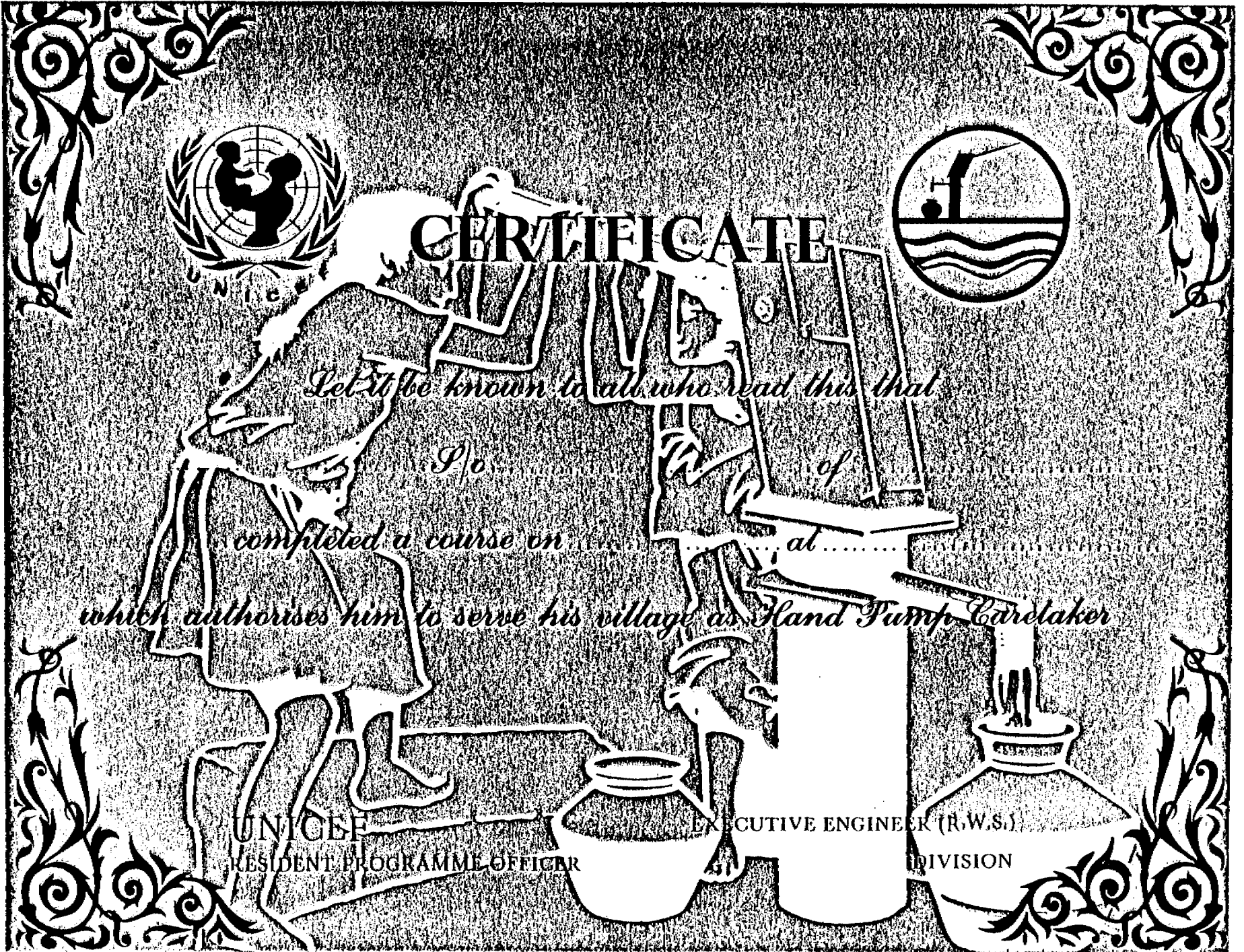


Fig. 5.8. Handpump Caretaker's Certificate used in State of Tamil Nadu (India)

தமிழ்நாடு குடிநீர் வடிகால் வாரியம்

பழுது பார்ப்போர் செயற்குறிப்பு

Form-C

கிராமம்

கைப்பம்பு எண் :

ஊராட்சி

கைப்பம்பின் அமைப்பும் :

ஒன்றியம்

வழங்கியவரின் பெயரும் :

மாவட்டம் தென்னாற்காடு

கைப்பம்பு பொருத்தப்பட்ட நாள் :

வரிசை எண்	பழுது அறிவிக்கப்பட்ட நாள் அல்லது பார்வையிட்ட நாள்	பழுது சரி பாக்கப்பட்ட நாள்	யாரால் பழுது பார்க்கப்பட்டது	பழுதுகளின் தன்மை	கைப்பம்பில் மாற்றப்பட்ட பகுதிகளின் விவரம்	குறிப்பு
55						

GUIDE TO SELECTION AND TRAINING OF VILLAGE HANDPUMP CARETAKERS

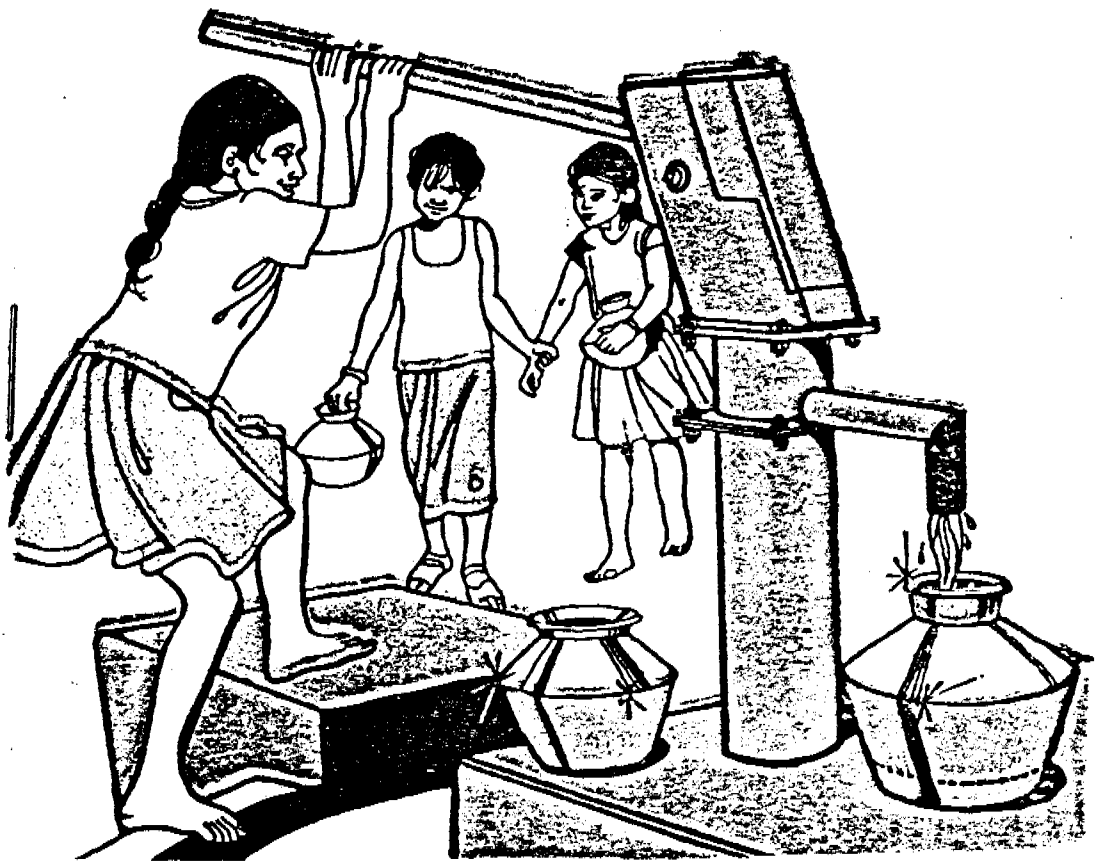


Fig. 5.10. Cover of pamphlet prepared by UNICEF for the Tamil Nadu Water Supply and Drainage Board.

6.3. INDONESIA

In Indonesia, the "Dragon (Jetmatic)" shallow well handpump of Japanese design is very popular. Most of these pumps are locally manufactured, and spare parts are readily available on the local market. The "Dragon" pump is of fairly complex construction. The quality of "Dragon" pumps imported from Japan is better than the local pumps, but their price is much higher.

Another shallow well pump used in Indonesia, is the "Bandung" pump which was developed for the West Java Rural Water Supply Project. The pump is manufactured in Bandung and a few other places.

Deepwell handpumps are, to date, not widespread in Indonesia. These pumps are mostly imported models (i.e. Dempster (USA), Climax (U.K.), Korat (Thailand)).

The Ministry of Health which has general responsibility for rural water supply, will be developing a handpump maintenance system. The district health officers are charged with the task of looking after the handpumps after their installation, and sanitarians belonging to the district health officer's staff, will carry out the maintenance of handpumps. This is just one of the many tasks they have, and pump maintenance actually is carried out only on a very limited basis. The condition of many handpumps is poor.

The matter of handpump maintenance is recognized by the Ministry of Health as an urgent problem. UNICEF is assisting in the development of the handpump maintenance system. At the request of the Ministry, UNICEF in October 1980 organised a seminar on handpump maintenance in Jakarta. The seminar was attended by representatives of the Ministry of Health (Department of Hygiene and Sanitation), several Provincial Health Departments, UNICEF, WHO, and staff of a number of rural water supply projects.

At the central and provincial level, the Ministry of Health (Dept. of Hygiene and Sanitation) will take charge of:

- purchase, supply and installation of handpumps;
- purchase and distribution of the spare parts to the Kabupaten;
- training of the sanitarians in handpump maintenance.

At the Kabupaten (district, part of province) level.

- the Kabupaten will store the parts of the pumps which normally are not replaced very often such as:
 - . the pump body;
 - . the handle;
 - . the head cover;

- the Kabupaten will take care of the distribution of small spare parts to the Kecematans and Puskesmases.

At the Kacamatan (subdistrict) level:

- The Kacamatan will store the spare parts which are more frequently replaced, such as:
 - . the pivot pins;
 - . plunger rods;
 - . cylinder linings.

The Puskesmas (rural public health centre) will store the tools and very frequently needed spare parts such as:

- . valves;
- . plunger cups;
- . bolts and nuts.

The Sanitarians on Puskasmas level, are very important in the handpump maintenance organization. They will be carrying out maintenance duties on the pumps, and also will be transferring "know-how" to people who live near the pump. The goal is that, eventually, the people can themselves do the maintenance work for their pump, with the technical support of a sanitarian.

POMPA TANGAN PADA SUMBURGALI

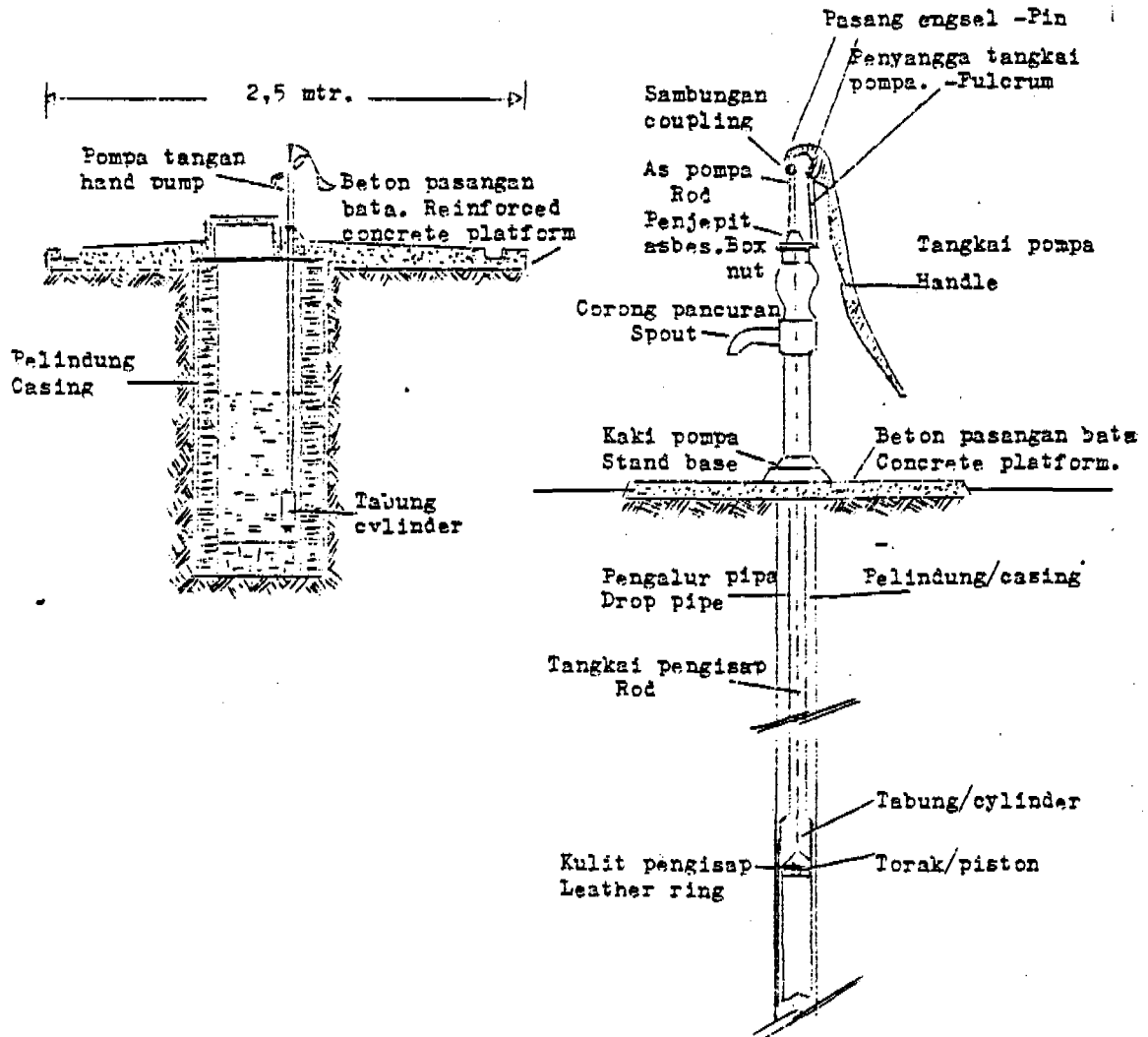
IMPROVEMENT OF THE WELL AND
HAND PUMP INSTALLATION-

KETRANGAN POMPA TANGAN

Lubrication and spare parts replacement of the pump on the spot.

Instruksi teknis untuk pemilik kesehatan.

Technical instructions for the maintenance for the field sanitarian.



KETRANGAN:

- Tangkai pengisap= Oli per minggu.
- Pasak engsel= Oli per minggu, periksa per tahun.
- Besi= Cat per tahun.
- Beton pasangan bata=Bersih setiap hari, kalau ada kerusakan.
- Tabung valve= Periksa setiap per tahun
- Kulit pengisap= Periksa setiap per bulan perhatikan bila ada kelainan.

MAINTENANCE

- Rod: Lubricate weekly.
- Hinge pins: Lubricate weekly, check annually.
- Exposed ironworks: Paint annually.
- Concrete platform: Clean daily, repair as necessary after any damage.
- Plunger valve: Check annually.
- Leather ring: Constant look-out on symptoms. Monthly check.

Fig. 5.11. Handpump Maintenance Instruction Sheet for Sanitarians (Indonesia).

INSPECTION OF PUBLIC HANDPUMPS

Date:.....

K a b u p a t e n :

K e c a m a t a n :

D e s a :

Exact place, kampung + block :

Responsible for maintenance :

Type of well : tube/dug well

Depth of well/or screen :

H a n d p u m p : present/removed/never installed

Pump installed/date/by :/.....

Pump out of order since/date :/.....

Type of pump : suction/lift pump

Manufacturer of the pump :

Material lining dug well :

Material suction pipe, size : iron/p.v.c./

Material screen : slatted iron/p.v.c./Johnson

Depth of water level if known : landsurface meter

Capacity measured : lt/5 minutes

Cap. increasing in wet season : yes/no

Cap. decreasing in dry season : yes/no

Number of users :

Used for drinking water : yes/no

Is preference given to other
water supply : yes/no why ?

Nearest toilet : meter

Taste of water : good/salt/muddy/.....

Smell of water : normal/bad/.....

Colour of water : normal/light/milky/brown

Construction general : good/normal/bad/out of order

H a n d l e : good/normal/bad/out of order

Bearings, levers : good/normal/bad/out of order

Seals, leakage : good/normal/bad/out of order

Sub structure, concrete slab : good/normal/bad/out of order

Spoil gutter, surrounding : open/clogged up/not existing

Reservoir : not existing/dimensions

Distance to hearest well/handpump :

Pump protection : with/without guard, fencing, pumphoom

Water sample taken : yes/no

Under pressure during pumping : yes/no

Pump paid by/price :/.....

6.4. TANZANIA

In Tanzania, a maintenance system for the handpumps has been selected, field tested in several Regions, and is being further developed.

Initially, two alternative systems were considered:

- (1) centralized maintenance, with two complete check-ups annually per well.
- (2) decentralized maintenance with responsibilities delegated to the villagers, and decentralized repair groups.

Under the early, centralized system, the pump maintenance organization did consist of three sections: a maintenance section, consisting of a number of maintenance teams, each operating in a specific area; a laboratory section; and a repair section.

The work of each inspection team would include:

- inspection of the pump head mechanism (above ground), and carrying out any necessary repairs.
- dismantling the lower parts of the pump if these are not operating effectively. If the pump cylinder is out of order, it is replaced by a spare one and the defective unit is returned to the central workshop for repair.

The work of the laboratory section would comprise the examination of all relevant constituents in the water samples taken by the inspection groups.

The work of the repair section would involve the repair of the concrete platform and the surroundings of pumps.

Every six months, each hand pump would be taken apart and completely serviced.

After careful study, it was decided to decentralise the handpump maintenance system, in order to obtain a considerable reduction of the maintenance costs. In the decentralised system the first responsibility for pump maintenance rests with the village communities themselves. Each village is required to appoint one or two men (or women) to receive a basic training on pump maintenance after which they are appointed as pump caretakers.

Their duties include:

1. daily

- check operation of the pump
- control bolts and nuts to be tightened
- clean the slab
- clean the drainage gutter
- surround the well with minyara or thorns to prevent cattle from entering the area of the well
- prevent the pump platform from being used as a working area
- prevent the pump surrounds from becoming a children's playing ground.

2. monthly

- check damage, rotting of wood, insects in wooden handle etc.
- grease or oil all pivot points and oil the wooden handle and upright
- inform if capacity or quality of the water has diminished
- check concrete slab and repair the cracks with some mud or stones.

To support the village pump caretakers, maintenance offices have been established at the district level. A District Maintenance Officer (D.M.O.) supervises all pump maintenance and is in charge of the inspection groups in his district. Major repairs are carried out by a repair section as in the earlier, centralized system.

The District Maintenance Officer's task is to check the village pump caretaker's maintenance work, to help with the larger repairs and to ensure the provision of spare parts. He is required to keep records on all handpumps in his district. In several regions, the District Maintenance Officers each have a motorcycle on which a large box is mounted for tools and spare parts. Experience in Shinyanga Region and in Morogoro District shows that one inspection group can carry out about 300 pump checks per year. A frequency of two checks annually per pump has proved to be adequate. The number of pumps that can be controlled by one group, is thus fixed at 150. The distance between the pumps plays an important role, and for wells and pumps in less sparsely populated areas than Shinyanga Region the capacity per group may be considerably higher.

In the centralized maintenance system the annual maintenance costs per pump in a situation comparable with Shinyanga Region (about 800 wells spread over an area of 50,000 square kilometers) were in the range of TSh 1,000 to 1,500 (approx US \$ 130-200!).

In the decentralized maintenance system the costs were considerably reduced to about Shs 700 (approx US \$ 95) per pumps per year.

Costs may be further reduced by introducing a system whereby the villages are charged for the maintenance of their pump. The pump and well would become the property of the villages, which would have to buy any spare parts needed from the District Maintenance Officer. The costs of spare parts may be estimated at Shs 300,-- (approx US \$ 40) per pump per year. For an average 300 villagers using a pump, the direct maintenance cost would thus amount to Shs 1,-- per person per year.

<u>Periodical Check-up</u>								
Date of check/	Controlled/ repaired by	Well dry?	General impression of			Pump re-paired	Water sample	Remarks/ action taken
			well cover	well sur-rounds	pump			
30.2.76	maintenance	no	ok	mess	ok	-	yes	drain cleared out

Fig. 5.12. Maintenance Report Sheet used in Shinyanga Shallow Well Project (Tanzania)

Health education and instruction in the importance of safe drinking water supply, is intended to be an essential part of the handpump maintenance activities. Instructional materials for these purposes, were produced.

An evaluation of the handpump maintenance system in Shinyanga Region (Tanzania) was carried out in November 1982. The survey indicated that about 70% of all pumps were out of order at any given time. This was due to technical reasons for about 30% of the total number of pumps, the other pumps being out of order for other reasons. The period of time the pump has already been inoperative, could be established accurately in only 10 cases; the average period was 4 months.

A selected sample of maintenance record cards of handpumps was analysed for frequency and length of breakdown. However, the maintenance card records were rather incomplete, and the findings are indicative only. The analysis showed;

- (i) intervals between major repairs on the pump cylinder assembly were, on average, 15 months; the range was 6-26 months. The most common repair was replacement of worn foot valves, the second most common frequent repair was on the piston assembly;
- (ii) repairs on the above-ground pump (pumpstand) were reported in a few cases only; the interval of such repair ranged from 9-29 month, on average about 18 months.

It was found that spare parts were not available, and the maintenance system suffered from enormous logistical problems i.e. transport, communications, and failure reporting.

It was clear that the main problem was to keep the pump working, that is to maintain them. Either the performance of the maintenance system must be greatly improved, or other means of drawing water from the well must be accepted that are more reliable or easier to repair. The bucket-and-rope system using a windlass would have to be considered as an alternative to the handpump. The shallow well design as developed in Shinyanga would be suitable for mounting a rope-and-bucket with windlass, if this type of open well is to be choice of technology.

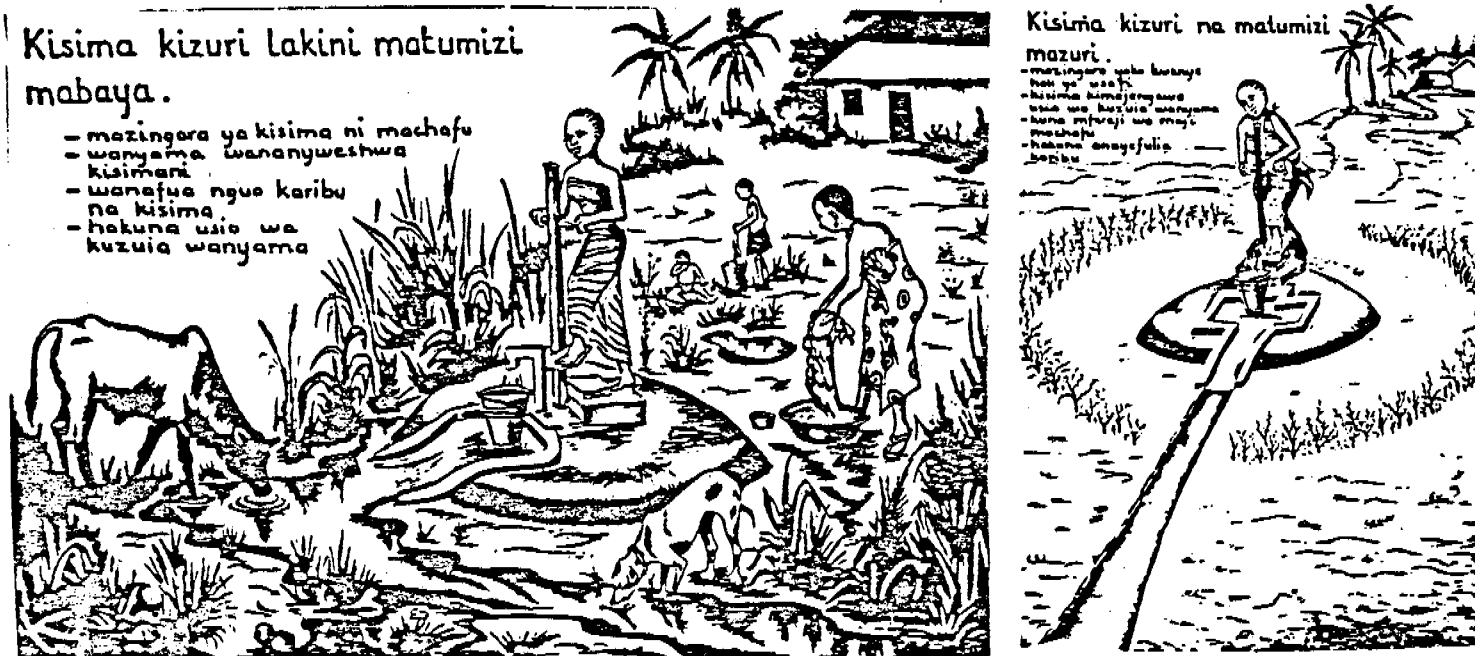


Fig. 5.13. Instructional materials used in Tanzania

5.5. MALAWI

In Malawi where 90% of the country's population lives in the rural areas, a programme has been carried out for the drilling of tubewells (35 - 45 m deep) on which handpumps were fitted. About 5,000 of such tubewells with handpumps are spread across the country. Full coverage of the country is planned to be reached by 1990. To maintain the pumps, there are 20 special teams who inspect them regularly and make urgent repairs on request. The system worked fairly well, but it has the major disadvantage of high costs. Each borehole serves about 130 people and costs about US \$ 4,000 to construct, i.e. US \$ 30/capita. The annual maintenance cost is about US \$ 70 for each tubewell and pump! At this price, Malawi which has a per capita income of US \$ 140 simply cannot afford to provide tubewells for the entire population. Moreover, because of the complicated techniques used for well drilling and pump maintenance, it is difficult for the villagers to contribute any labour to bring costs down.

A new system of maintaining handpumps is being developed in the Upper Livulezi Integrated Project for Rural Groundwater Supplies. This is a project of 4½ years duration under implementation by the Department of Lands, Valuation and Water (Office of the President and Cabinet). The main work has been carried out in the first 1½ year period, and is being followed by a 3 year period for establishing a low-cost maintenance system.

The new handpump maintenance system is set up as a multi-tier organisation which will involve a maximum of community participation at the village level. It will comprise:

Central Government/Departmental Level:

- (a) Planning and strategy (handpump policy)
- (b) Research and development in handpump design, with the major target to minimise and simplify maintenance
- (c) Training of district pump technicians
- (d) Procurement of pumps, spares, tools and equipment
- (e) Monitoring of the maintenance programme
- (f) Distribution of equipment to district stores

District or Regional Level

- (a) Supervision of about 1000 pumps by a trained technician (District Pump Technician) with support driver and one vehicle (1 ton pick-up)
- (b) Store for spares
- (c) Maintenance records for all water points within district
- (d) Training of area pump mechanics
- (e) Liaison with District Development Committee
- (f) Periodic inspection of area water points
- (g) Repair or replacement beyond capabilities of area mechanics
- (h) Estimate of annual maintenance requirements for spares etc.

Area Level

- (a) Area Pump Mechanics chosen on the basis of skills shown during construction phase. Further training by District Pump Technician or DLVW training courses. Supervision of about 50 pumps.
- (b) Visits to each pump/village at least once every four months (bycicle)
- (c) Recording all repair work and reporting to District Pump Technician.

Village Level

- (a) Village Pump Attendants chosen by the village Development Committee responsible for all pumps in one village (could be men or women).
- (b) Attendants ensure that the pumps are properly used, pump surrounds are kept clean and acts of vandalism are prevented.
- (c) Minor replacement, preventive maintenance and all simple repairs will be effected at this level. When major repairs or replacement parts are required the attendants will notify the Area Pump Mechanic.
- (d) The attendants will be trained on site by Project Assistants at the time of installation.

A new system for maintaining handpumps is being developed in Malawi. The aim is to reduce the maintenance costs to US \$ 20/year. Pumps of sufficient durability are needed, with a useful life of 10-15 years, and for this purpose the MALDEV pump has been developed. Field performance of the pump so far has been excellent at pilot installation sites. It is being subjected to extensive field trials in collaboration with the UNDP/World Bank Project for Testing and Technological Development of Rural Water Supply Handpumps.

An essential element of the new maintenance approach is that each community has to appoint a pump attendant, to assume responsibility for the regular maintenance and minor repairs of the pump. Training of the pump attendants is provided by the government, through a training course of five days duration. The course programme includes the following items:

- Strip down in the workshop a handpump of each model representative of those installed in the area.
- Describe the general layout of the pump, indicating all fittings and explaining their respective functions.
- Ensure that each trainee becomes familiar with all the working parts, and understands the operation of the pump.
- Demonstrate and thoroughly practise the fitting of replaceable parts, i.e. for maintenance and repair. Reassemble each model of handpump.
- Carry out practical demonstration on cutting and threading G.I. pipes and mild steel rods.
- Ensure that each trainee practises this exercise thoroughly.
- Demonstrate points for lubrication to reduce wear on moving parts.
- Explain in detail the technique of identifying pump troubles at an early stage!
- Demonstrate the correct procedure to be adopted when extracting a handpump from a borehole.
- Demonstrate the correct procedure to be adopted when inserting a handpump into a borehole.
- Stress the need for cleanliness, both of the pump and the surrounding area, and the simple rules which should be observed to avoid contamination of the pump and well.
- Discuss the relationship between water and disease.
- Explain the procedures for reporting breakdowns to have repairs carried out.

6.6. IVORY COAST

Ivory Coast has been using , since 1975, in its well drilling' and small-diameter borehole programme, fully covered wells equipped with various types of pump.

The maintenance of the pumps and other devices for drawing water, is the responsibility of the operating organisation for urban water supply, SODECI. The maintenance costs are financed from a special surtax on the selling price of the water in the urban areas. An evaluation report of the European Development Fund (EDF) stressed the point that this system has been possible by "several, particularly favourable conditions allowing it to function: a purchasing power that is sufficiently high to have a sliding-scale tariff system, a relatively low cost price of the water in the capital, a sufficient quantity of water being sold, etc".

The maintenance service for the rural village handpumps which uses vehicles with workshop equipment and fitted with radio for communication, is operating satisfactorily thanks to the available heavy-duty highway infrastructure. Repair of broken down pumps is effected within 48 hours (maximum) after the pump breakdown has been reported; a fine is to be paid by SODECI, if the pump is not repaired within 72 hours.

However, the increasing costs of spare parts, fuel, and personnel makes the financing of the maintenance system more and more difficult, in spite of the favourable conditions existing in Ivory Coast, as outlined above. In 1982, a change had to be introduced under which the communities are being charged to pay for effected repairs. The system for determining the retribution from the communities is not yet established in its final form.

The maintenance system, although technically satisfactory, has a very high cost, as it requires a considerable amount of infrastructure and equipment (radio's for communication, vehicles, highway network, etc).

This means that this system is probably not possible in countries where the urban water users do not have the economic capacity to subsidize the rural sector, e.g. in Niger where the urban population forms less than 10% of the total population.

6.7. GHANA

Introduction

The regional Handpump Maintenance System was implemented between 1974 and 1978 in the Upper Region of Ghana in support of the installation of 2,400 wells equipped with handpumps. This was part of Ghana's Upper Region Water Supply Project, jointly financed by the Government of Ghana, through the Ghana Water and Sewerage Corporation (GWSC), and the Government of Canada, through the Canadian International Development Agency (CIDA).

The well design and construction were carried out in a manner which would minimize the need for maintenance. Similarly, great care was exercised to ensure the selection of handpumps, which would require a minimum of maintenance. It was evident that the ultimate success of the entire project would depend upon the effectiveness of the handpump maintenance system.

Generally, a pump malfunctions when the screen is clogged, the leather-cups have become worn, or the water table has dropped. In most cases, handpump mechanical failure develops where the pivot points become worn or the handle is broken due to rough usage.

It is desirable, therefore, that each well be checked and serviced periodically. This entails an inspection of the exterior working mechanism, lubrication of the bearings and replacing the worn out parts. At the same time, an examination of the pumping capacity would indicate if a major below-ground problem existed.

The Maintenance System

The amount of servicing which the wells and handpumps would actually require was the most important factor that determined the organizational structure, capital outlay, manpower, transportation and equipment requirements of the maintenance system.

The strategy adopted was to:

- (i) establish the well maintenance activity within the existing GWSC organization, with control at the regional headquarters;

- (ii) operate the well maintenance system from five district centres;
- (iii) construct and equip workshop facilities at the headquarters and at the district centres;
- (iv) conduct maintenance of handpumps as two separate activities;
 - (a) inspection and minor repairs on a 2 to 3 month frequency;
 - (b) complete pump service on "as required" basis.

In order that rural wells and handpumps service would not have to compete with other services in the region, such as urban water distribution systems, it was set up as a separate function.

Personnel

The GWSC Regional Manager was responsible for the maintenance scheme and provided general direction. He was assisted by the Maintenance Engineer and Field Supervisor who were responsible for the proper functioning of the system.

A total of 250 field and workshop staff comprising a core of trained technicians and mechanics were assigned. Most of the staff were newly-hired. However, it was found desirable to use some of the existing staff to fulfill some of the new functions and this facilitated training.

Training for the experienced staff was aimed at upgrading their organizational and technical skills through on-the-job experience. Newly-hired staff received training in the maintenance, servicing and repair of handpumps; and in record keeping, related to work performed and materials used. The experienced staff were used to train the newly-hired through on-the-job and formal sessions.

Transportation and Equipment

The vehicles, and the mechanical and electrical equipment for the districts and workshops were carefully selected, after consideration of the levels of service to be provided at each district.

Vehicle access to a large portion of the handpump sites involved difficult terrain, following trails, footpaths and crossing cultivated fields. Thus transportation throughout the rural areas, especially during the rains and the growing season, was of particular concern.

Due to the poor access to the pumps, because of the limited road network, and due to the ever increasing cost of fuel, it was decided to utilize lightweight trail motorcycles* for routine inspection of the handpumps.

Each mechanic with motorcycle would visit about 50-110 handpumps each month, for inspection and minor repairs, and to report the need for major repairs to the mobile maintenance service. Complete field servicing of a handpump required the availability of at least two men having a service vehicle, equipped to remove and replace the handpump, drop-pipes, cylinder, leather-cups etc., that is all below-ground components.

The type and number of service trucks located in the districts were dependent upon the number of wells to be serviced and the distances to be traversed. These trucks were equipped with front-mounted winches; rear-mounted derrick facilities; compartments on both sides of the truck for storing spare parts; tool boxes full of accessory tools and equipment.

Workshops and Stores

In establishing the workshops, consideration was given to the level of services to be provided at the regional headquarters and in the districts. Five workshops were established.

Maintenance workshop operations consisted of:

- (i) repair, service and maintenance of vehicles (trucks* and motorcycles);
- (ii) repair of handpumps;
- (iii) repair, service and maintenance of mechanized pumps;
- (iv) storage and control of supplies and equipment.

Generally the workshop buildings incorporated the following facilities:

- (i) offices for supervisor/foreman;
- (ii) stockroom for pump and vehicle parts;
- (iii) sanitary facilities;
- (iv) maintenance and repairs sections.

* Honda CT 90 motorcycle equipped with special box to carry maintenance tools and spare parts.

²) Eight GMC one-ton trucks were distributed over the five maintenance districts.

At the Regional Stores Depot, a complete stock of pump, vehicle and equipment spares and consumable supplies was maintained. At the district depots only stocks of fast moving parts and consumables for pumps and vehicles were kept.

The Regional Stores had responsibility for the procurement of local supplies including: petrol, gas-oil, lubricants, cement and disinfectants required for well maintenance. Also, they were in charge of the identification and scaling of a large quantity of off-shore running spares, consumables and equipment.

Supplies were distributed to the districts and field under a controlled stores ledger system.

Operation of the Maintenance System

The Headquarters of the Maintenance Service was set up at Bolgatanga, the regional capital, where the Regional Stores Depot and the major repair workshop for pumps, vehicles and equipment are located. Here too a complete set of records of all the wells in the region was kept on file and up-dated as data were submitted from the District Maintenance Centres. Communication between Headquarters and the District Centres was facilitated by radio communication.

Field operations were carried out within five maintenance districts at Bawku, Bolgatanga, Tumu, Lawra and Wa. In each district, a system of motorcycle inspectors, service truck crews and workshop facilities was provided.

The operation was first established on a pilot stage in one district - Bawku -and on a successive district by district basis, until the entire region was fully serviced.

Each of the district organizations operated independently under the general direction of the Regional Headquarters, represented by the Maintenance Engineer and Field Supervisor. The District Officer was responsible for the repair, servicing and maintenance of handpumps and wells in his district.

Maintenance Inspectors utilized lightweight trail motorcycles for routine inspections of the handpumps, along designated routes within the districts,

providing a site visit every 2 or 3 months. They also carried out lubrication of pumps, provided preventive maintenance as well as made minor repairs and reported on pump failures. On the average 80% of the total handpumps in the region were inspected each month. The motorcycles themselves were non-operative due to breakdown and repair, for almost 50% of the time. The service life of the motorcycles proved to be only 1-3 years. The short service life of the motorcycles results in an excessive cost under the budget post "Equipment and Material".

Eight specially equipped service vehicles operating from the District Centres carried out repairs on handpumps which were beyond the means of the Maintenance Inspectors. These units did not make routine inspections, but responded only to the reports from the mechanics or the villagers, of pump failures. The vehicles were non-operative, due to breakdown and repair, for about 40% of the time. The estimated service life of the vehicles was 3-6 years.

Each reported breakdown of pumps was scheduled into the work programme of the service vehicles. Normally a response time of pump repair was at least 3-4 days after a failure was reported. Since there was usually more than one well in each community, these adjacent pumps were available in the interval period.

The service vehicle crews also undertook maintenance and repair of mechanized well pumps and periodic chlorination of the wells and pumps.

Reporting and Maintenance Records

Proper communication among the maintenance staff themselves on one hand and between them and the rural villagers on the other was particularly important in the early stage of the maintenance system implementation.

In fact, part of the reason for such frequent inspections of handpumps was because there was a lack of adequate communication facilities. Therefore, the routine inspections, in fact, provided the reporting system of needed repair of the handpumps. Thus, procedures and lines of communication for reporting had to be clearly spelt out.

A record system was incorporated into the maintenance system so that a history of repairs for each handpump could be filed. The records were used as a basis of organising the routine servicing of each pump. Other uses were for stocking of spares, upgrading maintenance procedures and for programming future maintenance activities throughout the region.

Operating Costs

As the handpump maintenance system was established as an integral part of the GWSC regional maintenance organization, it was difficult to assess the exact operating costs of it. Even though efforts were made at the initial stages to keep separate accounts of the maintenance operations, things fell apart due to lack of interest by the responsible staff.

The nature and scope of operating costs involved:

- (i) operating cost of service vehicles;
- (ii) operating cost of workshop and repair facilities; and
- (iii) manpower costs.

Being part of the regional maintenance structure, facilities such as personnel, buildings, equipment and vehicles were shared with other units. For example, some of the headquarters management, accounting and records personnel, had regional responsibility. Also, in order to avoid duplication of functions in the District Centres some of the staff such as accounting, general services and security personnel were shared performing dual functions.

Pump Performance

Pump performance and well site conditions are a reflection of the efficiency of the maintenance system. These were monitored monthly through the record system. A survey was conducted at the end of the third year's operation of the maintenance system to assess the prevailing sanitary conditions. The findings were as follows:

- (i) 83% of all the pumps in the region were in operation. The relative performance by districts varied between 68% and 90%.
- (ii) For these pumps out of service about 11% involved features above the pipe flange and could be repaired by the Motorcycle Inspector. The

remaining 89% needed service trucks to hoist below-grade components to carry out the needed repair.

- (iii) A visual inspection of these pumps which were still in operation revealed that:
 - (a) 63% were in good condition
 - (b) 28% were in fair condition
 - (c) 5% were in poor condition
 - (d) 4% were in very poor condition.

The survey results verified the accuracy of the on-going District Maintenance Records and the monthly reports monitoring the percentage of pump operating at any point in time. It also provided an accurate picture of the field situation.

Site Conditions

It was observed that at 56% of all handpump/wells some site improvements had been carried out by the users. Of the wells inspected 38% had back-fill placed around the concrete platform, while an additional 18% had extended concrete slabs constructed by the villagers. Well site sanitary conditions were considered to be:

- (a) 52% in good condition
- (b) 35% in fair condition
- (c) 13% in poor condition

Field Operations

- (i) To optimize the efficiency of the Motorcycle Inspectors, site visits preventive maintenance and minor repairs were added on. Additionally, to avoid unnecessary duplication of site visits, service crews conducted some inspection on handpumps which were in close proximity to defective units, which they visited for complete field servicing.
- (ii) Field records were analysed and general statistics were developed on the down-time on:
 - (a) pumps, motorcycles and service trucks;
 - (b) number of pumps visited per day worked by motorcycle and truck;
 - (c) percentage of pumps inspected which required service trucks.

These were used to establish time-targets for repairing pumps in each district.

- (iii) Due to the ever-increasing cost of fuel and sometimes its unavailability in the region, it was decided to change from using petrol trucks to diesel trucks. The benefit was in terms of lower operating costs and more reliability.
- (iv) The handpump water supply systems installed in the dry region were not designated to include the provision that livestock could be watered and small gardens irrigated. Nevertheless, it was observed that small dug-outs or water holes existed at about 70% of the well sites. Of a total of 1178 water holes, 792 of them (67%) were considered unsatisfactory because they were less than 20 feet (6 metres) from the well.

However, evidence of excessive animal excrement around the well heads was observed at less than 1% of the wells, in spite of the fact that animals regularly came to many of the well-site water holes. It was similarly observed that the number of small vegetable gardens in the vicinity of the well sites (in some of which fertilizer was applied) was increasing. Even though these activities would generally have a positive economic effect, their nearness to the well sites generated unhygienic conditions, and a pollution hazard to the water supply.

- (v) The routine inspections provided the necessary community involvement and training input required with the introduction of the new handpump water supplies to the villages. For example, on-site training was imparted to the rural population who were not accustomed to using mechanical equipment such as handpumps.
- (vi) Certain parts of the record system such as measurement of static water levels would prove useful to future hydrogeological investigations.
- (vii) The personnel involved in the maintenance programme coped very well with the new work procedures and tasks. They acquired a much higher social status at the village-level than was originally envisaged. Their visits to the well site proved useful in communicating with the villagers and educating them regarding pump usage, water conservation, hygiene and sanitation.

Village Involvement in Handpump Maintenance

It was evident that most villagers were willing to participate in maintenance and able to help improve the overall pump performance and well site conditions if encouraged to do so.

Based on recent experiments which showed that the below grade components of handpump could be removed, repaired and replaced manually, without using a service truck, it is feasible that the villagers could eventually provide a complete maintenance and repair service for their handpumps. Obviously, a few locally made special tools would be needed to facilitate such manual servicing. But it will undoubtedly take several years training before this can be achieved.

In view of the ever-rising cost of maintenance, the inherent problems of vehicle breakdowns, and the encouraging response by the villagers, this approach is now being developed.

DISTRICT MONTHLY REPORT

District Month ending 19..

- From Motorcycle Inspection Log
 - No. of hand pumps inspected
 - No. working on arrival
 - No. working but repaired by motorist
 - No. not working and repaired by motorist
 - No. working but requiring service truck
 - No. not working and requiring service truck
- No. of hand pumps reported not working by villagers but not reported by motorist
 - No. of hand pumps reported not working by villagers and also reported by motorist
- No. of hand pumps serviced
 - No. of pumps requiring service at month end
 - No. of mechanical pumps serviced
- Hand Pump Inventory

TYPES OF PUMPS			
.....

 - Hand pumps on wells in District at end of last month
 - Hand pumps removed from old wells
 - Hand pumps installed on old wells
 - Hand pumps installed on new wells
 - Total hand pumps on wells in District at end of month
 - Hand pumps in stock requiring repairs
 - Hand pumps in stock ready for installation
- Vehicle usage

.....	miles travelled	gallons of fuel	m.p.g.

 - Motor Cycle No
 - Motor Cycle No
 - Service Truck No.
 - Service Truck No.

SERVICE TRUCK REPORT

Date

District Service Unit

Travelling time Time spent on site

Well number Village

Type of pump Static water level taken Yes No
(from top of concrete base)

Pump operating on arrival Yes ... No ...

Work done	Parts replaced	
	Number	Name

Comments:

3 Copies

- Write to Region Officer Serviceman's signature
- Carry to District Office
- Pink remains in Report Book Serviceman's name

VEHICLE DOWN TIME

NOTE: RECORD ONLY WORKING DAYS VEHICLE WAS NOT USED

District Month ending

Vehicle No No of working days

No of days worked

Date	No work to do	No Operator	No petrol	Mech problem	weather	other

WELL SERVICE RECORD

Well No

District Village

Well Location

Type of pump

Date well drilled Depth of well

Diameter of casing Recommended yield lqpm

Date serviced	Pump operating on arrival		Work done	Parts replaced		Static water level
	Yes	No		Number	Name	

RECORD OF BROKEN-DOWN HAND PUMPS

District Month ending

Well No	Type	AG	BG	Date down	Date repaired	Remarks

RURAL WELL INSPECTION LOG

Well No.	Date	village	Odometer reading	Well operating on arrival		Work done	Parts replaced	Service Truck required	
				Yes	No			Yes	No

Fig. 5.14 Examples of Maintenance Reports and Records as used in Ghana.

6.8. TOGO

In spite of generous rainfall, most parts of Togo are in the dry season, depleted of surface water and only a few areas have phreatic groundwater (e.g. Tsevie, Kouvie, Kpalime regions). For about one hundred years already, cisterns storing rainwater have been in use, but this type of water supply can provide only limited quantities of water. In recent years, well drilling and handpump installation have become of greater importance.

The European Development Fund selected for its well drilling programme the "Hydropompe Vergnet" foot-operated pump. Efforts are made to train the villagers in the maintenance of the pump, and the replacement of parts. This specialised training of villagers is the responsibility of two teams of Togolese mechanics who have been trained in France by the manufacturer of the "Vergnet" pump. Since 1978, the training courses provided by these teams of mechanics have resulted in the development of a methodology and the preparation of special documents as training aids. The training is directed to the teams that are responsible for promoting community participation and health education with the rural population. It also supports the installation of the pump, and provides a guidance for the training of pump caretakers in the villages.

Health education and the promotion of community participation are provided with the objective of increasing the understandings of the villagers for the problems of hygiene and water use. The training of the village pump caretakers and of the women responsible for daily cleaning of the pump platform is also connected with the health education effort.

The first results show that trained villagers (often bicycle repair men) were perfectly capable of replacing pump parts and connecting rods, and of re-assembling the pump. In contrast, the health education results and the understanding of the villagers for hygiene and waste disposal problems leave much to be desired. It appears to be difficult for the mechanics to give, under the constraints of time and means, sufficient attention to the questions of community participation and hygiene as these are matters for which much time is needed. An evaluation would be desirable to determine the results of the maintenance system after three years of functioning, but the conclusions with regard to the technical capabilities of villagers may already be applied.

6.9. UPPER VOLTA

The prevailing hydrogeological conditions, with very limited surface water sources, and the dispersed population have forced Upper Volta, already for years, to use tubewell drilling and handpump installation for rural water supply. The envisaged coverage is to have, by 1985, about one modern water point per village; and, by 1990, to have 12,000 water points, about one per 250 inhabitants. A minimum of 10 liters of water daily per person is provided; by 1990, it should be increased to 25 liters daily.

Assisting the Government of Upper Volta, the European Development Fund, UNICEF, Communauté Economique de l'Afrique Occidentale (CEAO), FAC/French GTZ/West Germany, Netherlands, USAID, and the Islamic Fund will each be executing a rural water supply project in one (or more) of the country's regions. Other organizations involved in rural water supply, are the Volta River Valleys Authority (l'Autorité des Valées des Voltas) and various NGO's.

By 1985, the Government, through the Department of Water Affairs, Direction de l'Hydraulique, HER) will be responsible for the maintenance of some 10,000 wells and boreholes with handpumps (the 3,000 existing ones, as well as the 7,000 planned ones). In the past, the record of maintenance has been very poor. As HER was a centralized organization, all maintenance teams and equipment were located in the capital. There was no provision made for training community members or local artisans to carry out village-level maintenance on the handpumps installed. When a pump breakdown did occur and was reported by the village (which was often not the case) a maintenance team of HER would have to travel long distances over poor roads to repair the pump. Moreover, the necessary handpump spare parts were often unavailable from commercial dealers.

In addition to these infrastructural and logistics constraints, there are serious financial limitations. The real cost of the maintenance of pumps and replacement of defective pumps would amount to double the total annual budget of HER! The present situation is not satisfactory, and there is an urgent need to develop an adequate maintenance system for the village handpumps.

Recognizing these problems, the present priorities to develop a national handpump maintenance system are as follows:

- To decentralize HER and set up an HER regional office in each of the eleven district regions;
- To install a maintenance team service at each of the regional offices; they will be responsible for carrying out heavy-duty repairs, as well as providing support to village-level maintenance systems;
- To experiment with various organizational approaches to village maintenance in the pilot rural water supply projects;
- To develop a policy for funding the recurrent costs of maintaining handpumps;
- To develop a supply and distribution system which will ensure the availability of spare parts for the six or more types of handpumps installed throughout the country;
- To establish the legal framework which will permit the establishment and control of revolving funds at the district governmental level (sous-préfecture) in order to pay for the operating costs of the handpump maintenance service. This will involve, among other things, changing the fiscal laws so that the retainment of local taxes at the district level will become possible.

In the rural water supply project financed by the European Development Fund (European Economic Community) in the Yatenga and Comoë regions the project executing agency (BURGEAP), has established, on a trial basis, a three-tier maintenance system which is at present under consideration by HER for implementation in more regions, and ultimately throughout Upper Volta.

Regional district maintenance teams will carry out the major repairs and well lining; trained local artisans (bicycle repairmen) will be paid by the villagers to do regular pump repairs at the village level; and a pump attendant will be chosen by the village water committee to carry out preventive maintenance and minor repairs. The village water committee is responsible for the collection of the villagers contributions to pay for pump maintenance and repairs by the district teams. In this system, the village pump attendant's services would not be paid.

The economic feasibility studies conducted to determine whether it is within the villagers' means to pay for handpump maintenance have, found that this is the case. It is found that in collecting water from a traditional well, a family spends approximately 500 CFA a year for the rubber "container" and 400 CFA for the ropes, amounting to approximately 900 CFA a year. In comparison, the contribution of each family to a village maintenance fund would be approximately 1,000 CFA a year. This would provide, for an average of 50 families in a village, the 50,000 CFA it is estimated would be needed to finance the village contribution for handpump maintenance costs.

This would include paying the village pump attendant for his labour and travel costs, as well as for the handpump spare parts. For certain types of handpumps, i.e. the Vergnet and Volanta pump, the 50,000 CFA would probably also cover the payment of the regional maintenance service costs for the major repairs. Because of the design and nature of these pumps, the regional maintenance teams would not need heavy equipment or vehicles so that the overhead costs would not be high. Moreover, the replacement costs of these handpumps are relatively low so that their replacement may be within the financial means of a community.

A survey has been carried out in a number of villages, showing that the villagers generally have no difficulty in accepting to bear the costs of pump maintenance and repair, at the reduced level of CFA 50,000 annually per pump. These costs are certainly not high but when born by the government, they would represent a unbearable financial burden.

The situation as regards the ABI and India Mark II handpump, is different. The repairs for these pumps are much more costly so that the village fund would probably only cover the pump attendant's repair and spare parts expenses. Therefore, in those regions where the latter two types of handpump are used, a separate provision will have to be made to finance the major repairs and recurrent costs.

Community Participation in the Proposed Handpump Maintenance System

In implementing the three-tier maintenance system, there are a variety of arrangements possible for the community's participation, and for the degree

of responsibility entrusted to the village committee in managing the village-level maintenance and administrating the fund.

An "executive committee" consisting of a President, Treasurer, and Secretary would be the body to manage all financial matters such as paying for the pump attendant and the spare parts; probably also, paying the regional maintenance service for major repairs.

This type of arrangement is being implemented in the European Development Fund's regional rural water supply project in the Comoë and Yatenga regions. In this project, a great amount of emphasis is placed upon involving the community in all aspects of the planning and implementation of the water supply system, as well as organizing and training the community members to carry out the administrative and maintenance activities. Although this initial community mobilization, organization, and education phase will take six months, the project leaders view this degree of participation as essential and fundamental for the success of the project.

A similar arrangement for payment is proposed in the Volta Noire rural water supply project. Seventy five percent of what the committee collects would make up the committee funds which the committee would use to pay for the pump attendant, spare parts, and the repairs done by the HER regional maintenance service. The remaining 25% of what was collected would be paid to the HER regional district for its overhead costs of maintenance duties.

Another possibility would be that the committee would only be responsible for collecting the fund, passing it on to the regional district who would, in turn, pay the bills presented to it by both the village pump attendants and the district maintenance teams. The spare parts for the various handpumps would be stocked at the district warehouse.

In this three-tier maintenance system, HER will have responsibility for ensuring that there will be a supply of all the various handpump spare parts available. In the EDF project, the spare parts will be available from two commercial suppliers, one in each of the departments.

The problem with this type of arrangement is that the Vergnet pump manufacturer can only be obligated to guarantee that the spare parts are available during the life of the project. Although the logic could be put forth that it is in the Vergnet pump manufacturer's own interest to continue supplying and selling the spare parts afterwards, it is a fact that in the recent past when spare parts were needed in areas with boreholes equipped with Vergnet pumps, they were often unavailable at commercial dealers. One of the primary determinants of the success of the maintenance system is the ready availability of spare parts. For this reason, it is questionable whether an arrangement involving a commercial supply of spare parts would be the best to be applied on a country-wide scale.

The plan developed by HER for the national rural water supply programme also includes a provision for creating an on-going training programme for the rural maintenance mechanics. HER has arranged with each of the donor rural water supply projects that either the handpump manufacturer or the project itself will train two instructors at the National Training Centre for Professional Rural Artisans (CNAPR) in the maintenance of handpumps used. The instructor will, in turn, train the rural maintenance mechanics.

The fiscal laws have recently been changed, so it is now possible to retain taxes at the departmental level (the sous-prefecture). A part of the departmental budget could be allocated to the HER regional district office to cover part of its overhead costs, as well as the costs of the maintenance teams.

As mentioned earlier, various donor are executing rural water supply projects in the different regions of the country. Although the national water supply plan envisions the creation of a three-tier maintenance system, the projects are given freedom to experiment in implementing this. The extent of community participation, the way it is organised, and the techniques used, varies from project to project.

The Yatenga area of the EDF project is viewed as a test area for the effectiveness of a greater investment in community mobilization and education in the periods prior to, during, and after well construction and pump installation.

Coordination with Ministry of Health

The national rural water supply programme is to be a coordinated activity of the Direction de l'Hydraulique (HER) and the Ministry of Health (MoH). HER is responsible for the construction and maintenance of the water points, and the MoH is responsible for providing water-related health education in conjunction with the introduction of the new supplies.

In 1980, the MoH drew up a sectoral plan for an extensive primary health care programme based on a preventive approach in which a sanitary inspector at the sous-préfecture level will elaborate hygiene and sanitation plans and coordinate the activities of the itinerant health agent. Some 57 health inspectors will execute latrine construction campaigns, as well as supervise 7,000 village health workers who are to work with the village water or health committees.

Progress has been slow in implementing this primary health care programme, so that in many of the regions where rural water supply projects are being carried out, there is no existing community-level health personnel to perform education activities. If there are dispensary nurses in a village where a new water point is installed, their duties may be too time-consuming for them to have much time for health education activities. Moreover, when health education is given, it may not specifically be related to water and hygiene. It is reported that the Islamic Fund is allocating 6 million CFA in order to implement health education activities in conjunction with the introduction of water supplies.

A two year training programme for health inspectors is now awaiting the approval of MoH, and 22 candidates have been selected for this programme. Some 62 village health workers are currently undergoing a 2 month training programme in the USAID rural water supply project. The Voltaic medical officer for the Hautes-Bassins region is responsible for the health component of this project. He and the USAID public health specialist have drawn up a training course curriculum for the village health workers. This training programme is being tested in the project with a view to applying it in other areas of the country. This USAID project is the only example in Upper Volta of an integrated project for water supply, sanitation and health education. As such, it serves as a pilot area for developing and testing the effectiveness of such an integrated approach.

The National Centre for Health Education submitted a proposal for the health education component for the planned UNICEF water supply project. UNICEF's policy regarding its water supply project is that there must be a concurrent health education component to insure the hygienic use of the water.

Selection of Type of Water Supply Installation

The community participation is mobilized by a promotion team. Well drilling and handpump installation are only started after the acceptance by the village community of certain contractual conditions. The type of installation will be determined in full consultation with the population; they are asked to make the choice between a borehole or a well. The survey indicated that over half of the villages prefer a borehole. The possibilities of rehalitating existing water wells or boreholes, will also be studied. The final choice, obviously, will have to take into account the hydrogeological conditions and constraints.

In all situations, the well or borehole will not be constructed if the village does not agree to take responsibility for the maintenance of the pump. The village also has to express clearly that it wishes to have this type of installation.

Autorité des Aménagements des Valées des Voltas (A.V.V.)

AVV has been installing a considerable number of water points. Some 80% are boreholes equipped with ABI handpumps, the remaining 20% being shallow wells.

In the resettlement villages created by AVV, the village council selects a community member to be trained as a pump attendant.

The AVV has its own handpump maintenance team. The village pump attendants are trained in groups to carry out preventive maintenance, minor repairs as well as the simple replacement of parts. The villages are organized in blocks, six villages constituting one block. Each blok received one tool chest for each of the six pump attendants.

The villagers are required to pay for the spare parts for the pump. However, for major maintenance tasks, such as the relining of the well or the

replacement of the pump, AVV pays the costs. At present, there is no village committee fund to cover the cost of spare parts. Instead money for buying spare parts is taken from the "block" fund generated from the profit made by selling grain and cotton. When spare parts are needed, the village pump attendant must travel to Ouagadougou and purchase them from a commercial dealer.

The pump used in the AVV project necessitates the employment of heavy equipment in dismantling the pump. In practice, this maintenance system has not been successful. Because of the fact that the AVV maintenance service is centralized, and with the villages concerned located in various parts of the country, this centralized service is not really able to service the pump.

Plans exist to decentralize AVV's maintenance service as well as to make changes in the organization of the village-level maintenance. It is proposed that the village committee should collect a contribution from every family to cover pump maintenance costs and spare parts. However, the costs of ABI pump spare parts are very high, and further studies are needed to ascertain whether it is feasible to expect the community to bear the full costs. Furthermore, the ABI pump is not very well suited for village-level maintenance. Given the present strategy of AVV to maximize the villages' self-reliance, the ABI pump appears to be not suitable, and really in contradiction with this strategy.

A great problem in the AVV project is that the village pump attendants are not maintaining the hygiene around the pump area, nor cleaning the animals' drinking trough. This raises a question whether the health education has been effective. At present the health education related to water use and pump area hygiene is directed towards the women of the village. It appears that the village water council which is entirely composed of men, does not receive any health education.

6.10 NEPAL

In Nepal, in line with His Majesty's Government policy to decentralize responsibilities, the responsible Ministry is in the process of defining the specific functions for maintaining handpumps at village, District, Regional and Ministry levels. With due recognition of the fact that the eventual policy should be reached after a suitable period of transition, the envisaged allocation of responsibilities is as follows:

A. Village-Level

1. Routine inspection, maintenance and operation of the system.
2. Maintenance and repair of Standpipes. The boundry of responsibility shall be from and including the stopcock.
3. Provision of local materials and unskilled free labour for all maintenance and repair.

B. District Level

1. Technical, material and financial support for all repairs as requested by the Village Maintenance and Sanitation Committee through the Village Panchayat. The District responsibility shall be from the standpipe-stopcocks to the source.

C. Regional Level

1. Major repairs and rehabilitation of systems as requested by the District Panchayat for which the estimate exceeds Rs. 25,000. However, this figure may be raised or lowered in exceptional cases based on the technical judgement and at the discretion of the Regional Directorate.

D. Ministry Level

1. Supervision and support for the overall implementation of the maintenance programme.

The following gives a description of the envisaged responsibilities in the above maintenance system:

A. Village Level

1. Forming a Village Maintenance Committee (VMC) which shall be a sub-committee of the Village Panchayat.

The Village Maintenance and Sanitation Committee should consist of:

- a. One member from each separate user group.
- b. Ward-Chairman of the area served by the water system.
- c. One representative from school and health post if appropriate.
- d. At least two members should be women.

The chairman of the VMC shall be selected annually by the members and must be residing within the area served by the water system. The Pradhan Panch may be an ex-officio member of the VMC. The tenure of office shall be decided by the Committee subject to the approval of the Village Panchayat.

2. The Village Maintenance and Sanitation Committee shall be responsible for:
 - a. Operating, maintaining and protecting the water supply system.
 - b. Appointing and supervising the Village Maintenance and Sanitation Worker (VMSW) who should be nominated and trained during the construction phase. In case no VMSW has been previously selected, the committee shall select a suitable villager.
 - c. Ensuring tools and spare parts left on site after construction are stored and used properly by VMSW and that replacements are obtained from the District Technical Office.
 - d. Arranging for appropriate remuneration, either in cash or kind. for the VMSW. The VMSW's remuneration should be based on the number of standpipes, length of the system, and the ability of the village to pay.
 - e. Organising provision of local materials and unskilled voluntary labour.
 - f. Resolving social disputes and preventing vandalism and misuse.
 - g. Ensuring environmental protection of the source.
 - h. Educating community in their responsibility for proper system use and maintenance.

- i. Maintaining a project file and keeping records of repair work and minutes of meetings.
- j. Requesting support for major maintenance through the District Panchayat.
- k. Each standpipe user group's representative on the VMSC shall be responsible for ensuring:
 - Maintenance of standpipe and the surrounding area.
 - Collection of money, materials and voluntary free labour for tapstand repairs.
- 1. Encouraging proper use and maintenance of latrines in schools, Panchayat buildings, Health Post and other institutions, if any.
- 3. The water supply beneficiaries shall be responsible for:
 - a. Forming the Village Maintenance and Sanitation Committee (VMSC)
 - b. Contributing to the remuneration of the Village Maintenance and Sanitation Worker.
 - c. Providing local materials and voluntary labour as requested by VMSC.
 - d. Notifying the VMSW or VMCS member of any fault or potential problem in the system.

B. District Level

The District shall:

- 1. Assume overall responsibility for the maintenance of all water supply and sanitation systems constructed by the District Panchayat and Regional Directorate.
- 2. Allocate an adequate percentage of the development budget for maintenance of all village water supply and sanitation systems in the District.
- 3. Create a Maintenance Unit in the District Technical Office (DTO) consisting of at least one Overseer and two Technical Assistants.

4. Establish a store for spare parts and other maintenance materials:
 - a. Establishing a system and budget to replenish stocks.
 - b. Fixing cost of tapstand repair items at a subsidized cost to be purchased by the villagers.
5. Implementing repair work for which the cost estimate does not exceed Rs. 25,000 per system including skilled labour, transportation and spare parts from the DTO store.
6. Regular inspection by maintenance unit staff of each completed system, maintaining inspection records and preparing consolidated annual reports for forwarding to the Ministry through the Regional Directorate.
7. Assisting the Village Panchayat and VMSC in resolving social disputes.
8. Training VMSC's and VMSW's in the District with support from the Regional Directorate, if necessary.
9. Requesting Regional Directorate for major repairs and rehabilitation of systems with cost estimates over Rs. 25,000 per system.

C. Regional Level

The Regional Directorate shall:

1. Implement major repairs over Rs. 25,000 within available annual budget.
2. Implement rehabilitation of systems which should be treated as new projects.
3. Procure, or request the Ministry to procure materials as requested by the District to replenish stocks of spare parts and materials. Payment for procurement will be the responsibility of the District.
4. Provide training of relevant District officials.

D. Ministry Level

The Ministry shall be responsible for:

1. Formulating policies and guidelines.
2. Ensuring the allocation of annual budget and necessary manpower to the Regional and District levels.

3. Ensuring the inclusion of a maintenance component in each District Development Plan.
4. Procuring materials for District offices, if necessary, at the request of the Regional Directorate.
5. Maintaining records of the maintenance programme.

6.11 SRI LANKA

In Sri Lanka, an organisational structure for maintaining handpumps is being set up which will include the following:

- a) The Caretaker of the Community Centre for each pump
- b) The Community Centre for wells in its area
- c) The local authority concerned
- d) The A.C.L.C. of the district
- e) The Regional Office of the National Water Supply and Drainage Board.

The Caretaker will be directly responsible to the Community Centre for a well and its pump(s). Where necessary there could be another representative from the Community Centre to perform certain functions of the Caretaker are as follows:

- Lubricating the pump(s) on a weekly basis as shown in the maintenance manual.
- Replacing the plunger cups and connecting pins as shown in the maintenance manual.
- Maintaining the stores required and contacting the Technical Officer of the Local Authority concerned and/or the Technical Officer of the A.C.L.C. when the pump(s) need major repairs, when there is a lack of spare cups and pins, and when general advice about the pump or well is required. (All repairs other than the routine connecting pin and plunger cup replacement are considered major).
- Being responsible for the security of the well and the pump(s).
- Keeping records of pump maintenance and repairs, maintenance of water quality and utilisation of the Well, and submitting necessary information to the Local Authority.
- Ensuring that regular bacteriological tests are sent to the Community Centre.
- Ensuring that corrective steps are taken where the bacteriological tests show the quality of water to be unsatisfactory.
- Providing any other assistance necessary for the Community Centre to maintain and operate the well and to promote its use by the Community.

The Community Centre will have overall responsibility for the management of the well and its pump(s), and for this purpose it will have a Caretaker and if necessary an assistant, to attend to the duties assigned. Among the main responsibilities of the Community Centre are the following:

- Ensuring that the Caretaker performs his/her duties specified above.
- Ensuring that the pump is not abused in any way.
- Ensuring that the water from the well is available to all residents in the surrounding area of the well. In dry seasons, steps should be taken to conserve or allocate water to residents.
- Ensuring that a trained Caretaker is always available for the maintenance of the pump(s).
- Ensuring that water quality test are done regularly and corrective action taken, and that the members of the Community Centre are kept informed regarding water quality.
- Promoting use of safe drinking water in the Community.
- Liaising with the local authority and the A.C.L.G. in all matters concerning the well.
- Making necessary arrangements to collect any fees or subscription from the Community in order to maintain the well.

The Local Authority will have overall responsibility for the work of all the Community Centres in its area of authority in respect of the management of these wells. Among its main responsibilities are the following:

- Arranging the necessary institutional arrangements for the Community Centres to properly manage these wells.
- Arranging for provision and accounting of funds required by Community Centre for this purpose.
- Providing the services of its Technical Officer when required by the Community Centres.
- Passing any by-laws required and implementing them.

The Technical Officer of the Local Authority will carry out the following duties:

- Periodically check the condition and operatibility of all pumps in his area of authority, and provide any assistance required by Caretakers.
- Ensure that all pumps in his area of authority are operating properly. Necessary instructions for this purpose will be issued by him to the Caretakers, with copies to the Community Centres.
- Perform all major repairs such as replacement of foot valve. Where he has a difficulty in doing this, he will get that assistance of the regional office of the N.W.S.D.B.
- Ensure the sufficient stocks of cups and connecting pins are available with each Caretaker.
- Main sufficient stocks of spare parts and major components at the Local Authority.
- Coordinate work in respect of Water quality control.

The A.C.L.G. of the district will have supervisory responsibility in respect of the work of all Local Authorities in the district in connection with the proper maintenance and operation of the wells. In addition, the Technical Officers of the A.C.L.C. will monitor the work of the Local Authority Technical Officers, conducting regular test checks.

The Regional Office of the N.W.S.D.B. will provide any technical assistance when called for by the Local Authority or the A.C.L.G., for the proper maintenance of the well and the pumps. It will also undertake repairs to pumps where the Local Authority Technical Officers require such assistance. It will also have overall responsibility for the quality of water, and will make arrangements for samples to be tested regularly, and for advice to be given to Local Authorities and their Community Centres on remedial measures to be taken.

6.11 THAILAND

To date, the main approach to handpump maintenance in Thailand, is for the operating agencies to have their own maintenance units.

For instance, the Groundwater Division of the Department of Mineral Resources has separate maintenance units based in Khon Khaen and Saraburi, for maintaining handpump water supplies in the North-East Region of Thailand.

The unit has three mobile maintenance crews each equipped with a medium-size truck and repair equipment, and responsible for 250 pumps. Each month they serve about 125 pumps; thus, in two months all pumps are covered. Supervisors check whether the schedule maintenance visits are actually carried out, and they undertake inspection visits to randomly selected pump sites.

The costs of each mobile crew operating in the Groundwater Division's handpump maintenance systems, are as follows:

<u>Maintenance Costs</u> <u>for 250 pumps</u>	
<u>Category</u>	<u>Costs per year</u>
Material and spare parts for vehicles	7,200 Baht
Fuel	30,000 Baht
Repairs	6,000 Baht
Transportation	3,600 Baht
Salary for 3 officers	54,000 Baht
Per diem	60,000 Baht
Handpump spare parts	9,200 Baht
Depreciation of vehicles and equipment	20,000 Baht
Total	<u>189,400 Baht</u>
	US \$ 11,800
Overhead (20%)	US \$ 2,360
Total	<u>US \$ 14,160</u>
	=====
Maintenance Costs per Handpump	US \$ 57

A handpump is used by about 40 households, with an average of 5.6 persons per household.

Handpump Maintenance cost per person: US \$ 57 : (40 x 5,6) = US \$ 0,25.

A similar set-up for maintaining handpumps is used by the Accelerated Rural Development Office (ARD) of the Department of Interior. ARD does not employ mobile teams, but technicians from the ARD Provincial Office visit pumps that are reported as broken down.

Each province has about 100 handpump water supplies, and the number of visits made by ARD technicians per month is 20.

The performance of the pumps concerned shows no evidence that this form of maintenance is effective. Experience shows that the number of technical personnel and the available equipment are inadequate for the job.

The Public Health Department has adopted another handpump maintenance system in its water wells drilling and pump installation projects. They provide village-level training for village health volunteers in routine maintenance, such as lubricating, changing worn parts, etc. The Department assists in obtaining the necessary equipment and spare parts. At the village level, the Sanitation Section of the Provincial Public Health Unit provides technical support for the health volunteers. Its technicians are equipped with vehicles and equipment, and they undertake repair and maintenance work on request.

Involving local authorities in the repair and maintenance of handpumps may create a spirit of participation at the village or provincial level, and may reduce maintenance costs. However, this type of maintenance organisation requires effective coordination among the various levels. Although the type of maintenance system which delegates responsibility for maintenance work to the local authority at the village level should be supported in principle, as yet it cannot be regarded as feasible. Since maintenance work has a high marginal return, intermediate efforts are needed to create a maintenance system which can carry out the work even though it involves a high cost at the initial stage. Thus, at first, water supply agencies should set up mobile maintenance teams based in their operational centres.

By the year 1990, there would be 250,000 handpump water supplies to be maintained, requiring 500 mobile maintenance teams. Even if each team

requires only two technicians, 1,000 maintenance officers would be needed, and the total budget will be substantial, although quite acceptable when calculated per pump maintained. This is due to the following favourable characteristics of the envisaged maintenance system:

- (1) The shorter distance of communication due to increased number of operational centres.
- (2) The province as the operational base for mobile maintenance teams (under the provincial field agency).
- (3) Local participation in the maintenance of equipment.
- (4) The utilization of standardized equipment which makes bulk procurement and a reduction of unit costs possible.

ข้อควรทราบ

1. กรมทรัพยากรธรณี จะส่งช่างซ่อมและบำรุงรักษามาตรวจซ่อมเครื่องสูบน้ำโยกมือ ในหมู่บ้านของท่านประมาณ 2 เดือนต่อครั้ง
2. หากเครื่องสูบน้ำโยกมือชำรุด ในช่วงที่ช่างซ่อมยังไม่ถึง ท่านควรซ่อมใช้ไปพลาง ๆ ก่อนได้โดยใช้คำแนะนำจากคู่มือเล่มนี้
3. หากซ่อมเองไม่ได้ ขอให้แจ้งศูนย์ซ่อมบำรุงรักษาที่ใกล้ที่สุดตามรายชื่อ ในหน้า 18

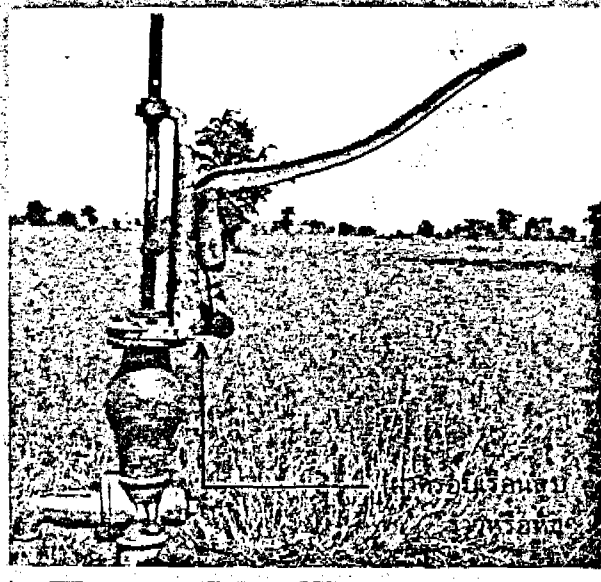
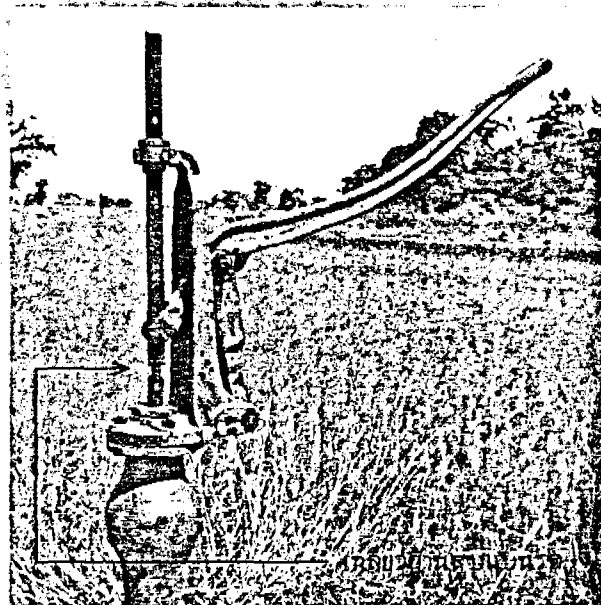
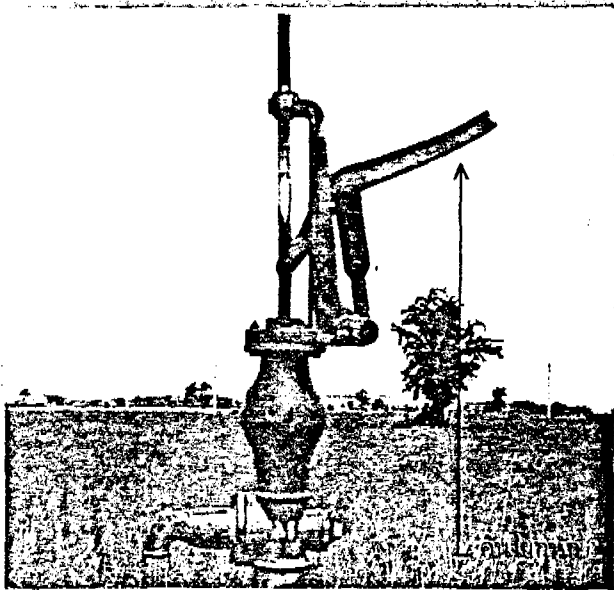
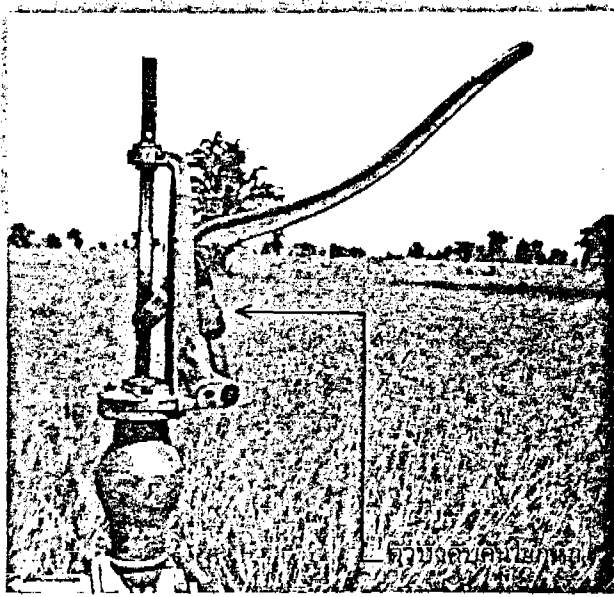


ใช้เครื่องสูบน้ำอย่างไรจึงจะไม่ชำรุดง่าย

1. ควรโยกคันโยกในแนวตั้งเสมอ เพราะถ้าโยกเอียง ๆ คันโยกจะหักง่ายและทำให้ชิ้นส่วนอื่น ๆ พลุ่ยชำรุดไปด้วย
2. ควรทาจาระบีตามสลัก และส่วนที่เป็นระบบขับเคลื่อนทุก ๆ สัปดาห์ โดยใช้จาระบีธรรมดา เหมือนที่ใช้กับรถจักรยานยนต์หรือรถยนต์
3. กวด (ขัน) น็อตทุกตัวให้แน่นเสมอ อย่าให้หลวมได้
4. ถ้าโยกหนักผิดปกติ หรือโยกได้น้ำน้อย ควรแจ้งให้ช่างของกรมทรัพยากรธรณีทราบ เพื่อไปตรวจแก้ไข
5. ถ้าหากโยกเบากว่าปกติ และไม่มีน้ำออก ควรแจ้งให้ช่างของกรมทรัพยากรธรณีตรวจสอบให้เช่นกัน

Fig. 5.15 Pages of Handpump Installation and Maintenance Instruction Manual (Thailand)

บ่อน้ำบาดาลในหมู่บ้านของท่าน ใช้การไม่ได้
เพราะเครื่องสูบน้ำยังมีสภาพดังในรูปข้างล่าง
นี้ หรือไม่



ถ้าใช่ เราจะแนะนำให้ท่านซ่อมเองได้โดยไม่ต้องเสียเวลารอช่าง

Fig. 5.15 (second page)

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