

Making your water supply work

Operation and Maintenance of small water supply systems

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Acronyms

CIDA	Canadian International Development Agency
DGIS	Directorate General International Cooperation of The Netherlands
DMT	District Maintenance Team
ESAs	External Support Agencies
HRD	Human Resources Development
IEC	Information Education Communication
IRC	International Water and Sanitation Centre
NGO	Non Governmental Organization
NRWC	National Rural Water Corporation (Sudan)
O&M	Operation and Maintenance
PM	Pump Minder
PSSC	Piped Supplies for Small Communities
SIDA	Swedish International Development Authority
SH	Services départementaux de l'Hydraulique
UNDP	United Nations Development Programme
VLOM	Village Level Operation and Maintenance
VOs	Village Organizations
WHO	World Health Organization
WPC	Water Point Committee
WUSC	World University Service of Canada

Foreword

The Ministerial Conference on Drinking Water and Environmental Sanitation held in Noordwijk, the Netherlands, from 22 to 23 March 1994, recognized that there is a crucial and urgent need to use water supply and sanitation sector resources more efficiently. It also considered that lessons learned from the International Drinking Water Supply and Sanitation Decade (1981-1990) give cause for confidence that the right changes can be made, which calls for major change in approaches and redefinition of sector priorities.

The development of action for improved operation and maintenance and the development of sound management practices in water supply and sanitation agencies are crucial to achieve effective and sustainable services.

Awareness should be created which recognizes that adequate operation and maintenance and sound management are essential components for successful development and resource utilization.

To give response to the needs brought about by the important gap between the current status of the services and the desired levels of performance, a working group on operation and maintenance of urban and rural water supply and sanitation was constituted by the World Health Organization under the sponsorship of the Water Supply and Sanitation Collaborative Council. This group has been active since June 1990 and is extensively promoting adequate operation and maintenance and sound management practices through the production of tools (guidelines, training packages and manuals), the organization of global, regional and country workshops and in providing support to the formulation and implementation of operation and maintenance programmes.

This occasional paper is a major contribution towards this process of promotion of the water supply and sanitation sector development. It combines the concepts, approaches and principles discussed over the past few years during the meetings of the Operation and Maintenance Working Group, with the ideas and vast experience and knowledge of the authors. It will complement and strengthen considerably the collection of documents which have been produced in the past years by different institutions.

José A. Hueb
Coordinator of the Operation and Maintenance Working Group

Introduction

The operation and maintenance of water supply systems of small communities have been neglected in the past in a great number of developing countries. According to the World Health Organization, it is estimated that 30 to 60 percent of existing water supply systems are not operational, which has an important impact on the wellbeing of concerned populations.

Governments and External Support Agencies, as well as local communities, are more and more concerned about the importance of integrating operation and maintenance components in the planning, implementation, management and monitoring of project activities, since operation and maintenance is a key factor of sustainability.

Professionals in the sector are also realizing that operation and maintenance is not just a technical issue. It also encompasses social, gender, economic, institutional, political, managerial and environmental aspects.

Moreover, there is a tendency in developing countries to redefine the roles and responsibilities of the various actors involved in operation and maintenance. Indeed, governments, because of heavy financial burdens and efficiency problems, are gradually changing their role of provider of services to that of facilitator of processes. Communities have increasing responsibilities, not only in the operation and maintenance of their water supply systems, but also in the financial management of these systems. New actors, such as private entrepreneurs from the informal or formal sectors, are now being considered as potential actors for operation and maintenance.

In the light of these elements, this document has been produced in order to provide project staff and sector professionals with the most recent information regarding trends and developments in the operation and maintenance of water supply systems of small communities. It has been done through a review of available literature as well as through the comments formulated during the meetings of the Operation and Maintenance Working Group of the Water Supply and Sanitation Collaborative Council and using the practical field experience of the authors and the advice of IRC staff.

The technologies described in this document are the most commonly encountered in small communities: protected dug well, borehole fitted with a handpump, gravity piped distribution of a spring supply to standposts, rooftop harvesting and motorized pump at village level.

Making your Water Supply Work has been divided into four major parts.

The first part deals with **The Challenge of Operation and Maintenance**, clarifying some basic concepts and highlighting the major constraints and benefits of effective operation and maintenance. It also presents an overview of the trends which are affecting the sector and which have an impact on operation and maintenance.

The second part reviews **Operation and Maintenance Requirements**, in terms of people and organizations, technical requirements, spare parts provision, hygienic operation and use, environmental protection and funding (financial resources).

The third part is concerned with **Developing and Managing Operation and Maintenance**, starting with a clarification of what is meant by the partnership approach in a context where communities are being made responsible for operation and maintenance.

Operation and maintenance are not limited to the sole activity of a caretaker or a technician, it includes the activities of various actors at different levels, hence the manual proposes a paragraph on the development of an operation and maintenance system. Management of operation and maintenance concerns the project in its planning phase, but also the community in the day-to-day management, including financial management. Finally, proper management includes monitoring and evaluation.

The fourth part deals with an aspect which is too often neglected in projects, **Supporting Operation and Maintenance**. Indeed, the transfer of responsibilities to communities does not mean that communities will take up all activities. Effective operation and maintenance will depend on a well defined role for government support, external agencies' support, the role of NGOs, and private sector involvement. Finally, human resources have to be developed, and information on operation and maintenance has to be made available.

PART I

THE CHALLENGE OF OPERATION AND MAINTENANCE

Chapter 1: Concepts and Trends

The first paragraphs will review the main concepts of operation and maintenance (O&M), the link between O&M and sustainability as well the main constraints and benefits of O&M.

The chapter is ending with an overview of the main trends in O&M presently encountered in the water supply sector.

1.1 What is Operation and Maintenance?

Operation

Operation refers to the everyday running and handling of a water supply. This involves several activities:

- Major operations required to convey safe drinking water to the users, e.g. starting and stopping a motorized pump, the supply of fuel and the control of valves.
- The correct handling of facilities by users to ensure long component life, e.g. the handling of a rope and bucket at a well, handpump use, and the use of taps at a standpost.

The proper operation of a supply results in its optimum use and contributes to a reduction in breakdowns and maintenance needs.

Maintenance

Maintenance refers to the activities required to sustain the water supply in a proper working condition. Maintenance can be divided into:

- Preventive maintenance - regular inspection and servicing to preserve assets and minimize breakdowns.
- Corrective maintenance - minor repair and replacement of broken and worn out parts to sustain reliable facilities.
- Crisis maintenance - unplanned responses to emergency breakdowns and user complaints to restore a failed supply.

Maintenance costs money and a policy of crisis maintenance alone may appear cheap in the short term. However, continuing crisis maintenance leads to frequent breakdowns, an unreliable supply, poor service levels, and a lack of user confidence. Reliance on crisis maintenance may ultimately lead to complete system failure.

Rehabilitation entails the correction of major defects and the replacement of equipment to enable a facility to function as originally intended. Rehabilitation becomes necessary when it is no longer technically feasible or economically viable to maintain a facility in good working order. Maintenance will become uneconomic if the long term cost of rehabilitation and subsequent operation is more favourable than continued repair and maintenance. Water supply statistics often give the number of people served by improved water supplies. Unfortunately, the actual number of people served is far less because many supplies do not function reliably due to the neglect of operation and maintenance. Unless operation and maintenance is properly implemented then continued investment in the development of water supplies is not worthwhile.

1.2 Operation and Maintenance and Sustainability

Sustainability is a widely used term which has a variety of meanings depending on the context in which it is used. A drinking water supply is sustainable if:

- the water consumed is not over-exploited but naturally replenished
- facilities are maintained in a condition which ensures a reliable and adequate potable water supply
- the benefits of the supply continue to be realized over a prolonged period of time.

Water supply projects are not to be seen as an end in themselves but as the initiators of a range of benefits which continue long after projects have been handed over. Figure 1 shows several possible lines of development of a project. Community based projects may take longer to develop but allow time for the factors which determine sustainability to be identified. Appropriate measures can then be taken to develop effective O&M. In the past, relatively short-term agency managed projects have often neglected critical aspects of O&M development.

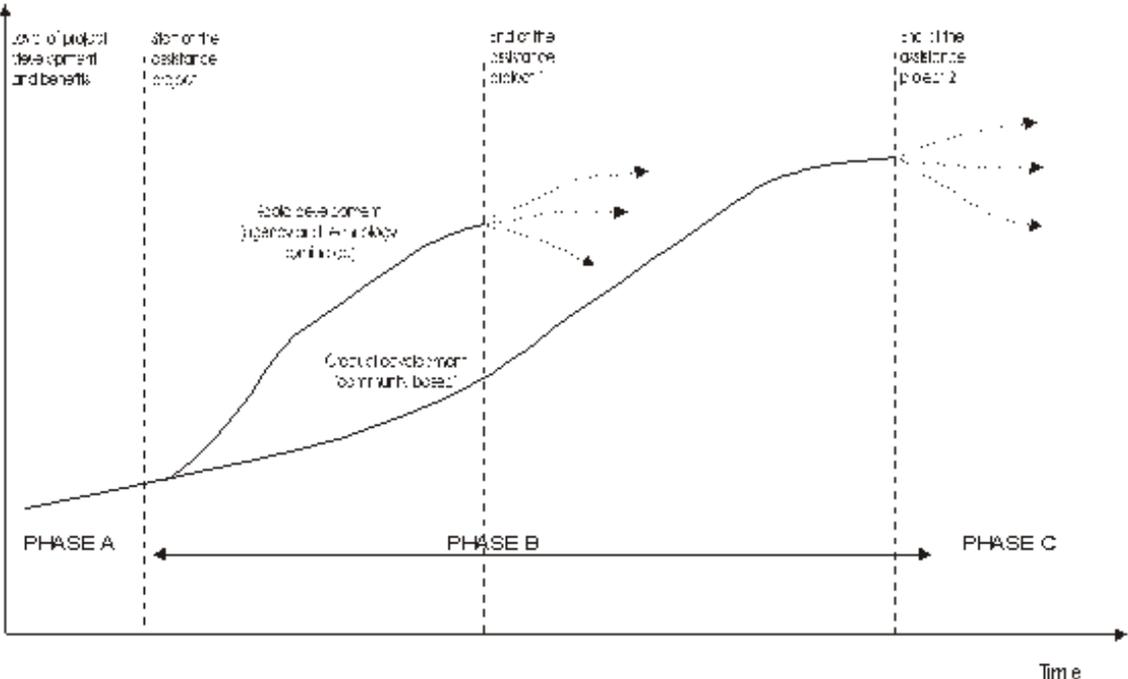


Figure 1: Realizing and sustaining benefits over time.

In order to sustain benefits in Phase C, factors influencing sustainability and operation and maintenance will have to be developed and/or strengthened already during the implementation Phase B, and in some cases supported and monitored even during Phase C. It is quite clear that factors influencing operation and maintenance will have to be planned for in Phase A, before the start of the implementation of the projects. Indeed, these factors could have an important impact on the technology selection, as well as on operation and maintenance.

Some benefits, such as health improvements, may take a considerable period of time before they are realized. Other benefits, such as easier access, may be realized on completion of construction. A benefit such as access to greater quantities of water may decline from an initial high level but still continue as an overall benefit compared to a previous supply. It is clear that the benefits of water supplies cannot be sustained without effective O&M.

The following key elements of sustainability are mutually supportive of effective O&M :

- **An enabling environment**
An environment which encourages sustainable systems through appropriate legal provisions, regulations, education, information and other similar incentives.
- **Felt need and health awareness**
The existence of a genuine appreciation of the advantages of safe water supplies so that users support O&M.
- **Strong institutions**
Water agency and community structures with established legal status, clear responsibilities, adequate financial support, good organization and the representation of all users, including women and poorer households.
- **Supportive attitudes**
A commitment by the water agency and community to share responsibilities, establish clear ownership and contribute to the financial support of services.
- **Expertise and skills**
A clear identification of O&M needs and the training of agency staff and community members in the necessary skills.
- **Appropriate service level**
An affordable and manageable service level which can be upgraded later as the socio-economic situation improves.
- **Appropriate technology**
Practical, affordable and acceptable technology.
- **Materials and equipment**
Items such as spare parts must be available to keep systems functioning.
- **Support services**
O&M support systems must be effective.
- **Financial matters**
Factors such as capacity and willingness to pay, as well as cost sharing and community financial management, are likely to influence the financial sustainability of the systems. Finance becomes more and more relevant, especially in a context where communities are being empowered with new financial responsibilities.

(Ngumbu, 1990)

The New Delhi Statement (1990), which tried to draw lessons learned from the International Water and Sanitation Decade (1980-89), emphasized four guiding principles for sustainable development:

1. Protection of the environment and safeguarding of health through the integrated management of water resources and liquid/solid wastes.
2. Institutional reforms promoting an integrated approach and including changes in procedures, attitudes and behaviour, and the full participation of women at all levels in sector institutions.
3. Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes.
4. Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies.

Finally, there is a wide tendency to make people aware that they should pay for the services they use, which could influence the financial sustainability of water supply systems, and at the same time give more responsibility in terms of ownership to communities. In other words, water is no longer a free good as it has been considered in the past in many countries, as a gift of God or a public responsibility of the governments. However, it should be clear that the price consumers are paying corresponds to the added value of providing a better service of water supply to them.

1.3 The Constraints on Effective Operation and Maintenance

Numerous reports reflect the record of poor operation and maintenance and the following list highlights the main constraints.

- The low profile and hence low priority given to O&M by policy makers.
- There is a need for clear policies, appropriate legal frameworks and a well defined division of responsibilities to support O&M in the sector. Centralized government departments are often unable to respond efficiently to the maintenance of scattered rural supplies. Governments, therefore, need to adopt workable policies which devolve responsibility to autonomous agencies and communities.
- Political interference makes sustainability that much more difficult to achieve. The political decision to provide free water means users do not contribute funds for the upkeep of supplies. Political influences can determine technologies (e.g. tied to aid) or result in sub-standard systems. Such influences can be reduced by devolving management responsibilities away from government.
- A focus on capital construction and expansion by governments and external support agencies neglects the maintenance of existing supplies.
- Overlapping responsibilities of staff and departments can divert skills, funds and equipment away from O&M. This often happens when operational staff are redeployed to construction work as a new project is started. New projects benefit while existing projects are neglected.

- Inappropriate design and technology choice creates unnecessary operation and maintenance difficulties and increases costs. Initial design must consider long term O&M. Poor design is often compounded by inadequate supervision of construction.
- A lack of community involvement in project development can lead to inappropriate designs. Poor user understanding of how to correctly operate systems can result in the misuse and damage of facilities.
- Some communities are disadvantaged by their remoteness or difficult access. This adds to the cost and problems of maintenance and requires special attention.
- There are often inadequate data for planning O&M. Data are required, for example, on the cause of breakdowns and the maintenance and repair costs involved. O&M can then be planned based on field experience.
- The state of national and regional economies can have a crippling effect on O&M as high inflation and fluctuating exchange rates can significantly increase O&M costs. For example, the operation of powered pumps and maintenance crew transport is especially affected by fuel price increases.
- Water supply facilities are often poorly managed. Some of the management constraints, such as unskilled staff, may be a result of underfunding but are often also due to poor management. O&M responsibilities are rarely delegated to individuals and this can result in a lack of sense of responsibility for the proper use and upkeep of facilities. Management supervision of operation and maintenance may be virtually absent in many cases.
- A lack of training and understanding of maintenance procedures leads to the poor performance of O&M staff (operators, mechanics, caretakers, etc.).
- Insufficient and inefficient use of funds for O&M restricts the availability of spare parts, tools and the recruitment and training of competent staff. A lack of accountability in many maintenance departments leads to inefficient use of maintenance funds.

(McPherson, 1990; Ittissa, 1991; Wyatt, 1988; Roark, 1993)

Table 1: Overview of major constraints concerning O&M as reported by twelve countries in the Harare subregional O&M Workshop (Brikké, 1994)

<p>Zambia</p> <p>Poor statistics of rural areas; overlaps in responsibilities; many actors involved; taking over by communities has been difficult; each one has its own technology; lack of coordination; standardization of Mark II did not succeed; communities do not contribute much apart for labour and materials; lack of skills and capacity of the communities; no standardization or interchangeability between different technologies; lack of clear strategy for water and sanitation; poor training policy; no comprehensive data on rural systems.</p>	<p>Zimbabwe</p> <p>Going through various stages of implementation of new concept of community management and decentralization; no policy on finance; lack of cost recovery system; community-based repairs established but communities are not managing, although they are provided with parts and training; maintenance of piped schemes very expensive, and lack of guidelines.</p>
<p>Tanzania</p> <p>Despite changes of policy introduced since 1990, people still used to old policy of free water and government intervening for all O&M; funding is a problem; some projects have still high technology, with high O&M costs; economic decline; inadequate priority setting of activities by the Government; poor data on O&M; lack of involvement of communities; lack of trained personnel; inadequate health education</p>	<p>Mozambique</p> <p>New approach of decentralized maintenance; AFRIDEV introduced, but failed due to drought; training and participation of communities is alright, but spare parts provision is inadequate, and the organization of collecting funds for maintenance is not working well; the number of pumps installed has increased, but it is difficult to know how many are functioning; because of war, many people went to the cities; lack of accurate information.</p>
<p>Malawi</p> <p>Community participation has declined, mainly due to urban migration; water quality is poor; use of slow sand filters not adequate; vandalism; government owns piped schemes and has problems of cost recovery, since not enough has been budgeted.</p>	<p>Swaziland</p> <p>Inadequate supplies; communities have little trust in their committees; inaccessibility; revenue collection difficult; collapse of pit latrines; lack of data; inadequate training of communities for management.</p>
<p>Nigeria</p> <p>Breakdowns are quite rampant; general unsustainable environment for O&M because of unstable politics and down turn of economy; inflation offsets the system even at rural level; cost sharing concept not yet clear and accepted; investments in the water sector are not looked in a wider perspective of general rural or urban economic development.</p>	<p>Ghana</p> <p>Despite national policy change with intensive educational campaign and a demand driven approach, collection of tariffs is difficult, and recovery insufficient; community management still needs to be pursued and the availability of spare parts is not yet efficient; in general, lack of coordination; overloading of sanitation facilities, because of population growth; priority setting of resource allocations not adequate.</p>
<p>Kenya</p> <p>Law on water use not adapted to real situation; despite a certain subsidization from the Treasury, cost recovery is not enough; high costs of spare parts; difficult to maintain adequate stocks of spare parts; passive community involvement in management of WS; lack of qualified operators; shortage of sufficient funding to finance regular rehabilitation/augmentation of water schemes; many water supplies were designed in the early 1970s; in slums poor access to adequate means of excreta disposal;</p>	<p>Lesotho</p> <p>Problems in implementing cost recovery policy, especially when sanctions have to be applied; question of village water ownership surfaces; Communities ignorant of their roles in community management; communities left to operate and carry small repairs and government has the responsibility of big repairs; lack of commitment on sanitation by Government; regarding urban water supply : lack of land management, inadequate policies and poor enforcement of available legislation, and staff movements resulting in a negative capacity building. Environmental hygiene greatly influenced by lack of hygiene education.</p>
<p>Namibia</p> <p>Country has very recently adopted a new policy aiming to decentralize O&M activities and make people pay for certain services. Cost recovery is not developed properly; difficult to assess new approach because too recent, but O&M was too centralized in the past and costs of maintaining were too high for the government alone to bear; lack of trained personnel; inappropriate technology.</p>	<p>Botswana</p> <p>Less constraints compared to other countries, except : poor data collection; poor management; not a lot of trained staff; insufficient funds for recurrent expenditures; sanitation is a bit neglected and no one is directly involved</p>

1.4 The Benefits of Effective Operation and Maintenance

Effective O&M benefits users, water agencies and countries as a whole. Benefits include improved health and wellbeing, and social, economic and financial advantages.

User benefits

Improved health through a constant, reliable supply of safe water of sufficient quantity for essential hygiene measures.

A nearby improved supply can often save water collectors time and energy. Women often shoulder the burden of collecting water and use the time and energy they save in several ways: they spend more time with the family; rest from other tiring work; and become involved in economically productive activities. A broken down supply can mean a loss of these important benefits.

Involvement of the users in O&M activities can reduce their dependency on external assistance. Technical and management skills within the community can be enhanced through appropriate training. These can have broad benefits for other community development projects and in commercially productive activities, such as transport maintenance and the operation of grain mills.



Figure 2: Good operation and maintenance can make a difference.

Water agency benefits

A reliable water supply encourages users to pay for their supply. This provides the agency with the revenue to fulfil their responsibilities.

An effective O&M system which also involves the users reduces the day-to-day burden of routine servicing and maintenance often carried out by the water agency alone.

National benefits

The government and country benefits because the existing stock of infrastructure is maintained and preserved. New developments then increase the number of water supply systems rather than merely keep pace with the existing coverage.

- Effective O&M means that designers do not have to over-compensate for expected poor O&M. The higher capital cost of such an approach can be avoided if planners initially establish an effective O&M strategy.
- Functioning water supply schemes contribute to a healthier and more productive population which benefits everyone.

The benefits of a new O&M strategy

In Sudan, a wateryard is a borehole supply providing water for drinking and animal watering. Wateryards are owned by the government and managed by the National Rural Water Corporation (NRWC). Due to the economic hardships experienced by Sudan, NRWC does not receive sufficient funds to properly operate or maintain the wateryards. The result has been that many of the yards do not function well, if at all.

In 1986 the World University Service of Canada (WUSC) began to work closely with the NRWC to develop a new O&M strategy in a limited trial programme. It was based on a partnership between the user community and the NRWC. Water rates were collected and paid into a community bank account. The community paid the NRWC for operation and maintenance services.

A legal Operation and Maintenance Agreement was established in June 1988. A further decree was passed in 1990 which allowed wateryard revenues to be retained in the provinces. Significant aspects of the O&M Agreement were:

- the establishment of a community revolving fund
- the fixing of the water rate at a realistic level
- joint management of the revolving fund by WUSC, NRWC and the community
- the establishment of community water committees
- the establishment of record keeping to monitor revenues and operational data. e.g. operating times, fuel consumption
- a preventive maintenance strategy supported by the training of community operators and regular inspections by NRWC
- the regular monitoring of performance by water committees
- the establishment of an operation and maintenance service group to provide maintenance services.

The trial was carefully monitored and the following initial benefits identified:

- the O&M costs were fully recoverable
- prior to the trial, users were paying two to three times more than the trial water rate due to the 'unofficial' system that had developed to keep the wateryards functioning
- additional revenue paid to NRWC could be used by them for the expansion and rehabilitation of other systems.

The trial of a planned, cooperative O&M strategy demonstrated clear benefits to the users, the water agency and the government.

(McPherson, 1990)

1.5 Trends

The growing emphasis on O&M is not unique to rural water supplies but reflects the changes that are occurring generally within developing countries. Many of the trends follow on from declining investment in infrastructure. In the absence of new investment, the only affordable option is to maintain what currently exists (Wyatt, 1988).

The major trends in O&M are summarized below and discussed in more detail in the following chapters.

Water is an economic good

Water supply is a service, and just like any service it involves manpower, repairs, spare parts, energy, etc. These are not free, therefore in order to provide a safe and sustainable water supply, a cost recovery system has to be introduced. Governments are facing the greatest difficulties in meeting recurrent costs, and the tendency is to make beneficiaries pay for the water they use, in order to recover partially or totally the costs of supplying this service, and to give to the communities more responsibility in the actual management of the water supply system.

Decentralization, collaboration

The users of water supplies are often the only viable source of funding for the regular maintenance of supplies. Users will only pay for a service if it is reliable and meets their needs. Hence there is a trend towards the greater involvement of communities in determining the level and type of service they want and can afford, and in the management of O&M by the users themselves.

The transfer of responsibilities for the financing and control of O&M to communities requires the loosening of centralized control by government departments. Hence, there is a trend towards decentralization and greater collaboration between government departments, external support agencies and water supply users.

The 'New Delhi statement'

At the New Delhi Global Consultation on water supply and sanitation in 1990, the Collaborative Council Working Group on Operation and Maintenance made a statement which recognized the need for fundamental changes required by agencies if water systems are to provide sustainable services:

- agencies should change their orientation to see their primary role as provider of a service and **not** the constructor of physical works
- agencies should become autonomous in efficient and transparent management and financing of services
- agencies should provide integrated water and sanitation services only in response to the effective demand of the consumer.

The integration of health, water and sanitation activities

An integrated O&M strategy in which the concerns of water, sanitation, hygiene education and waste disposal are tackled together is part of an overall concept of balanced development which is gaining acceptance. Effective O&M encompasses the maintenance of systems, promotion of the safe and efficient handling of water from source to home, and measures to prevent the contamination of water sources.

Environmental concern

For a water supply to function, the water supplied must remain potable and the source must continue to be sufficiently recharged to meet the demand. O&M, therefore, now tends to encompass the protection of the environment to ensure that the quality of source water does not deteriorate or quantity decline. The careful management of water sources and catchments as an O&M activity can help to achieve this.

Women's involvement and gender awareness

In an endeavour to involve the whole community, the role of women has become more prominent. As the principal users of rural water supplies, women are encouraged to participate in decision making and take active roles in management and maintenance activities.

Involving women more should not, however, lead to increased physical work for women or greater demands on their time as they already work longer hours than men in carrying out household and subsistence chores. A gender approach to maintenance and management ensures that work, authority and benefits are more equally shared with men. If women have to do the work alone, conflicts arise and maintenance and villagers suffer in the end.

Human resources development

As a consequence of greater community involvement, there is a shift in O&M responsibilities from skilled professionals to previously untrained community members who are expected to provide an improved O&M service. Such a radical change of roles requires corresponding changes in personnel support and training.

Water agency personnel need to be aware of their agency's changed role from constructing and running systems to providing supervisory, inspection and training services to communities and the private sector. Engineers need to be able to integrate the 'software' of communication and organizational skills with the 'hardware' of technical knowhow.

Private sector involvement

The private sector has always had a role to play in the design and construction of rural water supplies or in providing equipment, materials and skills for construction, operation and maintenance. An even greater private sector involvement in O&M is now being promoted.

Appropriate and affordable technology

Much greater attention is now being given to choosing technology according to the capacity of a community to operate, maintain and finance a system.

As long ago as 1981, the UNDP/World Bank Handpump Project introduced the term VL0M - Village Level Operation and Maintenance - to promote the development of handpumps that could be operated and maintained by the community. The concept can be equally applied to *all* water supply technologies. The VL0M guidelines recommend that the hardware should be:

- easily maintained by village caretakers or artisans with few skills and tools
- manufactured in the country of use to ensure the availability of spare parts

- robust and reliable under communal operating conditions
- standardized to take advantage of economies of scale, common skills training, user familiarity and the availability of spare parts
- low in capital and recurrent costs.

(Arlosoroff et al, 1987)

The trend now is to offer communities a range of water supply options from which to choose based on the technically feasible options suited to the local conditions.

Improving effectiveness

There is a trend to be more concerned with the effectiveness of a water supply in achieving overall aims. This is not indicated by numbers of schemes built but in terms of what people do. People's behaviour is a good indicator of change. Therefore, there is a greater emphasis on how supplies are managed, operated, maintained and utilized to achieve the desired benefits such as improvements in health, increased production, and reductions in women's workload (Glennie, 1994).

National policies

Many national policies still lack clear strategies on how to develop effective O&M. Revised water tariffs and more accountable systems for the recycling of revenue to support O&M activities have been gradually introduced where national policies have reflected the need to generate recurrent revenue. However, practice can often lag behind policy. Continuing economic crises forces ministries to reduce expenditure, especially on recurrent costs, and hence on O&M.

Revision of donor policies

Donor agencies have begun to implement well-defined policies to ensure O&M is a central concern of the programmes they support. The extent of policy implementation can be assessed through evaluation. The sharing of these findings helps programmes plan for effective O&M (SIDA, 1993). Participatory evaluations, in which donors, agency staff and users are all involved, assist in the orientation of all concerned to the needs of O&M.

Leading donors have supported the promotion of measures to assess O&M problems and potential solutions through sponsorship of and participation in workshops and conferences (McPherson, 1990). Donors have sponsored studies into O&M practices and issues. This has resulted in a growing range of literature (see the references at the end of this paper).

PART II

OPERATION AND MAINTENANCE REQUIREMENTS

This part deals with the factors affecting O&M and what is required for a water supply to function in the long term. An overview is given of the roles and responsibilities of a wide range of people and organizations involved in O&M. A procedure for the analysis of O&M technical requirements is described. O&M in its broadest sense includes the hygienic operation and use of a water supply and the environmental protection of water catchments. Examples are given to illustrate the integration of hygiene awareness and the need for environmental protection at both the local and regional levels.

Chapter 2: General Requirements of Operation and Maintenance Strategies

2.1 Critical Factors

The most appropriate operation and maintenance strategy for a particular supply will depend on a range of factors:

- **Technology**
complexity, familiarity, standardization, spares availability and skills required
- **Demography**
scattered or dense population; numbers of people served
- **Environment**
effect on the water source; effect on materials and equipment
- **Accessibility**
main road or remote water supplies
- **Cost**
total cost of O&M and the cost per individual user - what are users willing and able to pay?
- **Management**
level of community organization and cohesion; existing management structures and skills; efficiency of support agency management
- **General economy and level of development**
inflation; stability of prices; fluctuation in incomes; availability of skills, tools, equipment and services
- **Government policy and legal framework**
Government-promoted O&M strategies; legal ownership; accountability and the allocation of responsibilities.

2.2 People and Organizations

Who is required to support operation and maintenance?

It is useful to identify the wide range of actors - people and organizations - involved in O&M.

- **the community**
users (women, men; young and old), user groups, community leaders, water committees, village councils, caretakers, mechanics, operators,
- **the government and public authorities**
local, district, regional and national officials,
- **water agency and associated support agencies**
managers, maintenance teams, inspectors, trainers, and social, financial and health extension workers

- **private sector**

local entrepreneurs, local artisans, shopkeepers, wholesalers, manufacturers of equipment and spare parts, bankers, consultants, contractors

- **NGOs (non-governmental organizations)**

local, national and international NGOs

- **external support agencies**

multilateral and bilateral aid agencies, development banks.

The community

The many individuals and groups of people in a community will all have their own views on the requirements of O&M and their role as users, operators and managers. A general 'community view' may not highlight critical factors which ultimately determine O&M effectiveness.

Waterpoints are used by women for both domestic and productive uses whereas men utilize waterpoints mainly for productive activities. Productive activities include animal raising, vegetable and fruit growing, brewing, post-harvest processing, pottery and cloth dyeing, among many others. The various uses have an economic value which may be competitive and can sometimes lead to conflict. Users, as individuals or groups, who have an economic interest in a water supply will be economically interested in effective O&M. They may be ready to financially support O&M but they may also be keen to keep payment to a minimum, or even avoid payment. Firm management is often an important requirement.



Figure 3: Various members of the community are involved in O&M.

Users have a responsibility to operate a facility correctly. An understanding of the correct way to handle taps, waterpoints, pumps, etc. should not be assumed and raising awareness of the implications of misuse is sometimes necessary.

A water committee is a formal association representing users for the purpose of managing a local water supply system or point source. The important role and function of water committees in O&M are considered in detail in 3.4 'Community management'.

Caretakers, attendants and operators are men and women chosen by the water agency or community to operate and maintain water supply facilities. A participatory selection process using agreed criteria gives a clear idea of the tasks involved so that a reasoned choice can be made of the best man or woman for each job.

Typical caretaker selection criteria

- Good motivation
- Authority and respect to control use of facilities
- Able to carry out maintenance and small repairs after training
- Good communication with women and men about water use and hygiene
- Living near the water facility
- Seldom absent for long periods
- Likely to remain in the community
- Completes training successfully
- Able to keep records - not always a requirement but level of literacy to be stipulated if necessary.

Individual responsibilities need to be clearly defined and understood. The method of compensation or remuneration should aim to promote efficient operation and maintenance so that a supply keeps working, rather than one which pays more favourable rates for repair work.

The important supportive role of governments, the private sector, NGOs and external support agencies are considered in Part IV.

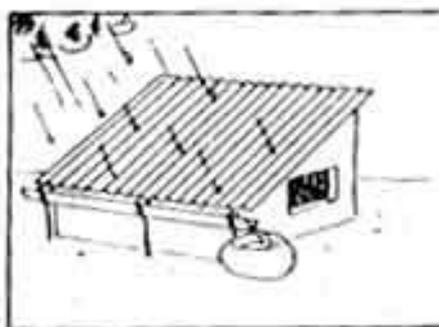
Chapter 3: Technical Requirements

3.1 Water Supply Options

The degree to which the above factors influence the sustainability of a supply will depend on its O&M requirements and the circumstances in which the supply has to function. As circumstances vary considerably from one water supply to another, it is clearly not possible here to give a definitive list of requirements for each supply option. Therefore, the examples which follow give a selection of water supply options and outline factors which particularly affect O&M. The options reflect an increase in management complexity from the household level to schemes serving several communities.

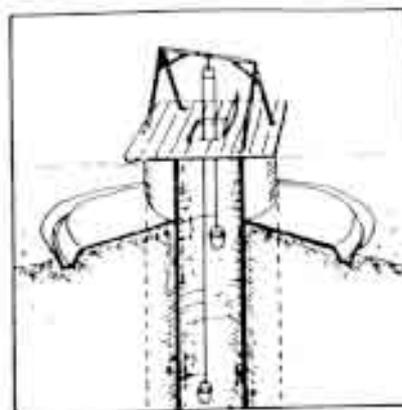
The selection of a water supply option is a collaborative effort involving all the partners in a scheme.

Table 2: O&M factors and requirements for rooftop rainwater harvesting



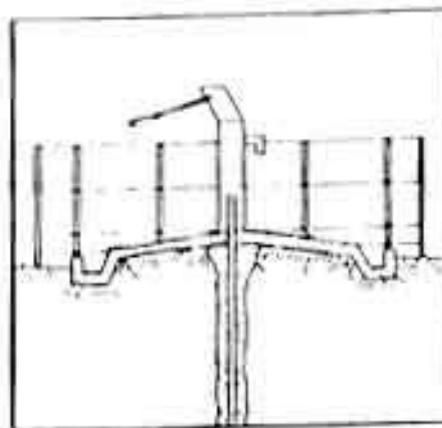
<i>O&M Factors</i>		<i>O&M Requirements</i>
Technology	tank material	Steel requires periodic corrosion protection. Ferro-cement and cement mortar require less attention
Environment	regular rainfall	Small leaks are not necessarily critical. Systems to deal with dust settlement are not essential and are therefore simpler to operate and maintain.
	intermittent rainfall	Systems must be well maintained and operated to collect rain whenever it falls and to minimize water loss from leaking tanks and taps.
Cost	recurrent cost	Recurrent costs are generally low. Having reserve O&M funds for household systems is not critical but is necessary for extensive institution systems.
Management	household	Household management and user responsibility is clear. Funds for maintenance come from the household.
	institution	Institution management must be made clear and institution funding allocated for maintenance. O&M responsibility for an institutional system is not as strong as for a household system. Supervising correct use is a part of O&M.
General economy and level of development		No fuel and few materials required for maintenance. Subsidized roofing material prices may assist O&M
User education		The use of stored water may be restricted to drinking water only, depending on the season. Users, especially women, to be made aware of how long water for different uses can be met from stored tank water and the implications for health.

Table 3: O&M factors and requirements for protected well at the sub-village level



O&M Factors	O&M Requirements
Technology - a simple pulley, rope and bucket	Basic local skills and materials for periodic repair or replacement are needed.
windlass system	Windlass may be too slow to operate when serving many people - strict supervision necessary.
rope pump	Understanding of operation and basic skills required to repair and maintain.
Demography - people far from a well may not use it as frequently as those nearby	Ownership and responsibility for O&M need to be clearly defined.
Environment - Open wells are susceptible to groundwater pollution and surface contamination	Hygienic operation and regular monitoring are essential to maintain water quality. A safe method of access and dewatering is necessary for cleaning. Wells may need deepening as the water table lowers.
Flooding	Raise or site wells above the flood line.
Accessibility - the level of external support	Minimum external O&M support required therefore suitable for remote communities. Cost Low O&M cost unless deepening or re-lining required.
Cost	Low O&M cost unless deepening or re-lining required.
Management	Good community organization necessary to maintain well in a satisfactory hygienic condition. The division of O&M responsibilities by gender is critical.
Government policy and legal framework - well ownership	Clarification of who owns the well and therefore who has responsibility for O&M: the government or users?

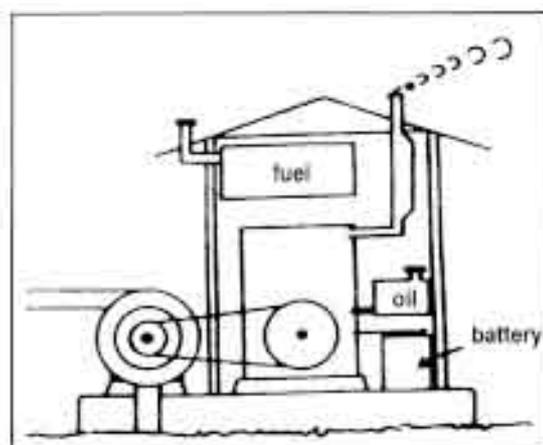
Table 4. O&M factors and requirements for handpump at the village or user group level



O&M Factors	O&M Requirements
Technology - VLOM* design	Training of local caretakers/mechanics. Availability of spares locally. Back-up support for major repairs. Women tend to be more conscientious in doing preventive maintenance and small repairs than men.
Demography - population	Adjust maintenance schedule to handpump usage which depends on the population served.
Environment - Lowering water table due to general aquifer exploitation	Cylinder setting depth may need to be lowered by adding rising main pipes. Suction pumps may need to be replaced by medium lift pumps.
Flooding	Raise or site pumps above the flood line.
Accessibility - back-up support	Communities which are difficult to reach or have poor access to spares and repair expertise need special consideration.
Cost - spare parts and preventive maintenance	Communities need to budget for ongoing maintenance and keep a reserve of funds for irregular expenditure. Training, appropriate financing, financial management and stock control is necessary.
Management - who? how?	Define the handpump user group (whole village, section of village) and who takes the management decisions - men, women or a sharing of decision making?
General economy and level of development	Spare parts: price stability and reliable delivery system.
Government policy and legal framework - handpump ownership	Clarification of who owns the handpump and therefore who has responsibility for O&M.

* VLOM - Village Level Operation and Maintenance

Table 5: O&M factors and requirements for motorized pump at the village level



O&M Factors	O&M Requirements
Technology - technical skills and spare parts	Training of pump operator/mechanic in use and servicing. Availability of reliable spares and fuel supplies. Back-up support for major repairs.
Environment - lowering water table due to general aquifer exploitation	Pump setting depth may need to be lowered by adding rising main pipes. Monitoring of groundwater level.
Extensive animal watering at a single waterpoint can lead to environmental degradation.	Control agreements with animal owners and herders.
Accessibility - back-up support	Communities which are difficult to reach need special consideration. Motorized pumps may be inappropriate.
Cost - spare parts, preventive maintenance and eventual replacement	Communities need to budget for ongoing maintenance. They need to be able to raise funds quickly in emergencies for irregular expenditure as reserve funds in high inflation economies depreciate quickly. A method of funding future pump and motor replacement is necessary.
Management - who? how?	Clear management procedure. Who takes the decisions - men, women or a sharing of decision making? Management skills training required: costing, budgeting, revenue collection, very basic accounting. Women often make good treasurers.
General economy and level of development	Spare parts: price stability and reliable delivery system.
Government policy and legal framework - pump ownership	Clarification of who owns the pump and therefore who has responsibility for O&M.

Table 6: O&M factors and requirements for gravity piped system serving several communities



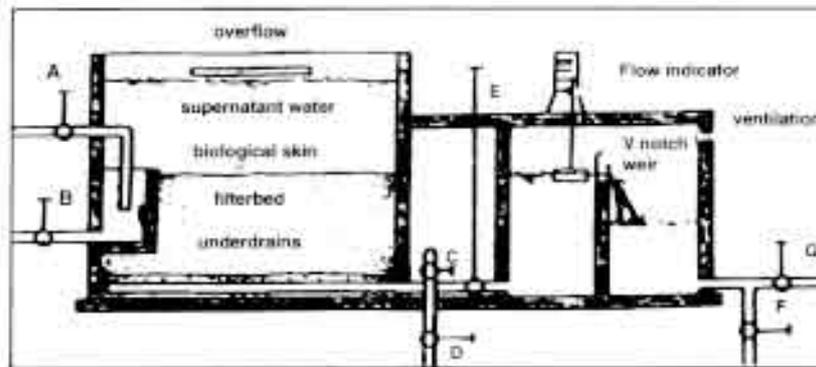
O&M Factors	O&M Requirements
Technology - operational understanding and technical competence	Training of system operators in use and servicing; spares available locally; back-up support for major repairs.
Environment - water catchment	Agreements and action to protect water catchment. This may affect women and men differently and the concerns of both must be considered.
Wastewater	Drainage and control of wastewater at waterpoints.
Cost - maintenance and extensions	Cost per user is low compared to hand or motorized pumped supplies but cost of funding future extensions of the piped distribution may be high - accurate budgeting required.
Management - who? how?	Complex management requires clear agreements at the different levels: overall scheme, village, and waterpoint. Management skills training in costing, budgeting, revenue collection and basic accounting.
Government policy and legal framework - scheme ownership	Clarification of who owns the scheme, or each part of the scheme, and therefore who has responsibility for O&M.

Table 6: O&M factors and requirements for gravity piped system serving several communities



O&M Factors	O&M Requirements
Technology - operational understanding and technical competence	Training of system operators in use and servicing; spares available locally; back-up support for major repairs.
Environment - water catchment	Agreements and action to protect water catchment. This may affect women and men differently and the concerns of both must be considered.
Wastewater	Drainage and control of wastewater at waterpoints.
Cost - maintenance and extensions	Cost per user is low compared to hand or motorized pumped supplies but cost of funding future extensions of the piped distribution may be high - accurate budgeting required.
Management - who? how?	Complex management requires clear agreements at the different levels: overall scheme, village, and waterpoint. Management skills training in costing, budgeting, revenue collection and basic accounting.
Government policy and legal framework - scheme ownership	Clarification of who owns the scheme, or each part of the scheme, and therefore who has responsibility for O&M.

Table 7: O&M factors and requirements for VLOM water treatment - slow sand filtration



O&M Factors	O&M Requirements
Technology - operational understanding and technical competence	Training of operators. Back-up support for major repairs.
Cost - maintenance and extensions	Community support for periodic cleaning of the filter. Irregular funding for maintenance of equipment (valves) and structure (cement). Method of funding future increased treatment capacity.
Management - who? how?	Clear definition of operation and management responsibilities. Management skills training: budgeting, revenue collection, basic accounting. Careful monitoring of the treatment process by an independent agency.
Government policy and legal framework - ownership and technical competence	Clarification of who owns the scheme, and therefore who has responsibility for O&M.

3.2 Identification of Technical Requirements

It is useful to have a systematic procedure to identify the technical O&M requirements of a variety of water supply options when choosing new schemes, or to analyze existing schemes. A standard procedure enables comparisons to be made. It shows what is involved in O&M so that both the users and support agency can decide either the most appropriate option, in the case of a new scheme, or the changes required to improve the sustainability of an existing scheme.

One systematic approach to the identification of O&M technical requirements can be broken down into four stages :

1. Description of the scheme

The major components of a scheme are described in which the essential aspects relevant to O&M are identified.

2. Description of O&M activities

O&M activities are described in a schedule so that the type and frequency of activities can be clearly seen.

3. Description of O&M requirements

The personnel, training, materials, equipment and funding requirements are identified. Responsibility for meeting the requirements can be allocated between the partners.

4. Identification of tasks

Tasks can be categorised into the different functions comprising O&M. Certain O&M tasks will be more critical than others for the sustainability of a scheme and they can be rated according to their importance. This enables priorities to be set either for comparison or for action (WHO and IRC, 1993).

The tasks are categorized as follows:

- supervision and monitoring
- operation
- preventive maintenance
- minor repairs
- major repairs.

An example of the procedure applied to a community managed handpump and a gravity system with standposts is given in the Appendix.

The following critical technical requirements need to be addressed if the most appropriate water supply technology is to be chosen:

- **Skills**

The technology must be suited to the existing skills among women and men. If the skills do not exist then either skills training must be arranged or, if this is not feasible, the technology must be revised.

- **Tools**

Operation and maintenance tasks must be capable of being carried out using tools which are commonly available and can be handled by men and women as required. (For example, The Afridev handpump spanner provides greater leverage when loosening than when tightening nuts). If specialist tools are required they must be provided and be capable of reproduction locally. Dependency on highly specialized tools is not sustainable.

- **Standardization**

Technology should be standardized as far as possible. Standardization leads to familiarity among users and maintenance personnel. Spare parts can be ordered and stocked in bulk and shared between communities. Skills training can be standardized and very specific. Maintenance tool kits can be standardized and limited to the essential tools required. The private sector is more interested in standard items which can be efficiently marketed.

- **Spare parts**

Spare parts are so important to O&M that they are considered separately in the following section.

- **Consumables**

Consumables - such as chemicals and fuel - must be available, affordable and of a quality which maintains acceptable system performance.

The above technical requirements are all pre-conditions for the local management of water supply operation and maintenance whether by a water agency or a community. Compared to individual communities, an agency often has better access to skills and services and a system of spare parts, materials and equipment supply. Therefore, when planning the handover of a water supply it is essential to identify each specific requirement so that the agency can continue to provide back-up support in critical areas.

In some cases, existing technology has been modified so that O&M activities can be carried out by the community. The development of the India Mark III handpump is an example.

Development of the India Mark III handpump

In India (c.1989) over 1.3 million India Mk.II deepwell handpumps served over 260 million people with safe water. Field experience had demonstrated that the handpump was durable but it was not easy to maintain. It relied heavily on a centralized mobile maintenance team comprising a vehicle equipped with special tools, heavy spares (pipes and connecting rods) and a team of three or four semi-skilled fitters to service the below-ground parts. An extensive project was undertaken to modify the standard India Mk.II handpump to make it more reliable and easier to service at the village level.

The research and development efforts resulted in a VLOM derivative of the India Mk.II known as the India Mk.III deepwell handpump. An essential feature of the new design allowed the extraction of the piston and foot valve without having to remove the rising main. This enabled repairs on the below-ground parts to be carried out at the village level by one caretaker with the help of another pump user.

In a report on the pump's development it was concluded that 'the shifting of most of the repairs to the village level will result in substantial financial savings and reduction in downtime which in turn will result in considerable financial and economic benefits'.

3.3 Spare Parts Requirements

The spare parts problem

The lack of spare parts has been a major constraint in the sustainability of water supplies. In some cases it has led to the complete abandonment of schemes. The problem is in large part due to the policies pursued by donors. In many cases, political considerations have required hardware to be purchased from the donor countries. Many donors, however, are only involved in the construction phase and do not make provision for the continuing supply of spare parts following handover. Some donors have attempted to overcome the problem by supplying a stock of spares at the time of installation. But this is only a short term remedy. Stocks do not get replenished due to the lack of a supply system and a lack of foreign exchange.

Even where donors have been receptive to the purchase and installation of equipment already used within a country, there has often been no consistent government or water agency policy on standardization. The outcome is a wide range of equipment for which the

stocking of a comprehensive range of spare parts is virtually impossible for an underfunded water agency. Therefore, spare parts availability and supply is a major consideration if water supplies are to be sustainable and suitable for community management.

Spare parts supply and demand

Spare parts are all those materials and goods that are necessary for the efficient and sustainable operation of the technical components of a water supply. This is a broad definition which includes mechanical and electrical parts and also tools, fuel, lubricants and chemicals.

Spare parts availability should be one of the main factors which decides the suitability of a particular technology or scheme. The mechanism for spare parts supply must be investigated, established and assured before deciding on a scheme. Very often, however, the question of spare parts arises only after the technology has been selected and installed, putting sustainability at risk.

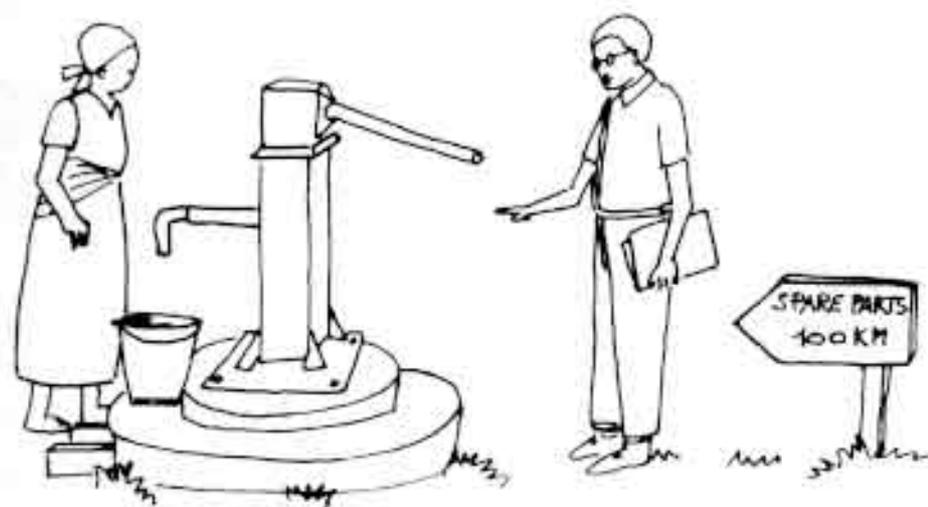


Figure 4: Are spare parts always available within an acceptable range ?

Assessing spare parts requirements

The community will need to know how much their water supply will cost to run and this will be determined partly by the demand for spare parts. Estimates may be based on previous experience, or on manufacturers' guidance. Care must be exercised in using manufacturers' figures as the need for parts will vary according to circumstances. For example, a diesel generator's air filter will require more frequent changes in a very dusty environment compared to standard conditions. The degree of usage, the care with which the equipment is used and the effectiveness of preventive maintenance will all have an impact on spare parts requirements.

A supply system will need to be identified which should include storage for fast moving parts (parts that are regularly used). An estimate of the parts required will indicate storage needs, frequency of purchase and allow a budget to be drawn up.

Subsidized parts

Subsidized spare parts may be helpful in the development of community managed maintenance. However, communities who are not fully prepared for the full cost of running their supply may run into difficulties if subsidies are withdrawn. Therefore, donors and external support agencies who do subsidize parts are not necessarily helping the long-term ability of communities to operate and maintain their own supplies.

Standardization

There are several important benefits that follow from the standardization of equipment:

- Maintenance personnel become familiar with equipment, spares and tools. Preventive maintenance needs become well understood.
- Common use of the same item of equipment encourages agencies and shopkeepers to store and supply spare parts as there is a guaranteed demand.
- Parts can be interchanged which makes the sharing of stocks possible and storage more economical.
- Users become familiar with the best way to operate equipment to give a longer life.
- The training of maintenance personnel can be standardized.

However, there are also several constraints to the adoption of standard equipment. Donor preference has already been mentioned. Projects funded by donors are often obliged to accept donated equipment which often originated in the donor country. This can build up problems for the future due to the large range of spares that must be acquired and stocked to support each donor's project.

Lack of a national policy does not help. If governments establish specifications with which equipment should comply, then standardization could be enforced. This would require donors to accept such stipulations.

For the formulation of a national policy on the standardization of specific equipment it is necessary to present possible options to the actors involved and reach agreements.

In 1993, a handpump standardization workshop was convened in Phnom Penh to recommend a set of standard handpumps for installation in Cambodia. All the main external support agencies and government departments responsible for the water sector attended. There had been concern among some agencies that with a large number of agencies becoming active in the water sector many different pumps might be introduced into the country. The workshop finally recommended the adoption of three different pumps based on lift requirement: low, medium and high lift pumps (UNICEF and OXFAM, 1993).

The introduction of standard equipment which is new to the country must be well planned so that sufficient support in terms of training and spare parts is provided.

It had been planned to introduce Afridev handpumps into small pilot areas in Mozambique. Based on the results of the pilot trials, installation of the pumps would be gradually extended to other parts of the country. However, due to a severe drought it was decided to import a large number of Afridev handpumps to replace worn out pumps and quickly install pumps on old and new waterpoints. Community workers and users were trained to install and maintain the pumps but difficulties were experienced in quickly establishing a spare parts distribution system. (Elias, 1993).

Local manufacture of spare parts

The supply of spare parts is substantially improved if they are manufactured within the country of use. This is a principal guideline of the VLOM concept. Therefore, equipment should be designed so that wearing parts are simple to manufacture from widely available materials.

Local manufacture can be stimulated through mobilizing local entrepreneurship and ensuring the right environment. Local businesses will need the appropriate licences for the import of raw materials and tax policies should encourage rather than inhibit local industry. Manufacturers in other sectors can be encouraged to consider production, e.g. plastics manufacturers, foundries and steel fabricators.

Local manufacture is reliant on raw materials supply, consumables (e.g. welding rods) and machinery. The initial selection of technology needs to take these factors into account. Material substitution can be investigated, for example, hardwood bearings in place of plastic.

Output should satisfy demand. Demand may vary but a stock of parts can act as a buffer to meet uneven demand. However, this requires capital for materials, labour and overhead costs and storage. This will require an injection of funds at the beginning of production to establish a stock for distribution. A government subsidy or donor grant can provide the initial kick-start.

To ensure the compatibility and reliability of parts it may be necessary for the government to institute standards and an inspection procedure. This happened in India, with UNICEF support, and the result was a widespread uptake of the standard India Mk.II handpump which is fully specified by the Indian Standards Institution.

Developing local production

The local production of India Mk.II handpumps was supported by UNICEF and it has been one of the successes of the rural water supply programme in India. By 1990 there were 45 approved manufacturers of the handpump in India with a capacity of 300,000 pumps per year. The advantages of developing local production were:

- Pumps available at short notice.
- Competitive prices.
- Spare parts easily available all over the country.
- Export of pumps worldwide earning foreign exchange.
- Employment created.
- Implementation of the rural water programme accelerated.

(McPherson, 1990)

A spare parts supply network

An important link in the supply of spare parts is the distribution system which gets the parts from the supplier to the user. To establish an efficient system a careful identification of potential businesses and outlets is necessary, for example shops, government agencies, local enterprises, extension agents and travelling artisans.

A supply system will include the holding of stocks at different levels to meet uneven demand. Adequate stocks at the village level are cost efficient and advisable if sufficient funds are available.

Spare parts monitoring and feedback

Monitoring of the purchase and use of spare parts can give useful indications of the performance of systems. If spare parts are not being purchased then systems are probably no longer working.

The frequency of part replacement may be allied to preventive maintenance schedules. Therefore, if the minimum number of planned part replacements have not been carried out then a preventive maintenance strategy is not being followed and further checks may need to be made.

The frequency of repairs and parts replaced need to be compared to previous experience and manufacturers' recommendations. Large discrepancies may indicate under-use, misuse, poor manufacture or that a change in the recommendations is required. Feedback to manufacturers on the use and weaknesses of spare parts can help to influence future design and manufacture.

The monitored costs of spare parts will aid in future budgeting. The economic life of a piece of equipment (a pump, diesel engine, etc.) is determined when the spare part and other maintenance costs exceed the cost of equipment replacement. Regular monitoring will allow decisions to be made on the timing of rehabilitation or equipment replacement.

Chapter 4: Financial Requirements

4.1 What are Funds Needed for?

Funds are needed to recover capital and recurrent costs.

Capital costs

Capital costs refer to the cost of construction, extension, rehabilitation and replacement of schemes. Capital funding must be sufficient to construct maintainable supplies. Cost cutting by constructing sub-standard supplies can be counter productive in the long term as poorly constructed systems will be more expensive to operate and maintain. External donors or the government have been the traditional sources of capital funds but there is now a trend towards asking the community to contribute too.

Recurrent costs

Recurrent costs are those incurred in the operation and maintenance of schemes. Examples include:

- fuel for powered pumps
- payment of caretakers and pump attendants
- spare parts for minor repairs and preventive maintenance
- important repairs
- extension or replacement
- monitoring
- transport.

The recent trend is to ask the users to pay for many of the direct and local-level costs of operation and maintenance. Additional funds are also required to provide agency support, e.g. payment of extension staff, training and monitoring. Therefore, even though a community may contribute to cover all the direct O&M costs of their supply, funds may still be required to cover the agency costs of O&M support. The support costs have been subsidized by the government and external agencies in the past. For sustainability, full coverage of O&M costs is the eventual goal for which communities will need to contribute both the direct and support costs of O&M, especially if replacement costs have to be included.

Table 8 summarizes the community contributions made to cover capital and recurrent costs for a selection of schemes in different countries.

Table 8: Community contributions to capital and recurrent costs of rural water supplies

LOCATION AND TYPE OF SCHEME	CAPITAL COSTS	RECURRENT COSTS
CAMEROUN Gravity-fed piped scheme from protected spring	Capital and labour contribution equal to 20% of total capital cost Trench and pit digging Carrying local materials (sand and stones) Cash contributions: CFA 500 per man and CFA 200 per woman	All recurrent costs paid by community, in accordance with service level: CFA 500 per taxpayer per year for standpost; CFA 5000 per year per house connection; CFA 100,000 per year per institution. Community contributions cover full costs of village plumber, spare parts and operating costs, at less than cost of service from state water corporation.
GUATEMALA Piped schemes with gravity feed or hydraulic ram, handpump schemes, and rainwater harvesting	Cash contributions for initial downpayment Repayment of community loan supplemented by agency donation Trench and pit digging Carrying local materials (sand and stones)	Users make monthly payments which cover all operation and maintenance costs, including employment of a local plumber. Community water boards form local associations to provide mutual assistance in solving problems of operation and maintenance, and local management.
HONDURAS Borehole wells, communal tank networks, independent communal tanks served by tankers	Payment of a cash contribution (30% of development costs) Repayment of a loan into a revolving fund for remainder (70%) Provision of unskilled and semi-skilled labour for construction Provision and carrying of local materials Funding of paid unskilled labour as substitute for own labour	Payment of a monthly fee in accordance with service level: US\$1.75 for use of a standpost; US\$3.00 for a yardtap. Monthly payments include costs of water board staff and hiring of a plumber.
INDONESIA Piped schemes and rainwater harvesting, public bathing facilities	Full cost met by most communities in most cases Combination of cash and in-kind payments + loans and credit Individuals contribute according to socio-economic status Poorest members often exempt from payments Grant assistance may be arranged if communities have difficulties Provision of local materials + skilled and unskilled labour	Full costs met through user fees, depending on service level and system costs; range from US\$5.00 to US\$50.00 per household per year. Funds also raised through local revolving funds, lotteries, credit systems, entertainments, etc.
PAKISTAN Gravity-fed piped scheme from protected spring, with yardtaps	Villagers contribute to a common fund to support the work of the Village Organization (VO) as a precondition for support Agn Khan Rural Support Programme secures loans or grants Provision of local materials and labour Additional funds raised by fining those who don't meet communal labour obligations Village funds hire local plumbers to help in scheme construction	Users meet costs of operation and maintenance through continuing contributions to the village fund. Additional funds raised through the imposition of fines for improper use or wastage of drinking water. Village funds used to hire local plumber for repairs as necessary Individuals are personally responsible for maintaining pipes and taps for their own yard connections.
UGANDA Borehole wells with handpumps, protected springs, gravity-fed piped schemes	Community contribution based on negotiation with no set formula Cash contributions usually cover only a small part of costs Provision of local materials and labour Funds may come from cash collections, donations from prominent individuals, auctions, lotteries, raffles, or local taxes	Users pay fees to cover costs of spares and payment of pump mechanic. Volunteer caretakers "paid" by being exempted from communal labour obligations. Additional funds raised through the imposition of fines.
YEMEN Piped schemes based on boreholes with motorized pumps	Communities must have a reliable water source, usually a borehole, before the project begins. This is secured either by the community's own efforts or by requesting assistance from the government or a donor Communities meet about 30% of scheme development costs through labour and other in-kind contributions	Users pay a monthly metered charge, which is enough to cover the costs of fuel, oil, spare parts, and the salaries of scheme operators. When a major breakdown occurs, special collections are made to pay for the repairs.

4.2 Why Should Users Pay?

Recurrent funding for operation and maintenance has generally been insufficient to protect the capital investments made in water supply schemes. The result has been a high percentage of poor and broken down supplies. As a consequence, rather than substantially increase the percentage of people supplied with safe water, new supplies have hardly been able to maintain coverage. The continued provision of free and subsidized services in the absence of sufficient funds to cover recurrent costs is not sustainable.

The case for user payment derives from several interconnecting arguments:

the capital funds which are currently made available are inadequate to provide a safe water supply for everyone

the public funds which are currently made available are inadequate to meet the full recurrent costs

subsidies reduce the decision making power users might have if they were paying for their service

subsidies discourage cost-efficiency and the development of low-cost solutions

many poor people already pay high rates for services and evidence suggests they would be willing and able to pay for improved services

properly regulated user charges would allow the provision of better services at a lower cost to the poor

payment may increase the commitment of users to the sound management and use of systems

user payments maximize the use of available resources

user payments result in the maintenance of a good standard of service.

(adapted from Briscoe and de Ferranti, 1988; Katko, 1990)

Many people are already paying a high price for poor quality and poorly delivered water services. In some cases, users are having to pay government water rates plus the extra costs of 'unofficial' maintenance to keep systems functioning (McPherson, 1990). High rates are also paid to water sellers where improved delivery systems do not exist or have broken down (Evans and Appleton, 1993). An improved service paid for by the user could mean that, in many cases, people ultimately pay less for a better service.

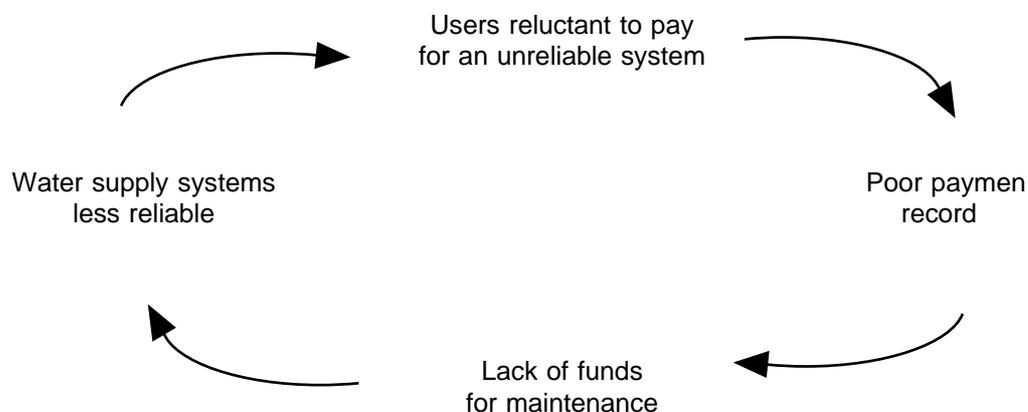


Figure 5: The vicious circle of underfunded and poorly maintained water supplies.

4.3 Ability and Willingness to Pay

O&M costs can only be recovered from users if they are both able and willing to pay for a water supply. It has been said that people should not have to pay more than 3 to 5% of their income for water and sanitation services. Actual payments vary greatly (Evans, 1992). A higher percentage of income expended on water will mean other important needs may not be fully met. Therefore, great care is required when setting user contributions.

Even if users can afford to pay O&M costs they may still be unwilling to pay. People will want to weigh the cost of an improved supply against a range of factors before committing themselves to paying.

Some important factors which influence the willingness of users to pay are listed below.

- **Income**

If users cannot afford to pay they will clearly be unwilling to pay.

- **Service level**

Users may be able and willing to pay for a handpump but not for a more expensive yard tap. On the other hand, users may only be willing to pay for a higher service level.

- **Standard of service**

People are unlikely to pay for a poor service.

- **Perceived benefits**

Agencies and donors may see the most important outcome of a safe water supply in terms of health benefits. However, users may place a higher priority on the more immediate social and economic benefits. Perceived benefits may vary within a community. For example, men may be attracted by the commercial opportunities of greater quantities of water whereas women may be more interested in the greater convenience of a supply. Some people may stand to gain more than others and this can result in a variable willingness to pay within the same community.

- **Opportunity cost of time**

In the majority of situations it will be women's time that will be saved by an improved supply. Men and women may value the time saved in collecting water differently and women may be more willing to pay than men.

- **Acceptability of the existing source**

If users perceive their existing source to be acceptable they may be unwilling to pay for a new supply.

- **Confidence in the service agency**

Past disappointments have often undermined people's confidence in existing agencies and new initiatives. Users must have confidence that whatever they pay will be used by the management body to provide an acceptable service. An open and clear financial management system will help to instill trust and encourage payment.

- **Community cohesion**

Individuals in a divided community (due to ethnic, clan, class, political, or leadership divisions, for example) may be unwilling to pay into a common fund.

- **Policy environment**

Previous policies have encouraged the belief that access to safe water should be free. People may be unwilling to pay for something which they feel should remain free.

- **Perception of ownership and responsibility**

People may be unwilling to pay for the upkeep of a facility which they feel belongs to the government. Such a feeling may persist even when a system has been formally handed over to a community.

- **Institutional framework**

Community management structures which either bypass traditional authority or do not give users a reasonable say in the running of schemes may not be supported.

Although people may want a water supply, there are a complex range of issues which decide whether they are ultimately willing to pay for one. It is particularly important to identify who 'they' refer to. Women are often responsible for the provision of water in the household and the burden of water payments may fall on them. Therefore, payment studies must carefully consult the actual people who are going to have to make a decision on payment rather than approach the often more accessible male leaders in a community.

People may be willing to pay but they may be unable to afford the immediate combined capital and recurrent costs to get started. In such a situation, the availability of loans and credit can facilitate the initiation of a scheme. Agreement may be reached among users to exempt the poorest and seriously disadvantaged from payment.

4.4 Cost Sharing

Cost sharing involves negotiation on both capital and recurrent costs between the partners in a scheme. Community management usually involves the community and at least one other partner: a government agency, a non-government organization or, in some cases, private contractors or suppliers. Capital costs are often subsidized by government or a donor to initiate a programme. The recurrent costs of services provided by a support agency, such as training, supervision and inspection, may be shared with the agency. To maintain standards, governments may have to fully fund some of these activities, such as sanitary surveys and water quality testing.

The costs of employing a plumber or mechanic and travel for someone to purchase spares and consumables may be expensive for one community. It can be more efficient and cost effective for several communities to share these costs.

Table 9: Division of operational and financial responsibilities of administrative tasks

Example: Administrative Tasks for Most Water Supply Systems		
Tasks	Operational Responsibility (Who will do it?)	Financial Responsibility (Who will pay for it?)
1. Conduct technical and economic studies of the most appropriate water system designs.	1. Government agency with community input	1. Government
2. Analyze operations and maintenance tasks for use in planning and budgeting.	2. Government agency with community input	2. Government
3. Prepare annual budgets and estimates of longer term financial needs.	3. Community with agency support and government Agency, for respective tasks	3. Community and government agency
4. Select and appoint operators/contractors for routine or special O&M.	4. Community with agency support	4. Community
5. Develop and evaluate technical and management training for water system operators.	5. Government agency with community input	5. Government
6. Provide ongoing technical and management training to operators.	6. Government agency and community	6. Government agency and community
7. Delegate task responsibilities, supervise and pay operators/contractors.	7. Community	7. Community
8. Keep archives, inventories, and log books.	8. Community	8. Community
9. Develop and evaluate financial and management training for community managers.	9. Government agency with community input	9. Government
10. Provide ongoing financial and management training for community managers.	10. Government agency and community	10. Government agency and community
11. Collect water fees and manage revenue.	11. Community	11. Community
12. Make payments for purchases, loans, or other obligations.	12. Community	12. Community
13. Keep accounting records.	13. Community	13. Community
14. Make visits to nonpayers or other problem households.	14. Community	14. Community
15. Respond to user complaints.	15. Community	15. Community
16. Organize and conduct general meetings for discussions, elections, etc.	16. Community	16. Community
17. Organize training and information on hygiene education.	17. Government agency with community input	17. Government
18. Develop information and materials on hygiene education.	18. Community and government agency	18. Government
19. Organize community contributions for upgrading or extending the system.	19. Community	19. Community
20. Report urgent problems to support agency.	20. Community	20. Community
21. Provide technical and management support to community managers.	21. Government agency	21. Government
22. Report periodically on O&M and administration to government agency.	22. Community	22. Community
23. Collect, analyze, and interpret monitoring results, and plan and conduct follow-up support or training if necessary.	23. Government agency	23. Government

4.5 Sources of Funds

The method of funding O&M must be appropriate to the type of supply and the socio-economic circumstances of the users.

Methods of funding

In northern Ghana, the operation and maintenance of communal open wells in remote villages required intermittent funds to replace worn buckets and rope. Regular charges for water were inappropriate as sufficient funds could be raised when required through household collections. Both men and women contributed as individuals.

In a commercial tea and coffee growing area of Kenya, the Murugi-Mugomango Water Society managed a gravity piped water supply and recovered operation and maintenance expenses by metering all yard connections and charging a monthly water tariff based on the volume of water used. Revenue was deposited in the Society account at a nearby rural bank. A bill collector and accountant were employed to collect and oversee the finances.

(Davis, Garvey and Wood, 1993).

Methods of raising funds for O&M are summarized in Table 10.

The success of community fund raising depends on existing practices within the community, leadership, trust and continuing confidence in the management of funds. The timing of fund raising may be critical in agricultural communities with marked variations in seasonal income.

A community revolving fund can be used to replace direct charges for water. Initially, a maintenance fund is established through a fund raising activity. Part of the fund can then be used to give loans to individuals or households. Repayment with interest increases the total value of the fund. Limiting the number of loans at any one time can help to put pressure on defaulters by members of the community who also want to take out loans. To be successful, a revolving fund must be responsibly used and well managed (IRC, 1989).

There may be informal methods of raising funds from wealthier individuals. Successful traders and farmers may be able to give loans to be paid back out of community funds, with or without interest. This type of informal credit is not suitable for the regular funding of preventive maintenance but it may hasten the response to corrective maintenance needs or finance the modification or extension of a supply.

The management of funds encompassing cost estimation, budgeting, tariff setting and the handling of funds are considered in chapter 3, 'Financial management'.

Table 10: A summary of operation and maintenance funding methods

<i>Type of funding</i>	<i>Method</i>
<p>Community funds</p> <p>Voluntary fund raising</p> <p>Community income</p> <p>Cooperative funds</p>	<p>Funds for simple water systems may be collected periodically when required through meetings, household collections and festivals or on a regular basis.</p> <p>In communities with their own sources of income, such as communal farms, a proportion of income may be set aside for O&M.</p> <p>Profit from a production co-operative or a village revolving fund is used.</p>
<p>Water rates</p> <p>Flat rate</p> <p>Graded rate</p> <p>Water metering</p>	<p>Users pay a flat rate per person, or per household, for a public standpost or private tap connection.</p> <p>In communities with significant differences in water use and benefits, users may pay different rates on a graded system.</p> <p>Connections are metered and users pay per household (private taps) or per user group (public taps).</p>
<p>Water selling</p>	<p>Water is sold from metered taps at set prices by concessionaires, paid operators or by user groups (such as women's associations).</p> <p>Coupons are bought by users and exchanged for a fixed volume of water, e.g. a bucket coupon.</p>
<p>Taxation</p>	<p>There are various forms of local government taxation for general services out of which funds for water supply O&M can be allocated.</p> <p>Community taxes can be raised through local taxation of agricultural produce leaving the area, road tolls, a tax on businesses using water, etc.</p>

Micro-credit

A micro-credit system could be useful not only in the case of initial capital investment, but also for the following activities:

- cash advance when problems of cash flow (in the case of seasonal incomes for instance)
- financing of big repairs or unforeseen expenses
- replacement, rehabilitation or extension costs
- rotating fund for spare parts and tools acquisition.

The implementation of a micro-credit system will depend on the needs and the local capacity to manage such a system. Some basic elements should be highlighted as pre-conditions for the setting up a micro-credit system:

- Confidence - among users of the system is the foundation of the system.
- Capacity to pay - the capacity to pay or reimburse loans must be well evaluated, taking into account various scenarios of reimbursement patterns.
- Building on existing structures - if possible, build on existing traditional groups, or women / rural small associations.
- Expertise - the setting up of a micro-credit system need the support of specialists.
- Step-by-step - the setting up of micro-credit system can be done gradually, as a step-by-step process.

Other possible sources of financing

Local authorities, municipalities, districts have an income through local taxes or through allocations from the regional or national level. Some of these funds can be used for recurrent expenses, but they will be submitted to a general municipal or district policy.

Regarding external funds, most donors do not want to be involved in the financing of operation and maintenance, unless it is in the case of capacity building exercises.

Other national or local credit organizations can have a role in the source of financing. Their usefulness will depend on the importance of the scheme and the level of development of the country.

Chapter 5: Health and Environmental Requirements

5.1 Hygienic Operation and Use

The advantages of a well-maintained, safe supply of water can be drastically reduced if the collected water is not subsequently handled and used hygienically. The hygienic handling and use of water is an important part of O&M in its broadest sense.

Hygiene may be more important in the operation and maintenance of some systems than others. Users can follow simple agreed operational rules as shown by the following examples.

Use of an open well

To maintain the quality of open well water, the correct use of a bucket and rope lifting system is important. There are various combinations of lifting systems using communal or household buckets. Each system has its merits and drawbacks regarding hygiene. What is important in many cases is not so much the type of system but agreement by all users on how to operate it so that water quality can be preserved.

User operation of a standpost supply

Unsafe and insanitary conditions due to the careless handling of water at the standpost must be avoided. Typical rules that consumers and users agree on through consultation include :

- wash hands and containers before collection
- avoid spillage, but if it does occur, direct all wastewater to the drainage channel
- do not leave taps open when there is no flow as water will be wasted and create insanitary pools when flow recommences
- do not leave taps running unattended
- do not drink water directly from the tap
- do not allow cattle and other animals within the fenced area of the standpost.

(adapted from IRC, 1993b)

The hygienic transport and use of water from the source to the point of final use is important for all supplies. For example, the coverage of containers during carrying and storage and the prevention of contamination through touching the collected water. Raising awareness of the need to take measures to safeguard water is an important part of community action. Hygienic operation and water use can be promoted by all O&M personnel. For example, a standpost caretaker's role often includes promoting the careful and hygienic use of taps.

The user is responsible for how the water is used and the engineer has a responsibility to design and construct a system which encourages hygienic use and which can be maintained in a hygienic condition.

5.2 Environmental Protection

The state of the environment can directly affect the quality and yield of a water source. Therefore, in its broadest sense, maintenance of a water supply includes the protection of the water source environment.

Protection of the environment to maintain water quality

This means the protection of surface water catchments and groundwater sources at both the local level and beyond. At the local level there should be procedures to ensure that the positioning of latrines and the agricultural use of chemicals (fertilizers, pesticides and herbicides) do not result in the pollution of water sources. Land-use can affect the quality of surface water sources, especially upstream of supply intakes. A change in land-use from forest to cultivated farms can give rise to high turbidity levels due to the fine soils washed into water courses by rainfall runoff. High turbidity can result in blocked pipelines and valves as well as in a drastic reduction in water quality. Sedimentation and filtration processes cannot always cope with the higher loads and operations become strained.

Participatory activities on how men and women use water catchments and waterpoints help to raise awareness of how water is contaminated. This can be a good start to jointly addressing problems which can be solved locally.

Community monitoring of sources and their catchments can help to alert users and the relevant authorities to the dangers of contamination.

Partner agencies can raise awareness of the potential problems through participatory activities and provide practical advice on environmental protection. Periodic monitoring by government inspection agencies through a combination of sanitary surveys and water quality testing is an important aspect of O&M.

At a wider level, community sources need to be protected from industrial pollution through the enactment and enforcement of appropriate legal provisions. Communities have a role in monitoring polluters and lobbying for effective control measures. If measures are not taken to control pollution then the consequences can be very serious as the following example shows.

In Tamil Nadu, an immense growth in the tanning industry has resulted in polluted groundwater far from the tanning sites. Percolating effluent reaches the water table after being discharged from the tanneries into dry river beds. Groundwater contamination is known to spread up to 5km from a discharge site and as there are many scattered tanneries the effect is widespread. The tanning process uses many chemicals including heavy metals such as cadmium, arsenic and chromium which can all be toxic to people in sufficient concentrations. Many community wells are contaminated as a result of the tanning practices (Muthu, 1992).

Management of the environment to maintain water yield

Deforestation and the burning of grassland removes the absorptive capacity of land to retain and slow the drainage of water. The resulting rapid runoff and reduced groundwater recharge can result in water sources drying up. The pressures on land for many communities makes it difficult to enforce measures to manage and protect water catchments. Communities need advice on the effects of land-use changes and what can be done to

protect water supplies. As part of village management training, some projects include the promotion of measures to protect the water source and the catchment area (IRC, 1993a).

Management of water-use to avoid the over exploitation of water resources

The over exploitation of groundwater sources by both manual and motorized pumping for agricultural purposes can result in declining groundwater levels. If measures are not taken to limit water abstraction then the effect on domestic wells can be disastrous, as described in the following example.

The large scale use of groundwater for irrigation in Bangladesh resulted in a significant lowering of the water table before the monsoon season. As a result, in the early 1980s many suction pumps supplying water for domestic use were unable to function as the water table fell below the maximum suction lift of about 7.5 metres (Kjellerup, 1989).

Therefore, monitoring to detect early signs of the significant long term lowering of groundwater levels is an important aspect of O&M. Groundwater levels can be monitored locally by the community as part of regular O&M activities. The government or responsible water agency can monitor regionally and nationally.

PART III

DEVELOPING AND MANAGING OPERATION AND MAINTENANCE

Chapter 6: Operation and Maintenance Development

6.1 The Partnership Approach

Management models

Management models range from highly centralized government systems to localized community management. Several models lie between these extremes. Typically, O&M management systems comprise stratified levels of maintenance and repair bodies. A common model has a central government agency at the first tier, a second tier regional government or private body and a third tier community organization. Traditional water supplies are managed by a single tier system of community management.

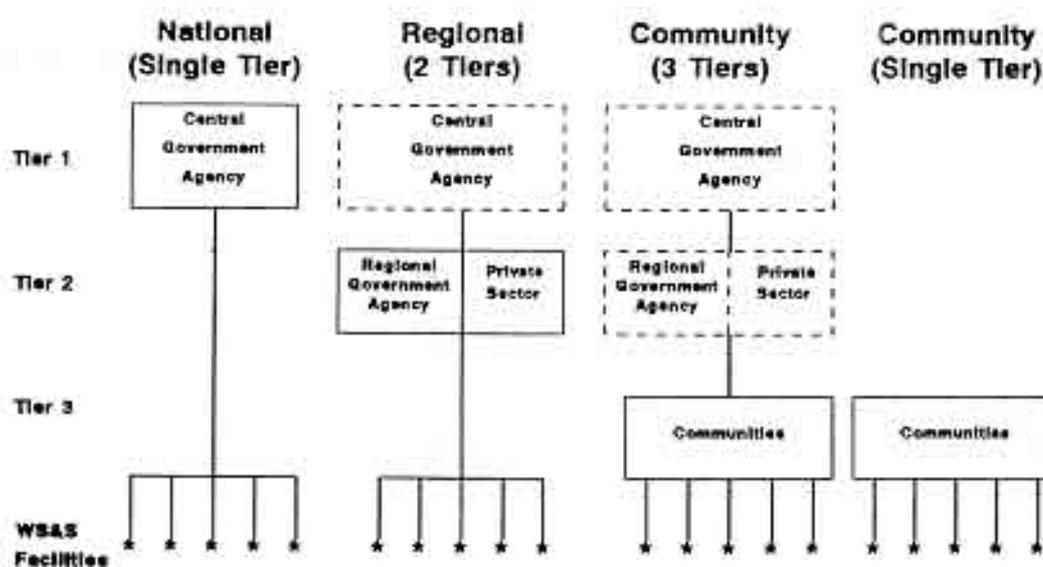


Figure 6: Management models and tiers of responsibility (Roark, P. et al., 1993).

A three tier maintenance system

Zimbabwe has adopted a three tier maintenance system:

at village level where the community is involved in basic and preventive maintenance of their water source through an elected Waterpoint Committee (WPC), which includes voluntary pump caretakers
a mobile Pump Minder (PM) operating at ward level (sub-district) assisting WPCs and having responsibility for up to fifty water points
a skilled District Maintenance Team (DMT) equipped with transport and tools to back-up the Pump Minders and WPCs.

(Clever, 1991)

It is clear from past experience that, in many cases, centralized government controlled systems of management have not always been able to sustain supplies. This chapter advocates the revision and adaptation of centralized systems of operation and maintenance to decentralized management partnerships.

The following factors relating to centralized management often contribute to O&M failure:

- an overdependence on government agencies who do not have the resources to keep supplies functioning
- user expectation that government provides all the necessary services and funding required to maintain supplies
- user non-payment for water services
- a lack of user involvement in decisions concerning their own water supply.

Attempts have been made to adapt existing centralized management systems to overcome some of the above problems by adding a 'community participation' element. But 'community participation' has often merely referred to contributions of labour for construction rather than the comprehensive participation of a broad range of community members in decision making and long term management. The expression also suggests that the community is taking part in an agency project. Perhaps what is really required is more accurately described as 'agency participation' to support a community service. The 'partnership approach' refers to a more equal and supportive relationship between the community and external organizations.

An agency-community partnership means joint decision making and management from the start of a project. This is essential if the choice of technology and scheme design is to meet the community's needs, expectations and capacity to operate and maintain a system in the long term. The partnership, therefore, starts at the beginning of a project and continues through every stage of the project cycle, from feasibility through construction to the management of operation and maintenance.

The division of partner responsibilities

Partnership should be seen as a flexible and evolutionary process, requiring continual dialogue. The sharing of costs and responsibilities will vary according to the type and stage of development of the partnership. Some communities will want and be able to manage a major share of the responsibilities from the outset. Others will need to start with a low level of responsibility and gradually build their expertise and confidence.

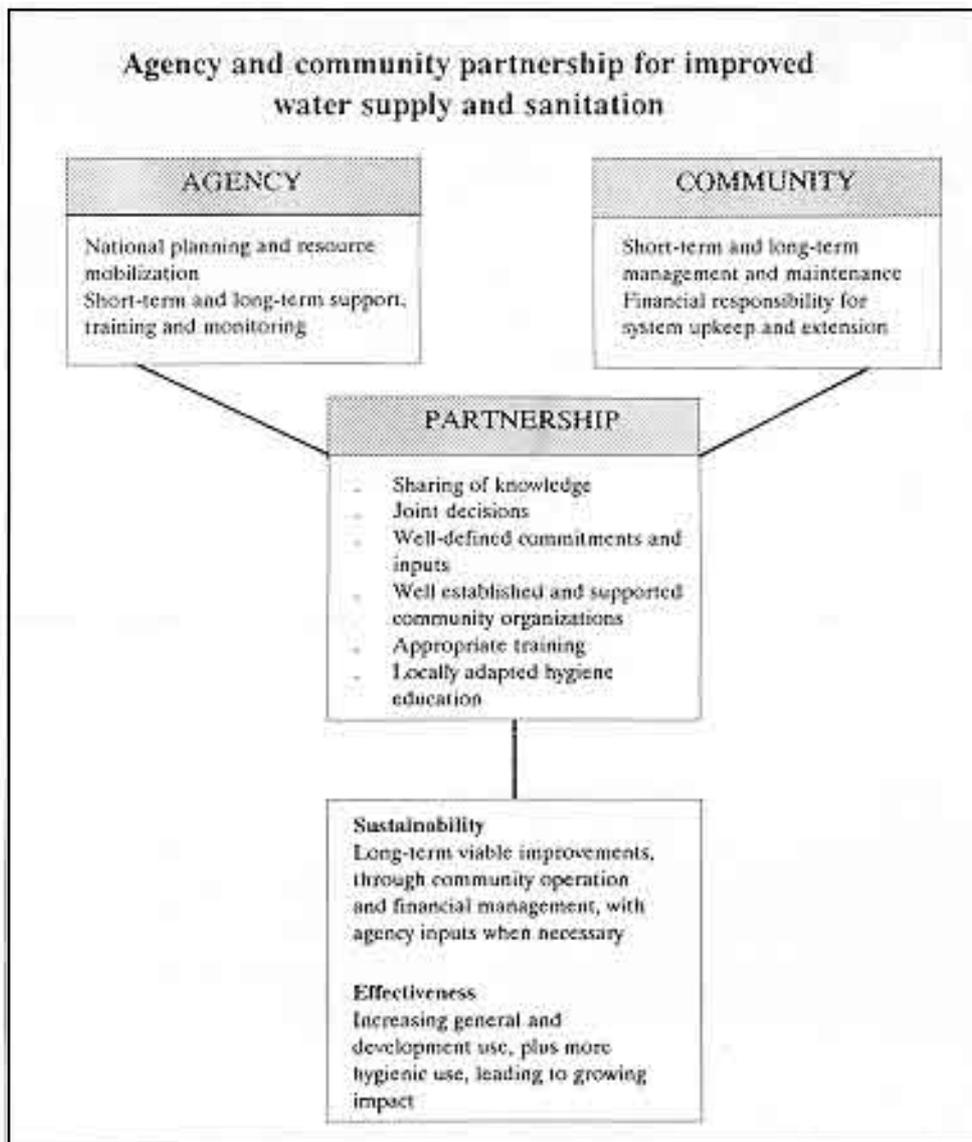


Figure 7: Agency and community partnership (IRC, 1991).

Benefits of the partnership approach

The benefits of the approach are clear:

Technologies can be chosen based on community awareness of their advantages and disadvantages.

Different communities have different expectations and capabilities. Even within one community there will be differences. The partnership approach allows time and opportunities for people's views to be considered in relation to the long term feasibility of operating and maintaining supplies. Differences in service levels and ability and willingness to pay can be accommodated in scheme designs, and so on.

In the process of implementing a water supply project the various management, technical and financial skills required by members of the community can be identified and specific training programmes established.

The general enhancement of community skills, knowledge and capabilities will benefit other development activities. This 'capacity building' is a principal aim of the partnership approach.

Implications for the water agency

This different approach has several implications for a water agency:

- The aim is to replace unsustainable government subsidized O&M services by externally supported community management. This is expected to eventually reduce government expenditure per operational water supply.

In Benin, for example, the replacement of a centralized handpump maintenance system with a community based approach reduced agency maintenance costs by 16% per year after an initial investment for community support of 13% of total construction costs (IRC, 1988).

- Agency staff will need to adjust their attitudes. Staff will no longer be making all the decisions themselves and giving instructions. They will need to listen to people's views and ideas. They will need answers to questions communities ask on O&M costs, reliability, service levels (e.g. the cost of house connections), and so on. Compromises will need to be made between the technical efficiency of a scheme and the non-technical factors influencing the wishes of the users.
- The new roles of community liaison, training, hygiene promotion and financial advice require personnel with the requisite skills. This may mean the appointment of new staff, the secondment of staff from other government departments, the contracting of consultants and private sector advisers or the retraining of existing staff.
- The multidisciplinary approach requires the integration of professionals from non-technical fields and closer cooperation with other government departments. This in itself is a challenge as existing practice does not always provide for the easy integration of different disciplines and government departments.
- Training on gender awareness and gender skills and the employment of female field staff will help to encourage and enable women in communities to participate in the partnership.
- Agency targets and staff achievements should no longer be measured in terms of systems built but in the capacity of communities supported by the agency to maintain and use their water supplies efficiently.

An essential condition for the partnership approach to succeed is that agency support must be timely and reliable.

6.2 Developing an Operation and Maintenance System

There are two levels at which the development of an O&M system needs to be considered:

- the programme, perhaps country, level
- the individual project level.

This paragraph proposes a generalized systematic approach to the development of an O&M system at the programme level. The subsequent section considers the planning of O&M at the project level.

Experience shows that non-technical issues play a considerable role in determining the effectiveness of O&M. Therefore, personnel involved in O&M assessment and development should cover a range of relevant disciplines: social development, health, management, as well as engineering. It is important that the process is consultative and carried out in partnership with the operators and users of schemes.

Developing O&M at the programme level

Review

The first stage is a review and analysis of the present approach to O&M as applied to all schemes within a programme. This entails identification of the problems and constraints related to organization, finance, personnel, logistics and technology.

Identify the cause and effects of poor O&M within each scheme. Review the analysis and possible solutions with key personnel and organizations. Establish guiding principles and decide on the general approach to be promoted.

Development

Analyze the O&M requirements for the proposed water systems. Identify the activities and actors to fulfil the different O&M roles. Consider the implications in terms of organization, management, financing, logistics, technology, training and gender. Compare the feasibility of the proposed system in relation to the existing legal and political framework and the prevailing and likely future economic conditions.

Consult with the different actors on their roles and activities. Adjust the proposed system so that it is feasible and replicable throughout the programme. Present the O&M system for discussion with all the main parties involved, including national and local government departments, policy makers, the private sector and representatives of the users.

Testing

Select areas for pilot projects to test the feasibility of the O&M system. Conduct training for the people involved, including key agency staff, community representatives, and people and businesses in the private sector. Take the gender implications of training into account as regards who is able to attend - women and men. Ensure training methods and materials are adapted to different literacy levels and local language variations.

Test the O&M system in the selected areas. Monitor and evaluate the functioning and long term sustainability of the O&M system and adapt it where necessary. Present the findings of the test phase to the main parties involved. On the basis of the findings and feedback received, decide how to apply the system further to the whole programme. If necessary, make submissions for alterations to policy and the legal framework.

Expansion

Make three-year and long term plans for expansion of the O&M system. Identify the implications of the changing roles of personnel and organizations with particular reference to technology selection, community management, gender balance, agency support, monitoring, and spare parts production, distribution and sale. Identify the training needs and

establish training programmes for those involved. Publicize and communicate the plans for the new approach and its implications to all those concerned through seminars, workshops, meetings and the media.

Apply the O&M system to all new projects and introduce it in existing systems. Adapt the system to take account of regional and local conditions. Monitor the performance of the system and adapt it as necessary. Changes can be introduced as part of regular (three or five year) rolling plans.

Developing O&M at the project level

There are two different starting points for developing O&M at the project level:

- A completely new scheme
- An existing scheme with inadequate O&M.

- **New scheme**

A new scheme will pass through a series of stages in a project cycle before it is commissioned as a functioning water supply. A principal aim of the partnership approach is for the community and agency to work together at every stage so that the community can manage O&M from the first day of commissioning.

The critical factors which affect O&M at each stage of the project cycle are indicated in Table 11.

The project cycle includes the selection of a water supply, service level and O&M management system best suited to a particular community. A proposed outline selection procedure is shown in Table 12.

Partnership planning

The partnership approach to planning has been successfully followed in the Community Self Financing of Water and Sanitation Systems (CSFW) project promoted by the NGO CARE in Indonesia. CARE outlines various water supply options for the community who then make their choice of system. The village water committee is then assisted to design and cost the system and develop a resource mobilization and construction plan. The plan is considered by the community at a meeting before a formal agreement is signed between the three partners: the community, the Government of Indonesia and CARE. A village sub-committee is trained on the prevention of water-related diseases and how to conduct a hygiene and sanitation survey. Based on the results of the survey a public health education campaign is planned.

(Sucipto and O'Brien, 1992)

Table 11: Incorporating O&M issues at each stage of the project cycle

STAGE OF THE PROJECT CYCLE	ACTIVITIES	O&M ISSUES
INITIAL CONTACT	Establish a committee	Commitment to long term management of O&M.
ASSESSMENT	Needs assessment	Water quality and quantity to be supplied. Level of service required and desired. Degree of hygiene promotion for men, women and children. Priority of a water supply against other needs. The particular needs of women as traditional managers of domestic water.
	Resource assessment	Male and female leadership and user support for community management. Legal framework for community management. Existing management structures. Existing interest, management expertise, technical skills and organizational capacity among women and men. Funding for both capital and O&M costs. Existing water resources and potential for development. Knowledge of water and health issues among women, men and children.
IDENTIFICATION SELECTION & PROPOSAL	A comparison of water supply options.	Can the proposed scheme meet the needs within the available resources? That is: Chosen technology - familiarity, complexity, skills, spare part supply, reliability, suitability, gender sensitivity.
See Table 4	Selection of a supply and O&M management system following consultation between the partners.	Cost - total and individual user cost of O&M, regular and intermittent payments. Share of costs and O&M responsibilities with the partner agency. Can funding cover costs ? O&M time frame - time for training, user Impact on the environment and implications for O&M.
	Proposal for a plan of action.	Impact on women and men and their roles in O&M.
IMPLEMENTATION	Design, construction, community mobilization, training, health and hygiene promotion, fund raising.	Community involvement (women and men) in: <ul style="list-style-type: none"> • Detailed design - to ensure workable operation and maintenance. • Construction - familiarization with the scheme. • Hygiene promotion - water handling and use. • Training - O&M technical and managerial skills acquisition, gender awareness.
MANAGEMENT	Management of O&M.	Operation and maintenance of the water supply. Collection of O&M funds. Liaison with the partner agency. Optimizing the handling and use of water. Planning future modifications and extensions.
MONITORING & EVALUATION	Regular monitoring of O&M activities. Joint evaluation exercise by the O&M partners.	Is the water supply functioning reliably, how is it being used, and is this expected to continue? Is the O&M partnership functioning satisfactorily and is this expected to continue? Impact of O&M on health, the environment, women, men and children.

- **Existing scheme**

An existing water supply may require redesigning to match the capabilities of the partners involved in O&M management. The project cycle followed will be similar to developing a new scheme. Freedom to choose a viable O&M system will be constrained by the system that already exists. The protection or rescue of former investment may be a high priority.

After a review of multi-village piped water supply schemes in Tanzania, operation and maintenance was found to be too complex. It was decided to re-design the schemes to serve single villages only and simplify the management of O&M. There were also good technical and economic reasons to choose single village, small-scale schemes: the system hydraulics is simplified and peak demand is not so high, therefore pipe diameters and tank capacities can be smaller.

Problem analysis

The identification of the social and technical problems which caused system failure should provide a starting point for the rehabilitation of a scheme and improvements to O&M management. Both the community and agency need to identify the problems together as they may have very different perceptions of the reasons for failure.

Risk analysis

If a risk analysis is carried out for each water supply option then an attempt can be made to anticipate factors which may change and affect O&M. This will not be easy, especially in unstable economies where inflation and the availability of imported equipment and spare parts are difficult to predict. However, a comparison of schemes can indicate the degree of risk attached to each option.

If such a risk analysis had been carried out prior to implementation on the multi-village piped water supply schemes in Tanzania, described above, the weak points and chances of failure might have been anticipated. If the economic cost of failure and other risks had been deemed too high then single-village schemes might have been implemented from the beginning.

Table 12: An outline procedure for the selection of a water supply and associated O&M

<i>STEP</i>	<i>DECISIONS</i>	<i>CONSIDERATIONS</i>
1	Choice of technology	Existing and potential water sources. User preference by gender. Service level. Skills and spare parts availability. Cost. Reliability.
2	Initial degree of community management	Sharing of management responsibilities between the partners. Skills availability. Capacity to organize and integrate functions. Cost of management. Risk of management failure. Women's involvement.
3	Division of costs	User (women and men) ability to pay. User (women and men) willingness to pay. Availability of subsidies. Other external financial support.
4	Is the technology and service level manageable, affordable and agreed between partners?	
return to step 1	NO	
	YES	
	Formal agreement on a plan of construction and O&M management	

Chapter 7: Operation and Maintenance Management

7.1 Community Management

All communities comprise a diverse range of people categorized according to ethnicity, socio-economic status, religion, politics, trade, age and gender. One of the challenges of O&M management is to enable all the people within a community to organize and work effectively together.

Community cohesion

The degree of community cohesion can be a critical factor in determining the type of water supply and how it should be executed and managed. For example, a divided community may not work happily together on the management of a common piped distribution system whereas separate handpumps for each group might be acceptable. But more positively, the management of a water supply might provide the opportunity for previously divided communities to work together.

Demography

Rural communities can be compact villages or scattered settlements. The distribution of people in a community can have an important influence on the choice of water supply technology and the character of the O&M management system. For example, in a village which has developed along the line of a road, a handpump is only likely to serve a limited number of people. Therefore, only a small section of the village may be interested in its management and in paying O&M contributions. This is likely to be the same for a borehole drilled on the edge of a large village or within a widely scattered settlement. If the small user group is unable to fund handpump O&M then a technology requiring lower cost maintenance might be more appropriate - a protected well, for example.

Piped supplies are often attractive to users because of the reduction in effort and time required to obtain water. However, residents near to a spring source may be reluctant to participate or contribute to a scheme if there appear to be no extra benefits. In some cases they are not served at all as the spring water is often piped directly to the main settlement downhill.

Scale and the number of communities served

The management of a large scheme supplying several sections of a village or several communities is clearly far more complex than the management of a single well. As far as capital costs are concerned, it may be more cost-effective to supply a large number of people with an extensive distribution network than to have several smaller pipe networks supplying individual groups or communities. However, extensive distribution schemes are only appropriate if all the communities can work effectively together. Furthermore, it cannot be assumed that the operation and maintenance of large schemes will be as cost-effective as small community managed schemes. The example of multi-village schemes in Tanzania which had to be redesigned as single-village systems was mentioned earlier.

Collaboration between communities

Communities can benefit by working with others in loose cooperation or in formal associations. Success in one project can lead to success in others and the multiplier effect in a region can be significant.

In Guatemala, 'micro-regional organizations' have been formed following the support of several communities by a Guatemalan NGO, Agua del Pueblo. Each community's knowledge and experience is shared through organized training programmes. This strengthens their efforts and has allowed them to negotiate with other bodies at a local and national level. Through their strong organization, communities have been able to expand their activities beyond O&M management into cereal crop, coffee and fruit production (Gonon, 1992).

All partners have a role in promoting greater mutual support among communities to realise the many potential benefits of working closer together.

Traditional management systems

People have always managed their traditional water sources. Single point sources will usually have rules for the control and use of water. Complex forms of management may have been established for critical, heavily used or extensive supplies. Rules and widely understood agreements on the use of water for drinking, washing, animal watering and farming can be identified and acknowledged during the early assessment and planning stages of a project. Women are often the managers of traditional sources and they can, if given the opportunity, explain the existing management system, its merits and drawbacks, and how they feel it can be integrated into the operation and maintenance of an improved supply.

Traditional agreements on ownership and access to wells often define who owns a well and is responsible for its upkeep. In many societies access to a well for drinking water cannot be refused, although its use for other purposes may be restricted. This may be an important issue when introducing charges for an improved water source.

The degree of user representation through traditional community decision-making bodies will determine the extent to which all members of a community can be involved. Outsiders must be careful not to miss the informal consultation mechanisms that lie behind many formal bodies, for example, the informal representation of women's views through women's networks and leaders.

Some projects have attempted to by-pass traditional leadership structures which have appeared unrepresentative to agency staff. This has sometimes created problems.

In some piped water supplies in Malawi tap committees were elected without the involvement of local leaders. Subsequent disputes over communal water points were referred by tap committees to the government extension workers who had helped to establish the committees. Village headmen and party leaders had previously been responsible for settling disputes and so they felt their authority was being eroded through being bypassed in this way. As a result, many tap committees relied on support from the extension workers as little support was given by local leaders. This arrangement did not encourage sustainable community management (Ndoya et al., 1992).

The management of O&M must be adapted to community structures and community structures must be supported to cope with O&M.

7.2 Community Management Committees

Support agencies often require communities to establish water committees for the management of new water supplies on the assumption that existing or alternative forms of organization are inappropriate. This may be the case in many situations but experience also suggests that whilst the establishment of a water committee can be of great value, existing structures and committees may either do the job just as well or so heavily influence the workings of a water committee that there can be little distinction between them. Therefore, consider carefully the need to create a water committee.

Water committees

Committees often enter into a formal written management agreement with the partner agency (often the government water authority) and sometimes a third sponsoring partner, such as an NGO. Agreements define the roles and responsibilities of each partner. An agreement is often made at the beginning of a project to include each phase of the project cycle through implementation to the final management of a supply. In a true partnership all partners will participate in the drawing up of the agreement. However, standard agreements are often used. This is convenient for the support agency but leaves little scope for individual community negotiation. Long agreements in legal language are better avoided.

It has been noted that in some instances the construction phase of a project necessitates a large water committee to deal with the many different aspects of implementation. On completion of construction, however, it might be more effective to re-form into a smaller committee for the management of O&M (Hussain, 1992).

Committees may be freely elected, nominated, or formed by the community with or without the encouragement of an external agency, water agency or local government administration (See below). Committees normally comprise a chairperson, secretary, treasurer and ordinary members. The handpump or tap caretakers or pump operators are often included as automatic members. Committee rules may stipulate a minimum number of women members.

The tasks of a water committee normally include the following :

- to represent the community in contacts with the partnership agency and the government,
- to organize and manage the collection and use of O&M funds,
- to organize and supervise O&M activities - operation, preventive and corrective maintenance,
- to keep accurate records of payments and expenditures,
- to promote the hygienic and effective use of facilities,
- to keep users informed of the O&M activities and finances.

(IRC, 1991)

Tap committees represent user groups within a community. They are also variously called neighbourhood, standpost, or user committees, and are the lowest level of user representation within a scheme. A tap committee's role is to manage the use and maintenance of a facility, such as a standpost, and provide advice and feedback on

operation and maintenance to the water committee. They may be responsible for the collection of water rates within the user group.

In extensive piped distribution schemes it is usual to have an overall management committee at the head of a hierarchy of committees and sub-committees representing each community, standpost or user group.

Internally and externally organized committees

There are important differences between an externally organized committee, created through the intervention of government or an external support organization, and an internally organized committee created from within the community. These differences affect O&M as described in a review of water committees in Central and South America (Espejo, 1989).

Where the government agency or contractor was mainly involved in the organization and planning of construction work the water committees were simply created as a convenient means of administering the schemes. In some cases the committees were formed after construction, and administrative responsibilities were then handed over. This resulted in the implementing agency, often a contractor, making the decisions concerning construction of the scheme with the community participating only as unskilled labour. Subsequent O&M was either continued by the implementing agency or handed over to the community who had received little preparation for the task.

Training activities tended to favour the training of government personnel rather than committee members. Where the training of community members had taken place it tended to be a one-off event and of short duration, just a few days.

The lack of participation of communities and their poor preparation for O&M had several adverse effects. O&M committees were not established, users did not agree with the externally set fees and sometimes fees were not paid.

In comparison, the initiators of internally organized committees could be community members, local organizations, neighbourhood associations or interest groups, such as women's groups. The main motivation for the formation of water committees was an awareness of the need for water and a strong community interest. Internally organized committees are generally better motivated but many require external support, by government or another agency, if they are to be successful.

Gender aspects of committee management

A balance of men and women on committees may help to achieve, but not necessarily ensure, an equitable division of work and responsibilities between men and women. The aim is to avoid either men or women doing all the work or making all the decisions. Gender often plays a role in the division of tasks. A man usually chairs a committee but a woman may be secretary or treasurer. Widespread experience indicates that women treasurers often perform better than men but appropriate training is required.

The Kochogo/Kakola project in Western Kenya is run through committees in which women form over 50% of the members. Women are trained in operation and maintenance of the installed Afridev handpumps. Women's groups are taught basic book-keeping to register project revenues which are used for maintenance or banked for later use (Mwangola, 1991)

Common problems associated with management by committee

There are common problems associated with management by a committee which may be overcome by appropriate and timely agency support. They include:

- Committees fulfil their responsibilities during the construction phase but fail to continue their work after commissioning.
 - Committees only become active when there is a breakdown. In the time between breakdowns committees feel there is no need to meet or even collect maintenance fees.
 - Committees tend to break up shortly after their formation due to a lack of regular activity.
 - Forceful personalities dominate the committee.
 - Unlimited terms of membership result in reduced interest and participation by some members. (Elected fixed term membership might overcome this problem).
 - The handling of funds can be a focus for conflict. In a survey of the problems affecting tap committees in Malawi, the committee position with the highest drop out rate was that of treasurer. It was explained that treasurers were often suspected of embezzling funds and to avoid being accused of malpractice many left the committees.
 - Conflict between the decision making role of the committee and the authority of traditional leaders.
 - Over-dependence on external support from agency extension staff.
 - Internal community friction adversely affecting a committee's work.
 - Overlapping of roles, especially the involvement of the chairperson and secretary in the handling of funds.
 - A high turnover of male members compared to female members due to their greater mobility.
- Espejo (1989), Ndoya et. al. (1992).

If these problems can be identified and overcome, the benefits to O&M are considerable.

Preconditions for community management

- There must be community demand for an improved system.
- The information required to make informed decisions must be available to the community.
- Technologies and levels of service must be commensurate with the community's needs and capacity to finance, manage and maintain systems.
- The community must understand its options and be willing to take responsibility for the system.
- The community must be willing to invest in capital and recurrent costs.
- The community must be empowered to make decisions to control the system.
- The community should have the institutional capacity to manage the development and operation of the system.
- The community should have the human resources to run these institutions.
- There should be a policy framework to permit and support community management.
- Effective external support services must be made available from governments, donors, and the private sector (training, technical advice, credit, construction, contractors, spare part provision, etc.)

(source : McCommon et al, 1990)

7.3 Financial Management

The constraints on effective financial management

The present trend in most developing countries is to transfer part of the responsibility of operating and maintaining water supply schemes from national or regional level to local or users level. This transfer is also concerning financial matters.

This situation means that actors have new roles and responsibilities, and communities have a greater role to play in the financial management of their schemes. The main constraint lies in the capacity and willingness to pay of the communities who are already facing important economic problems. The other constraint concerns the capacity to manage and the financial know-how of communities.

The more a water supply is dependent on imported technology and goods, the more it is susceptible to changes in the country's general economic position. The following extract from a project evaluation comments:

All imported goods and materials purchased for the programme have to be paid in foreign currency. While in foreign currency terms prices remain stable, devaluation makes them increasingly expensive. Long term continued dependence on imported goods will lead to serious problems of sustainability as only 15% of procurement is done locally at present (Smet et al., 1993).

Within a national or regional economy there may also be seasonal price fluctuations. Adequate funds are necessary to take advantage of such fluctuations and this often means collecting funds in advance to use when prices are low. Although such a situation can work to the advantage of users it also adds to the complexity of managing O&M funds.

Replacement costs

In some cases, O&M funds are expected to pay for the complete overhaul and replacement cost of equipment when it wears out. The estimation of replacement costs is even more hazardous than making regular O&M estimates due to the longer time scales involved. Estimates can be made in hard currency of the eventual replacement or extension costs. The local currency equivalent can be adjusted as exchange rates alter over time to give an indication of the real cost to users who have to raise funds for replacement in their own currency. A mechanism to monitor and adjust replacement costs is necessary and is a service that a support agency can provide to users.

The cost of replacement is unlikely to be met out of a single fund-raising event and either regular contributions will need to be saved or a loan taken out to be paid back out of future water payments. Rural development banks, where they exist, are a possible source of loans.

Savings are problematic as their value must be protected and the interest earned on savings is not necessarily guaranteed to keep up with inflation. Many rural communities do not have ready access to banking or post office savings facilities. Some banks may not be sympathetic to a rural community's needs and credit unions, where they exist, may be more appropriate.

An alternative to simply leaving savings to gain interest is to use them to finance income generating activities. However, this is risky as careful management is required and investments may not be profitable. Additionally, the original intention of providing funds for O&M, and the replacement and extension of a water supply, can become obscured by other activities.

Recycling water rate revenue for O&M

A difficulty often experienced by a government water agency responsible for O&M concerns the recycling of revenue from water rates. Unless the revenue generated by water charges is directly allocated to O&M services, it joins the general pool of government, or departmental, funds. The reallocation of funds for O&M can be cumbersome and inefficient. In some cases funds may be diverted for other uses, such as the construction of new schemes. This may be acceptable if sufficient funds are available. However, where funds are limited, investing O&M funds for non-O&M uses can undermine the sustainability of both existing and new schemes.

Key factors in community financial management

Sufficient funds

Sources of funds were considered in section 4.5, 'Funding'.

- **Accountability**

People must have confidence in the management of their funds. It is, therefore, imperative that the handling of funds is as transparent as possible and that simple, understandable, accounting procedures are followed. Bank account statements and the water supply financial accounts should be available for all to see. The establishment of an independent committee of user representatives to audit the accounts can help to reassure users that their money is being properly managed. Annual, or bi-annual, user group meetings can be an opportunity to show clear and simple statements of income and expenditure for schemes. For example, groups in Thailand use a schoolboard to publicly display statements.

- **Identifying costs**

There is little data on the true costs of O&M. Much of the data presently available applies to agency managed schemes and it is difficult to separate agency overheads from individual scheme costs. However, O&M costs are essential for budgeting and users will want to know them. This is particularly important when moving from subsidized schemes to full cost recovery within the community as there will be a need to adjust tariffs according to expenditure. It is not unusual for users to over-estimate their contribution to schemes and people may resent being asked to pay more. Therefore, clear explanations of the cost of consumables, spares and staffing is needed.

- **Collection of payments**

Contributions must be collected at times when people are able to pay and may therefore be irregular. The method of collecting charges should not be disproportionately costly compared to the revenue collected. There must be sanctions on those who do not pay.

- **Keeping money**

Money needs to be kept safe. Where rural banks exist a village water account can be opened. Payment into a credit union may be an alternative. It will be inconvenient if a

community is far from a bank as money may be difficult to get hold of when needed quickly. In addition, travel and subsistence expenses to deposit and withdraw money can be high. Clearly, there are substantial risks and an additional responsibility if someone, usually the treasurer, has to personally keep O&M money. However, this is often the case. A fund can also reduce in value if kept without some form of inflation protection.

- **Fund administration**

The administration of funds requires the issuing of receipts for payment and expenditure and the careful keeping of records. Dealing with a bank will add to the amount of administration. Financial reports are necessary to account for the use of funds and to give users feedback on how their money has been spent.

- **Financial and administrative skills**

The administration of O&M funds will require men and women with administrative skills. In rural communities, people such as teachers and retired administrators have the necessary skills but are usually in demand for a range of duties. Experience has indicated that women generally make good treasurers. A role of support agencies is to provide appropriate training and initial supervision when needed.

- **Remuneration for maintenance work**

Remuneration schemes should be arranged to give maximum reward for the minimum down-time. Regular preventive maintenance tasks are sometimes poorly rewarded compared to payment for major repairs. Such an arrangement does not encourage care of the system as it becomes financially more rewarding for a caretaker or mechanic to let the system deteriorate until it requires major repair work.

- **Smooth handover**

Some schemes are supported by a donor from inception to operation. It is important that the handover phase, during which the donor withdraws support, does not leave a community with sudden financial obligations for which they have not been prepared and are not able to meet.

- **Accurate costing and appropriate tariffs**

The estimation of O&M costs and the setting of appropriate tariffs are keys to sustainability and are considered in the sections that follow.

Estimating costs and budgeting

Accurately estimating the O&M costs of a new supply can be difficult without operational experience for guidance. A comparison with similar schemes already operating may give an indication of running costs. Cost factors based on past experience, or a percentage of the capital cost, are sometimes used to determine national or regional O&M rates but these are based on average costs and they can vary greatly between schemes. The comparison and use of cost data between countries is even more problematic because of distortions due to fluctuations in exchange rates, differences in the economic and physical environment and in cost estimation methods.

It is important, therefore, to keep accurate O&M records of existing supplies for the future estimation of their running costs. In a partnership between an agency and the community, each partner will share O&M costs. Examples of typical shared costs are shown in Table 13. The exact division between agency and community will depend on the partnership agreement.

The agency approach to cost estimation will be different from the approach taken by the community. The agency will be supporting a number of water supplies within its area of operation. The community will only be concerned with their individual supply, unless they collaborate with neighbouring communities to take advantage of economies of scale.

Table 13: Typical O&M costs shared by agency and community

Component of O&M	Agency	Community
Personnel	Management, technical, administrative and training staff. Extension staff, Inspectors, health promoters, rate collectors.	Caretakers, mechanics, operators, supervisor, administrator, rate collector.
Materials	Water testing consumables.	Spare pump and motor parts, fuel and oil. Replacement pipes, taps, buckets, rope.
Transport	Agency transport for field support staff.	Local transport (e.g. bicycle, bus fares, etc.) for caretakers/mechanics, treasurer.
Private contractors	Repairs. Rate collection.	Private artisans. Accountant.
Other expenses	Office and administrative overheads	Stationary, repayment of loans, bank fees.

Estimating agency O&M costs

Personnel

- Identify the type and number of staff assigned to O&M.
- Estimate the proportion of time spent on O&M if staff also have other duties.
- Calculate the cost of wages, including overtime. Official government pay rates can be misleading as various other benefits may need to be included such as vacation and sick pay, field allowances and undisclosed unofficial payments. Estimates can be based on typical local rates for non-government work and the actual numbers of hours worked.

Materials

Most of the cost of O&M materials in community managed supplies are the responsibility of the community. Agency material costs will be those related to training, inspection and health promotion.

Transport

This includes the transport costs of trainers, extension staff, inspectors and health promoters. Define the transport needs for each O&M task by vehicle type, distance travelled and frequency of trips. Based on the needs, estimate the cost of fuel, oil, tyres, servicing and repairs, insurance, driver wages and an allocation for vehicle depreciation.

Private contractors

The extent to which an agency contracts private companies to carry out work on community schemes will depend on the terms of each community management agreement, agency policy and the availability of contractors. Contracts are often issued through a tendering procedure. Cost estimates based on unit prices given in tenders and contracts need to be checked against actual payments.

Other expenses

Administrative and overhead costs need to be apportioned according to agency activities. Depending on the scope of the analysis, office support services may not be included under O&M costs but under overhead costs in a broader financial analysis of the agency.

Estimating community O&M costs

Communities may need initial guidance by agency trainers on the estimation of costs and the preparation of a budget, followed by extension staff supervision.

Easily followed step-by-step procedures encourage maximum community involvement. The simple procedure suggested below might be followed by water committee members, operators and the community treasurer working together.

1. Identify the community O&M tasks.
2. For each task, identify the labour and material requirements.
3. Estimate the labour and material costs.
4. Investigate how costs might be reduced.
5. Produce a budget.

Costs might be reduced by the optimum use of local resources and by co-operating with other communities. Examples include:

- **Labour**
Voluntary work, payment in kind through preferential rights and water for gardening or livestock.
- **Materials**
Use of local materials, local replication of parts, bulk purchase with other communities.

If a new supply is being contemplated by a community they will want to compare the implications of different options. Technical and extension agency staff can advise the community on the technical viability of schemes and the capital, operation and maintenance costs involved. Estimating costs and drawing up a budget for each option is crucial to choosing a sustainable scheme and the community need to be fully involved in this process.

A community O&M budget

Expenditure on O&M will vary throughout the year and over longer periods. A community O&M budget, or money plan, aims to set out the expected maintenance costs so that sufficient funds can be raised in time to cover expenditure. An annual budget assists in spreading the cost of preventive maintenance throughout the year and indicates the level of reserve funds required to meet corrective maintenance costs as they arise. Corrective maintenance costs depend on a range of factors and they can vary considerably over time.

In a study of the maintenance of handpumps in Zimbabwe, the relationship between the age of a pump and the number of breakdowns was found to be complex. Several relatively new pumps had experienced multiple breakdowns while the rate of breakdowns levelled out for 'middle-aged' pumps. The rate only substantially increased for very old pumps. There are a number of possible explanations for this variation including differences in the quality of manufacture and installation, improving community commitment to maintenance and increasing familiarity with maintenance tasks over time (Clever, 1991).

Tariff setting

A water tariff is the rate at which users are charged for water. If cost recovery aims to satisfy an increasing demand for water then the tariff should reflect the cost of the expansion of water supply facilities as well as the costs of operation and maintenance. However, many water supply tariffs do not even achieve coverage of the current costs of O&M.

Some governments establish national or regional rates in countries with standardized water supplies incurring similar O&M costs. Alternatively, community management committees set their own rates.

To set a water rate, a community needs to estimate the costs of running their water supply and draw up a budget. This is followed by deciding how much and how often users need to be charged to match the budget. The choice of funding method - see Table 10 in chapter 4 - will depend on several factors including the spread of costs throughout the year, seasonal factors affecting ability and willingness to pay, and the merits of periodic contributions versus regular payments.

Agencies have an important advisory role in assisting communities to set an appropriate rate.

Community Development Assistants in the Morogoro/Shinyanga rural water and sanitation programme, Tanzania, were trained to provide village committees with practical assistance in setting a water rate. Three rates were considered:

- a flat rate per user household
- a flat rate per adult in each user household
- a graded rate for different households.

The different rates were compared and the final decision on the rate to adopt was made by the committee (IRC, 1989).

Flat rates per user household are relatively straightforward to implement. It is a fair system when there are no great differences in water use and distance from the households to the water collection points.

The advantage of a flat rate per adult user is that households with many adults pay a higher fee for using more water per household. This method entails additional administration.

Graded rates are appropriate in villages with considerable differences in water use between households. Some households may be wealthier and use more water. Others may use water for commercial activities - washing taxis or lorries, gardens for market produce, livestock watering, etc. Rates may be graded according to water use - e.g. payment per animal watered per year - or by classifying households into large, medium and small users. Lower rates may be charged to disadvantaged groups such as old people, female headed households and people with disabilities. The administration of graded rates is more complicated than a flat rate and agreement on the grading system with all concerned may be difficult.

Collecting money costs money and the cost of rate collection must be included when estimating overall O&M costs.

If in the past water has been heavily subsidized or free, a tariff to cover O&M costs must be introduced carefully. This will entail close collaboration with the community, clear explanations of the costs involved in running the water supply, and a tariff which may need to be introduced incrementally over time. If the system supplying the free water had been poorly run and payment promises a better service then willingness to pay can be high.

A new tariff may undercut the price of water previously set by water-sellers. This will be welcomed by consumers but not by the water-sellers who will lose business. Therefore, it is advisable to consider how to involve them in developing a supply and setting a tariff.

Tariff formulas

Various formulas can be used depending on what costs have to be recovered. A set of formulas are presented here, which include gradually more and more elements, depending on what the community has decided to recover, (tariffs calculated on an annual basis). The choice of one tariff will depend on the technology used, but mostly on the capacity and willingness to pay of the communities. A cost sharing approach should still be studied as far as possible :

MT (Minimum Tariff)

$$MT = \frac{\text{Operation costs} + \text{Administration costs} + \text{Maintenance costs}}{\text{No. of people served}}$$

Operation costs + Administration costs + Maintenance costs = Functioning Costs (FC)

EM (Efficiency Tariff)

This tariff will include costs of replacement or extension of the services. A percentage can be estimated, which corresponds to the life cycle of the equipment; in this case we propose to estimate the replacement costs as a percentage of the functional costs (25 percent); this will depend on the technology and the dynamics of the community :

$$ET = \frac{\text{Functional costs} + 0.25 \text{ of functional costs}}{\text{No. of people served}} = \frac{1.25 \text{ of functional costs}}{\text{No. of people served}}$$

EEM (Environmental Efficiency Tariff)

This tariff includes the costs of the ecological impact of the use of the water supply system, and the protection of the water resource, in order to sustain the quality of the water supply over a long period of time :

$$EET = \frac{1.25 \text{ of functional costs} + \text{Costs of protection environment (CPE)}}{\text{No. of people served}}$$

LEET (Leakage and Environmental Efficiency Tariff)

This tariff includes not only replacement and environmental costs, but also costs linked to leakages in the system. Leakages are very common, and they represent a loss of gain, which can be quite important (20 to 60 percent in some cases). As an illustration we have chosen in this example a leakage percentage of 25 percent of the functional costs:

$$LEET = \frac{(1.25 \text{ of functional costs} + 0.25 \text{ of functional costs}) + CPE}{\text{No. of people served}}$$

TET (Total Efficiency Tariff)

This tariff includes the recovery of all the above costs and the initial investment costs. This will depend on the agreement reached with the community. Some communities will have to borrow with an interest rate, some others will just reimburse a certain percentage of the initial investment. We have chosen in this example, that the community will reimburse 5 percent of the initial capital every year, such as IR (Investment Recovery = 5 percent of capital costs) :

$$\text{TET} = \frac{1.50 \text{ of functional costs} + \text{CPE} + \text{IR}}{\text{No. of people served}}$$

Additional costs, such as depreciation or inflation can be included in the TET, if the project decided to recover them as well.

Tariffs are set on an average yearly basis, however expenses do not follow such a regular pattern, and some financial adjustments might be needed in order balance income and expenses. Moreover, the pattern of expenses might vary from year to year. Indeed, in the first years, there might not be any important expenses, whereas after a while, important repairs and some replacement costs can be very high. It is hence advisable while planning for a tariff on an annual basis to plan for costs on a longer period, which could be the full life time of a particular equipment. Some regular adjustments might be needed in case of inflation.

The collection and management of funds

There are a variety of methods employed in collecting water rates:

- Visits by a rate collector to all registered households. There may be objections to male collectors visiting houses during the day when men are often absent. Therefore, there are often advantages in having women rate collectors as this may be more acceptable and suit an existing pattern of social visiting. A potential disadvantage, however, is that women may end up carrying the full financial burden of paying the rates from their own separate funds (Wijk-Sijbesma, 1989).
- A tap or pump caretaker collects from each user in the tap committee or user group and passes the funds to the scheme treasurer. In dispersed settlements it may be more efficient for the treasurer to collect funds from each caretaker.
- Users pay at a community or agency 'water office' or directly to the scheme treasurer.
- Seasonal collection may be more effective in agricultural communities. Demand for water is usually highest when traditional sources dry up. But this is often a time when the proceeds from harvesting have been spent and people have little to spare for water charges. A good time to collect money is immediately after harvesting.

Defaulters may be dealt with in the form of fines or, for yard taps, disconnection. Social pressures, such as publicly announcing defaulters, may be sufficient sanction in small communities. In some areas it may not be socially acceptable to deny someone use of a water supply. In such cases, penalties for non-payment may take the form of a denial of rights in community affairs and access to other community benefits.

There will often be a delay between the collection of funds and the need to spend them. An accumulation of funds can sometimes lead to pressure to spend them.

Although accounts have been opened, they are in effect not being used and a large amount of money is lying idle to the dissatisfaction of many villagers. ...many committees are reluctant to use the accounts because they have not received any clear advice on what else they could use them for. (Smet et al, 1993)

The problems related to using community funds for non-O&M activities have been mentioned previously. Appropriate advice and careful fund management is essential.

A procedure for registration, collection, keeping and spending funds is needed. Agency support and advice may be necessary. This is often a new activity for a water agency and may require a change in working methods. Extension staff trained in financial procedures may need to be recruited. Alternatively, it might be possible to collaborate with another agency which has the appropriate expertise, e.g. community development or a government department responsible for small industries.

The training of committee members and the treasurer in simple bookkeeping is an important aspect of community support. A straightforward system of issuing receipts and registering payments is often all that is required so that proper accounts can be kept. Adapt to the "cardboard box and school book" system if that is what the community uses. Good record keeping is important for public accountability and provides data for future budgeting.

Problem solving

Agency extension workers have a critical role in monitoring the progress of financial management. Common problems include:

- theft or fraud
- users refusing to contribute funds or pay water fees
- the cost of unexpected breakdowns, high spare parts expenses or capital replacement
- public accountability
- treasurer incompetence or dishonesty
- overlapping roles and conflicts among committee members.

Advice and encouragement from agency staff will be important. The aim should be to reinforce the capacity of communities to manage their own finances.

The treasurer's tasks

The Piped Supplies for Small Communities (PSSC) project in Zambia makes recommendations on the tasks to be carried out by the treasurer to try to avoid the misuse of community funds. These include simple but practical guidelines:

- The treasurer systematically registers all contributions and purchases in a cash record book.
- All receipts are kept in an envelope at the back of the record book or glued to the back pages.
- All payments have to be agreed by members of the committee.
- All deposits and withdrawals at the bank or post office savings account must be made by the treasurer with the chairperson and secretary as joint signatories to the account.
- The treasurer or committee must report to the whole community at agreed time intervals on income and expenditure and the state of the finances.

(Ng'ambi, 1991)

7.4 Monitoring and Evaluation

Monitoring and evaluation provide a systematic assessment of the functioning of an O&M system and its benefits to the community. Monitoring is the regular collection of information concerning performance. Evaluation uses monitoring and other data to provide an indication of performance, benefits and trends. Monitoring and evaluation are not ends in themselves. An essential outcome is that the findings are used to improve individual systems and general approaches to O&M at the programme level.

There are two levels at which the operation and maintenance of community water supplies are monitored and evaluated. Users monitor and evaluate their own systems at the community level, with possible back-up from extension agents. Support agencies and the government are concerned with a broader overall view of programme performance and monitor and evaluate at the programme level.

Monitoring

Guidelines for successful O&M monitoring:

- Keep it simple
- Do not collect more information than is really needed
- Collect information which is objectively verifiable
- Ensure the data collected can be processed and used within the time, human resources and budget available
- Aim for flexibility and avoid a top-down approach. Involve users and water committees in the process
- Develop performance indicators which are accepted and understood by all managers in the O&M system

An indicator shows the extent to which the objectives of a scheme, or schemes, are being achieved. There are three main types of indicator used in monitoring O&M:

1. Performance indicators

These mainly relate to the functioning of schemes and the key components of an O&M system, such as the provision of spare parts. Each indicator has associated with it a performance target against which actual performance is compared.

2. Managerial indicators

These combine performance indicators with data reflecting the use of human and other resources. For example, the cost of achieving a particular performance with a certain number of staff.

3. Policy implementation indicators

These monitor progress towards achieving the overall desired impact or long term goal of a sustainable O&M system.

A recent WHO draft report for the assessment of the status of O&M details the following performance indicators for application to rural water supplies (Cotton et al., 1993):

Operational indicators

$$\text{Functioning supply points indicator (\%)} = \frac{\text{Number in working order}}{\text{Total number}} \times 100$$

The functioning supply points indicator shows how many waterpoints, standposts or handpumps, are delivering water. However, this must be further defined to establish what is meant by 'delivering water'. There is a big difference between a tap running full all day and a trickle for one hour. The indicator must be fully defined and understood for each situation.

$$\text{Reliability indicator (\%)} = \frac{\text{Functioning time}}{\text{Total elapsed time}} \times 100$$

The reliability indicator reflects the fact that a system which breaks down frequently, but can be quickly repaired, is 'more reliable' than a system which breaks down only once in a while but takes a long time to repair. What is important to the users is that a safe water supply is available for most of the time, no matter how often it breaks down.

Further operational indicators can be used to indicate reductions in the planned quantity of water delivered, the availability of water each day and water quality.

Financial indicators

It is often difficult to obtain accurate financial information. Subsidies may be difficult to quantify and records may be inadequate. In addition, the underfunding of O&M will mean that the funds allocated will not reflect the actual funds required for effective O&M.

The simplest indicators include:

- the payment by users of water tariffs,
- the amount of funds in the water account, versus what is needed
- level of expenses, by category.

Personnel indicators

Personnel indicators can be applied to indicate the numbers of operators, maintenance teams, pump mechanics, or personnel trained who are in post and are working. These indicators could be compared with performance indicators to monitor efficiency.

Materials indicators

Operation and maintenance requires a range of materials and indicators can show the availability or accessibility of items such as spare parts. Suggested indicators include: the time required to obtain a spare part; the number of items in or out of stock; the number of repairs awaiting spares, and so on.

Work control indicators

$$\text{Work control indicator} = \text{Backlog of repairs or planned spare part replacements}$$

The efficiency of maintenance personnel in responding to breakdowns can be shown by work control indicators. They refer to the time required to complete a repair or the number of items replaced on a preventive maintenance schedule compared to the number that should have been replaced.

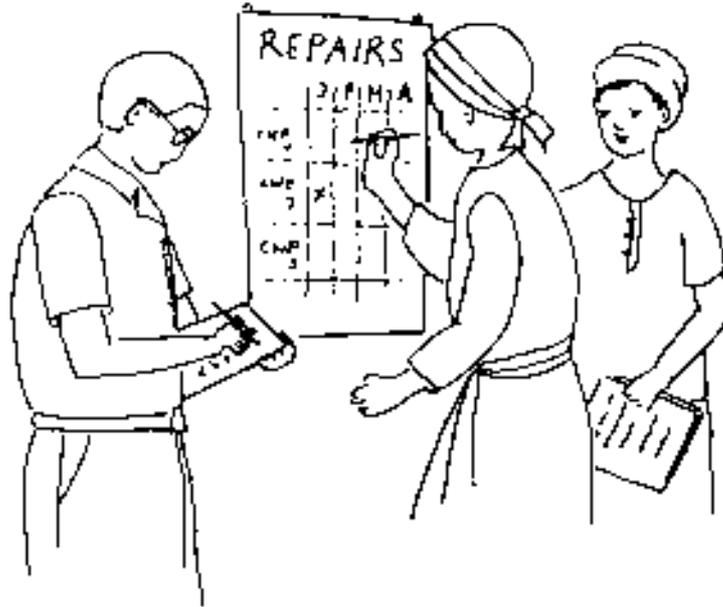


Figure 8 : Communities can be involved in monitoring activities.

Developing a monitoring system

A problem with many monitoring systems is that they are imposed from above by remote management and as a consequence they are often unrealistic to put into practice and they do not give the information required. A suggested approach towards improved O&M monitoring is to start with individual schemes to ensure that monitoring systems are appropriate to the needs of users and field level managers. Relevant field data can then be conveyed to managers and planners provided it is processed and combined with additional information concerning the use of resources.

The following steps for the development of a field level monitoring system are proposed:

- at the local level, identify the basic O&M tasks, to include key tasks such as the provision of equipment and spare parts
- identify the information needed to manage staff at the local level
- identify basic O&M performance indicators
- test the indicator on a small-scale for a limited period to ensure that the intended users of the information give feedback
- carry out an evaluation to verify the monitoring data is significant in reflecting the actual status of O&M
- adapt the indicators and apply on a larger scale
- begin to build up a management information system, including the development of management and policy implementation indicators where appropriate.

Using the information

Periodically collected information will indicate overall trends in the O&M management system. This will help to anticipate problems and point to areas which need specific priority attention.

Establish targets and compare monitored performance against them. An example of performance indicators and how a monitoring system can be planned is shown in Table 6.

Table 14: Extract from a plan for the monitoring of O&M performance

<i>O&M Performance Indicators</i>	<i>Targets</i>	<i>Who collects the data</i>	<i>Who verifies the data</i>	<i>Method of verification</i>
Functioning supply points (%)	Percentage of supply points functioning to exceed 90% by (date)	Users Operators	Extension agent Health dept.	Check data sheet with the actual situation in the village
Repair time	Maximum repair time reduced to 2 days in all villages by (date)	Operators Water committee member	Villagers Extension agent	Sample surveys
Essential spare parts available at the market price	Quantity of spare parts sold to exceed (no.) by (date)	Sales outlet - shopkeeper	Supplier Manager	Check supply figures

(Adapted from WHO, 1993)

'Safe values' can be established beyond which action must be taken. These trigger values prompt urgent action rather than allowing a situation to drift.

In all cases, the monitoring analysis can only be as good as the information received. It is important to check the reliability of records and the accuracy of data collected in the field. The percentage of replies not received can also be useful to monitor. Avoid a one way flow of information by providing feedback to the data collectors.

Standardized monitoring systems

A standard system of monitoring allows the performance of individual schemes and programmes to be compared. This is desirable within a country so that data can be easily consolidated and national trends, successes and problems can be identified.

At the international level, a Water and Sanitation Monitoring System (WASAMS) is being developed and applied in a number of countries by WHO and UNICEF. It is a monitoring system which focuses on selected performance indicators for collecting and managing data in the water and sanitation sector.

WASAMS is a computerized system designed to adapt to a country's administrative structure. This enables information collected at district, regional, provincial and national levels to be combined at each administrative level and forwarded for collation nationally. Summary reports can be generated for each level based on the entered data. There are five standard reports:

- population and system utilization
- coverage
- management - O&M costs
- number of people served
- funding.

Reporting

Reporting on the state of O&M is often neglected. This is partly due to its low profile but a lack of available reports in turn contributes to the low profile of O&M. Producing summary reports periodically, say bi-annually or annually, is a discipline which ensures monitoring data is analyzed regularly and trends do not go unnoticed. Reports help in the analysis of problems and help initiate action before the problems grow bigger. They also assist in the planning and design of new systems.

The type and content of reports will depend on the intended readership. Engineers will tend to want information on technical performance. Accountants will be concerned with revenue and costs. Community development staff will want to see how the formation and working of water committees has been progressing. The presentation of monitoring data in a graphical form can show trends clearly and make a greater impact. Visual information avoids jargon and can be more easily shared with a wide range of people.

Evaluation

An evaluation utilizes and supplements monitoring data to conduct a periodic review of O&M. It is also an opportunity to verify the validity of the monitoring system and the data that it produces.

Social and behavioural aspects cannot be dealt with effectively in a monitoring system but an evaluation can look at them in depth. These aspects include the interrelationships between O&M and other community activities, the dynamics within a community that affect O&M success, the inner workings of management committees and the broader community development goals which complement or can benefit from O&M management experience. The following is an example:

Annual surveys and mid-term evaluations

In the community managed rural water supply component of the South West Integrated Programme (SWIP) in Uganda, annual surveys are carried out to evaluate the status of water systems. The surveys are conducted using questionnaires to investigate the following:

- physical maintenance and construction workmanship
- community worker and water committee performance, constraints, drop out rate, financial arrangements, user complaints concerning taste, yield, breakdowns and basic health messages
- the Resistance (village) Council perception of pump mechanic and community management performance.

Major findings have shown:

- over 80% of water systems are operational
- downtime ranges from 7 to 10 days
- a low level of women's involvement
- community workers retained knowledge on basic health messages but were not transmitting them to the communities.

SWIP also conducts mid-term evaluations involving donors, government officials and consultants.

(Kiwe, 1992)

Wherever possible, a participatory approach should be employed to involve the users in evaluating their own O&M systems. There now exists a growing body of techniques which complement the more formal questionnaire approach of gathering information. Participants receive feedback which can be of immediate use in helping to improve O&M.

The overall outcome of an evaluation will be one of three possibilities:

1. The O&M system functions well and it should be continued
2. The O&M system requires modification to make it more effective
3. The O&M system does not function and major changes are required.

There are two options where major changes are required:

1. Make alterations within the existing structure.
2. Decide the existing O&M management structure does not work and overhaul it. This may mean moving away from a centralized management system to a community based approach.

PART IV

SUPPORTING OPERATION AND MAINTENANCE

Chapter 8: What Type of Support to the Communities?

8.1 Government Support

Governments provide the framework within which O&M policy is developed. The role of government is vital to create an 'enabling environment', one of the key elements of sustainability. An enabling environment can be fostered by appropriate legal provisions, regulations, education, training and information. If a supportive O&M policy is not forthcoming from central government then support for O&M at the local level will be considerably hindered.

Local government promotes an awareness of national policies and supports water user committees. However, many local government departments are under-resourced and are unable to give effective support. The degree of support may also be influenced by local politics.

Development of an O&M system and a legal framework

Changes may be necessary where existing legal frameworks hinder rather than encourage the establishment of autonomous bodies for the management of water supplies. Legal provisions may need to be amended to allow for the community administration of funds, the legal status of water committees, and the community ownership of water supply assets. The legal responsibility for maintaining a water service may need to be redefined.

The government of Pakistan has established a National Rural Support Programme (NRSP). The basic principles behind the programme are the promotion and development of community based institutions - Village Organizations (VOs) - which are responsible for managing and maintaining their projects and affairs, including water supplies. The government has recognized VOs as legal entities in some parts of the country (Hussain, 1992).

Strong institutions

The partnership process means that even stronger institutions than at present are needed to promote and support community management. The recruitment and training of personnel and the organization of departments should all reflect O&M as a priority. Therefore, adequate funding is still required for agencies to be able to perform their essential supportive role.

Where reorganization may be necessary is in the promotion of basic health messages related to water. This has traditionally been undertaken by the Ministry of Health in many countries. Good coordination between agencies and a clarification of roles will be essential if government departments are to effectively coordinate their activities in the sector.

There is a need for the standardization of approaches rather than external agencies developing their own plans and working with different government departments:

Some donor projects finance a special support service in the Ministry of Water, Energy and Minerals, while others co-operate with the Ministry of Community Development, Women's Affairs and Children and the Ministry of Health. The national policy is not clear on the role of the Ministry of Community Development, Women's Affairs and Children. It describes its roles as strategy formulation and the training of villagers and water staff. It does not specify who will do the implementation of non-technical activities in the field (IRC, 1993a).

Without clear guidelines on who should be responsible for each non-technical input (which government agency, NGO or private sector participant), duplication of effort, non-standard approaches and perhaps even confusion can ensue.

Personnel attitudes

The partnership approach will also entail a change of attitudes among government personnel towards their maintenance activities and the communities they serve. This cannot be assumed. An internal report notes that in the partnership approach:

Staff do not give instructions and impose decisions but provide information and skills with which villagers themselves can take decisions, organize activities, monitor progress, etc. Many staff are not trained to work in this way and have a top-down attitude to village work. Participation is limited and often only consists of calling a meeting and having a discussion. Activities to change staff attitudes and improve skills occur but scope and impact is still small (IRC, 1993b).

Government monitoring of O&M

Governments will need to support O&M by ensuring that the O&M strategies adopted function well, and that standards are established and maintained. This will entail monitoring management systems, the quality and quantity of water being supplied, the efficient supply of spare parts and the appropriate choice of new schemes. Specific staff and funds will need to be allocated for the purpose.

It will be in a government's interest to ensure that new schemes will not put an undue burden on the country in terms of future foreign exchange requirements and external support needs, e.g. spare parts. This will mean the close monitoring of donor programmes.

Benin

The Republic of Benin (Le Ministère de l'Énergie, des Mines et de l'Hydraulique) has established a comprehensive strategy for the development of rural water supply and sanitation which, if implemented, will have a major impact on operation and maintenance. The strategy is based on the following principles:

- Decentralization of the decision making process to the beneficiary communities through a programme of information, education and communication activities involving government and non-government organizations.
- Community contributions towards the initial capital cost of systems as well as future maintenance.
- Research into the reduction of construction and maintenance costs.
- Privatization of construction, operation and maintenance with a particular emphasis on the promotion of national consultants and small enterprises.

The Benin strategy aims for a radical and comprehensive change of approach from a centralized government dominated sector to decentralized, community based systems in which the private sector has a prominent role.

(Ministère de l'Énergie, Bénin, 1992)

India

In guidelines for the implementation of an accelerated rural water supply programme, the Government of India Department of Rural Development recommends that state governments review and streamline maintenance arrangements. In particular:

- Develop O&M standards and allocate O&M funds accordingly to different water supply schemes.
- Analyze the overall cost effectiveness of alternative technologies taking into account O&M.
- Mobilize funds directly from the users.
- Involve the local government panchayats in O&M as much as possible.
- Train more women in O&M activities such as handpump maintenance, chlorination and water sample testing.

The implementation of the policy guidelines has varied from one state to another. In Uttar Pradesh, priority has been given to the installation of handpumps over powered pumps because they are cheaper to install and maintain and they do not depend on an unreliable power supply for their operation.

Water committees and women are beginning to be involved in:

Uttar Pradesh - handpump maintenance and the upkeep of public taps.

Gujarat - the upkeep of public taps.

Kerala - the upkeep of public taps; the monitoring of tap performance.

Mechanisms are being developed for the raising of O&M funds in the piped water supply schemes supported by the Indo-Dutch rural water supply and sanitation programme. In Kerala and Gujarat, local government panchayats either pay for O&M services out of general taxes raised locally or all households are charged a water tax. However, this is only a start towards full local financing.

(IRC and DGIS, 1993)

8.2 External Support Agencies

External support agencies (ESAs) include multi-lateral and bi-lateral donor agencies and development banks. They are an important source of capital funds for the construction of new supplies and for rehabilitation work. For the investment of donor funds to be worthwhile, however, it is essential for donors to consider future O&M needs at the earliest stage of project formulation.

Funds, resources and time need to be allocated for full and proper consultation with the community, government departments and other donors during project formulation. Close co-ordination will help to standardize technology, tariffs, community management responsibilities and aid the exchange of past O&M experience for use in future planning. A prescriptive blue-print approach to community management is unlikely to be successful.

A rapid assessment of community management in the pilot district of Luwero found that communities had adopted innovative and ingenious systems which sometimes deviated from the original designs (Kiwe, 1992).

The traditional handover of donor projects in the past has often left both community and water agency with schemes which neither party was properly prepared to operate and maintain. By following a supportive approach both parties should be fully equipped and

prepared to continue O&M. It has been noted, however, that the continued presence of an agency in an area can lead to false expectations on the part of some communities:

"Babying" of communities should be avoided. This takes the form of agencies overstaying even after a reasonable community management capacity has been built. Agencies respond to "baby cries" from water committees with free spares, etc. In the process they create harmful dependency by failing to "wean" communities and letting them evolve their management capabilities and grow on their own (Kiwe, 1992).

There is a careful balance between support which builds and support which supplants community O&M ability.

The Canadian International Development Agency (CIDA)

CIDA first collaborated with the Ghana Water and Sewerage Corporation (GWSC) in 1974 to improve rural water supplies. Initially, community involvement was very limited. The technical aspects of the programme were dominant and cost recovery was not considered. The result was a poor operation and maintenance record.

Later, in the 1980s, CIDA promoted a policy in which users became involved in waterpoint care and maintenance and a water tariff was introduced. Most maintenance problems could now be handled by maintenance personnel. However, the revenue generated by the water tariff was inadequate to cover operation and maintenance costs.

Therefore, CIDA began funding a new strategy of community management. A project was designed to find out the extent to which communities were willing and able to assume the management of their water supplies and how much people could pay into maintenance funds.

The effect of CIDA's policy has been to improve the O&M component of the programmes it supports in Ghana.

(McPherson,1990)

8.3 Non-Governmental Organizations (NGOs)

Traditionally, local, national and international NGOs have worked closely with communities and have often provided an interface with government agencies and other bodies to facilitate the joint development of schemes. NGOs tend to be more flexible than formal water agencies which enables them to integrate, for example, hygiene promotion into long term O&M activities.

The NGO, Kenya Water for Health Organization (KWAHO), has worked closely with the Ministries of Culture and Social Services, Water Development, and Health in the development of community managed water facilities in Kwale District, Kenya. A particular aspect of the partnership has been the establishment of O&M funds by assisting communities to register themselves as legal self-help groups with the Ministry of Culture and Social Services. This has enabled communities to open bank accounts with communal banks or the post-office savings bank which are present in the district (Munguti, 1989). Many governments produce guidelines for NGOs working in their country. It is to the benefit of all concerned that small-scale NGOs work within agreed guidelines to ensure compatible schemes, tariffs and O&M procedures.

NGOs are seen to work in close contact with communities and some have specific expertise in the development of community management. However, many NGOs rely on external funding and if the form of O&M developed between an NGO and the community is also reliant on external funding then its sustainability may be jeopardized.

The potential for the involvement of local and national NGOs is reflected in the radical approach to project implementation and O&M proposed for Benin:

The government strategy for the development of the rural water sector in Benin details the role of NGOs as important intermediaries between communities and the private sector. The close contact local and national NGOs have with communities enables them to pursue the promotion of environmental sanitation measures and the encouragement of communities to fund environmental improvements. In an arrangement with the department responsible for the implementation of water supplies, Les Services départementaux de l'Hydraulique (SH), an NGO will receive funds based on the number of contracts signed between communities and SH. The contacts made with communities are continued after construction in supporting O&M (Ministère de l'Energie, Bénin, 1992).

8.4 The Private Sector

There has been an increasing trend towards the greater involvement of the private sector in both the construction and upkeep of water supplies. This brings potential advantages of flexibility and cost effectiveness to operation and maintenance activities. However, private sector involvement may be limited by the poor profit margin in scattered rural communities. Where little or no competition exists, charges are likely to be higher, rather than lower. Therefore, the impact of the private sector will very much depend on circumstances.

In the absence of rigorous inspection and regulation there is a problem of private sector accountability. Communities who contract services from the private sector need to be sure that they get a job well done and at a fair price. To some extent, communities themselves can monitor the quality of work if they know what to look for and this may, initially, require external assistance. But if the private sector is to be promoted then safeguards must be instituted to ensure cost-effective minimum standards of work. Any such monitoring and regulation will have a cost which governments will need to meet.

The proposals for a radical approach to O&M in Bénin, referred to in the previous section, plans to use NGOs as intermediaries between communities and the private sector. NGOs are in a position to negotiate contracts and are, therefore, more able to exercise some supervisory control within an established framework. This way the arrangement has the potential to become partially self-regulatory.

Who constitutes the private sector?

The private sector encompasses a range of individuals and companies from the village blacksmith to international companies manufacturing pumps and diesel generators. They all have a part to play in supporting O&M.

Table 15: O&M support roles of actors from the private sector

	O&M support role
Actors in the private sector International and national manufacturers and suppliers	Design and manufacture pumps and other equipment for operation and maintenance at the village level. Supply spare parts and consumables (e.g. chlorine).
International and national consultants	Design schemes for community management. Develop community/agency managed O&M systems. Provide O&M training.
International and national contractors	Rehabilitate and extend schemes for community O&M. On-the-job training of O&M staff during construction.
Local contractors	Service and maintenance contracts. Major repair work.
Small-scale industries Self-employed artisans in the formal and informal sectors	Local manufacture of spare parts and tools. Local skills for preventive and corrective maintenance and repair work: mechanics, plumbers, builders, masons, blacksmiths, electricians, etc.
Administrators and accountants Banks	Operation of facilities. Billing, rate collection, auditing of accounts. Provide banking facilities for O&M funds. Provide credit facilities for irregular high cost items and for the expansion or modification of facilities.

The private sector at the community level

A strengthened private sector will give communities greater freedom to decide who they involve in O&M. Even within existing centralized maintenance systems the private sector has been involved in providing a range of support services.

A review of pump maintenance in Baty District, Cambodia, suggests that pump maintenance is being 'privatized' within the existing government structure. The lowest tier of the maintenance system comprises a pump mechanic trained by the provincial maintenance team. Extra payments are being made to the pump mechanic for repairs and some spare parts can be obtained from the market. This is quicker and easier than following the official procedure (Davis, et al., 1992).

In the same programme, local bicycle repair fitters were supplying leather cup seals to the pump mechanic for India Mark II handpumps installed locally.

Large community schemes serving several communities may decide to contract operation and maintenance to individuals or private organizations. Alternatively, communities might operate a system themselves but arrange a preventive maintenance and repair contract with an external body. Small schemes are unlikely to provide enough work to employ full-time staff and may rely on local artisans for periodic maintenance.

Payment arrangements for private services must encourage preventive maintenance wherever possible:

The effectiveness of pump mechanics in the SWIP programme in Uganda presented a problem due to the method of payment. The pump mechanic was either paid by the users or the water committee for each repair made. There was no incentive to work on preventive maintenance as the mechanic was only paid when there was a breakdown. Therefore, the mechanic had an inherent interest in a continual cycle of broken down pumps. This did not encourage good workmanship and certainly discouraged preventive maintenance! (Kiwe, 1992).

Billing and rate collection can be contracted to the private sector. Payment for the service can be arranged as a proportion of the funds collected. This ensures that the cost of contracting the tasks is recovered and provides an added efficiency incentive.

In the Dominican Republic, commercial agents were employed to improve the collection of rates. Each agent was responsible for 15 piped water supplies which were each visited once a month. During the visit the accounts were checked with the treasurer and a meeting took place with the water committee to discuss problems or matters of interest. The agent then accompanied the treasurer or bill collector to visit households whose payment was in arrears. In 1975 this resulted in payment of 92% of the bills (Wijk-Sijbesma, 1987).

The private sector has a potentially crucial role in the provision of spare parts as the following extract from a programme evaluation noted.

Potential private sector roles must be more closely examined, beginning with the serious pursuit of the commercial production and distribution of spares by local industry and entrepreneurs. A national level initiative may be appropriate, given the widespread problem of spare parts availability and distribution in the country as a whole (Smet et al., 1993).

Chapter 9: *Development of Skills and Awareness*

9.1 Human Resources Development

Human resources development (HRD) entails the development of skills, the raising of awareness, confidence-building and the motivation of people. Training is an important and major component of HRD but it is not the only one. Improving access to information, recognizing people's endeavours and worth, and providing monetary and non-monetary incentives, such as promotion prospects, can all contribute.

Agency staff development

WANTED URGENTLY
OPERATION AND MAINTENANCE TECHNICIANS
Skilled men and women required.
Poor pay, few prospects, no recognition, inferior
status and unsocial hours.

(Kerr, 1982)

Government water agencies often have a surplus of staff in their departments but the majority are untrained or only semi-skilled. Staff who are suitably qualified tend to be few and often overburdened. This situation is partly due to the problem of attracting and retaining skilled staff. Little professional interest in O&M, poor salaries and low esteem have been responsible for the failure to retain managers, engineers, technicians and other skilled personnel. It is not uncommon to find a skilled worker's monthly salary in the public sector to be equivalent to a day's income for an artisan in the private sector (Wyatt, 1988).

Better qualified staff are often found in major urban centres. This results in an uneven distribution of personnel. In Tanzania it was observed that 'a major bottleneck to implementation by the districts is the shortage of suitably qualified staff at district level and the surplus of technicians at the regional level' (IRC 1993a). This has important implications for HRD.

Incentives for skilled staff are often restricted by rigid salary structures. Incentives are more easily paid on donor-supported construction programmes but the effect then is to divert much needed O&M staff away from their important tasks of running existing water supplies. Such incentives can harm O&M and be counter-productive in the long term. On the other hand, new projects with appropriate donor support can provide valuable experience to personnel and give the opportunity and funds for the further development of skills. Women are often less mobile than men and, therefore, the training of women may have a longer-lasting benefit.



Figure 9: Are training activities always appropriate ?

Restructuring and training

Human resources development complements the restructuring of organizations. Job descriptions will need to be adapted and new performance criteria established. Agency staff - professionals, managers, technicians, extension workers - will need orientation to a partnership approach and extra skills will need to be acquired. Technical field staff, for example, are potential trainers themselves and may need to be sensitized to their expanding role as advisers rather than 'doers'. At the community level, committee officials, treasurers, operators, leaders and users will all need support to be able to participate and perform their new operation and maintenance tasks.

In the area of training, curricula may need adapting, documentation must be appropriate and available, trainers and suitable trainees need to be identified. Sufficient time must be allocated for training to be developed and for it to take place.

Training and education will vary for the different personnel in the O&M system:

The incorporation of aspects of O&M in existing formal courses for technicians, engineers, trainers and managers.

In-service or on-the-job training for existing and new personnel: technicians, mechanics, health and social workers, extension staff, accountants.

Specific short courses held informally in rural communities and follow-up support for unskilled community personnel, committee members and artisans.

- Information campaigns aimed at all levels to promote the understanding of O&M needs, activities and strategies.

Training should be appropriate to the skills and abilities of the trainees - practical not theoretical - and timely so that people are prepared in advance for their future roles.

Government policy states that it is the government's responsibility to supervise and train water committees created with government support. Existing training activities, however, address the personnel from government institutions more than the committee members. Training programmes also take place after the system has been constructed rather than before or during construction (Espejo, 1989).

Training of trainers

Training should aim to generate a 'multiplier effect' whereby everyone who is trained becomes a potential trainer themselves.

In a dug-wells programme in northern Ghana, a core group of experienced wells supervisors worked with communities to construct village wells. A village supervisor was appointed by each community to work alongside the core supervisors during construction. The village supervisor gained knowledge and skills that were valuable in the future maintenance of the wells. Particularly competent village supervisors were recruited as core supervisors as the programme expanded and became trainers themselves (Author's own experience).

Training for women

Generally, women are good managers and approach maintenance conscientiously. But it is important to choose the right candidates and to adapt training and working conditions. Working jointly with a group of women is often a useful way of arriving at good candidates, establishing peer support for the job and obtaining help at home for candidates who have to go away for training (IRC, 1992).

The importance of adapting training to allow women to participate is illustrated by the following case from Ethiopia:

An NGO financed training for community handpump caretakers during a two-week course at the water authority workshop in the regional capital. This excluded most women from being caretakers as it was unacceptable for them to be away from their homes overnight. Therefore, the approach was modified to encourage the training of women caretakers by bringing the trainers to the villages and replacing workshop-based technicians with trained women extension staff (Davis, Garvey and Wood, 1993).

9.2 Operation and Maintenance Information Management

O&M information management is the recording, documentation and dissemination of information relevant to O&M to support the sector.

There is a need to exchange information at a localized level - within a country or region - and globally. The kind of information is broad and includes performance and technical data,

skills needs and training, financing and costs, all related to O&M. The people who will use the information are professionals in the water sector involved in planning, design and management; policy makers, practitioners at the field level, community members involved in O&M management and the users of water supply facilities. The type of information, who will use it and how it might be made widely available is summarized in Table 17. The information categorization is not strict and one type of information will feed into another.

How can information on O&M be made accessible?

The lack of available detailed information on O&M and past operational experience is a major problem in planning and implementing effective O&M systems. Agencies do produce reports but they are often only available through informal contacts.

The difficulty of collecting O&M information and making it accessible is part of a wider problem of information management in the water and sanitation sector. Recognizing this gap, various attempts have been made to establish, or in some cases revive, national documentation centres (Parker, 1993). Government water departments or technical institutes have been seen as the natural focal points for information collection and dissemination. However, if they are to be successful they require adequate funding for personnel, materials, equipment and buildings.

A concern in sharing and comparing information between countries, programmes and individual projects from widely different situations is that different methods of analysis and compilation are often used and the data may not always be reliable.

The following extract from an evaluation report highlights the problem of inadequate information flow and the unreliability of data.

'The flow of financial information from the villages to the districts is poor, being largely based on visits by district staff, and on village plans. There is no routine system for collecting financial data from the village level. Because of these weaknesses, the figures appearing in the reports have to be treated with great caution' (Smet et al, 1993).

Fluctuations in exchange rates and the relative cost of materials also complicate comparisons between countries. Care must be exercised to ensure like is compared with like.

Information, Education and Communication (IEC)

As applied to O&M, IEC aims to create public awareness, provide encouragement and change behaviour in relation to the community management of O&M. Typical IEC information is listed in Table 16. IEC public information and campaign materials may be developed and produced locally by communities and partner agencies working together and then shared with other communities and disseminated at various levels.

Table 16: Framework for an O&M information system

<i>What O&M information?</i>	<i>Who will use the information?</i>	<i>How and where can it be accessed?</i>
<p>Project and sector information General reports and statistics on the status and progress of O&M at project, regional and national level.</p>	Planners and policy makers in government and external support agencies.	National information systems and international networks.
<p>Management information Operational performance indicators: functioning supplies, reliability, maintenance response times, cost recovery. Coverage data, water demand and water use</p>	Managers, administrators and planners of O&M systems.	Government water agency or water sector information network.
<p>Administrative information: O&M personnel trained and in post, stocks of spares and spares supply system, number and activities of water committees.</p>	Project staff	Agency reports.
<p>Technical information VLOM technology, operation and servicing schedules of equipment and machinery, preventive maintenance schedules, O&M technical problems, availability and improvements to equipment, tools, materials and techniques.</p>	Engineers, technicians, managers directly concerned with the implementation of O&M systems.	Agency technical reports, libraries and documentation centres in water technology institutes, manufacturers' literature.
<p>Information for IEC* campaigns Operation and use of facilities, cost of O&M, fund-raising activities, savings and payment schemes, financial accounting, committee functions and procedures, agency support services, legal provisions related to O&M, health and hygiene promotion material.</p>	The general public, policy makers, planners and extension agents.	Users of water facilities, support agencies, documentation centres.

* Information, Education and Communication

APPENDIX

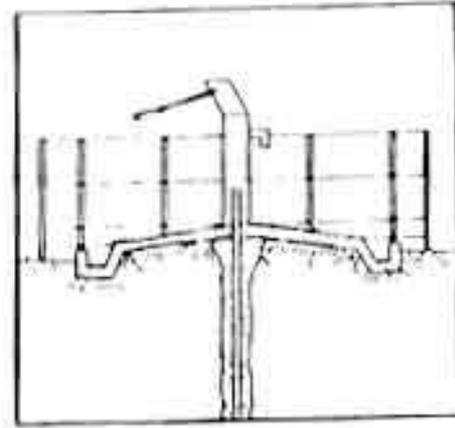
Examples of a systematic approach to identify the O&M technical requirements of a water supply scheme

Example 1

Borehole fitted with a handpump

Boreholes may be fitted with a variety of pumps. This example considers a small diameter borehole fitted with a fabricated steel, reciprocating handpump made in the country.

1. Description of scheme



The borehole

The borehole has an internal diameter of 100mm.

The total depth of the borehole is 55m; the average static water level is at 20m; and the pump cylinder is set at a depth of 35m.

The borehole is drilled into stable fissured rock and therefore the casing extends from ground level for 5 metres until the stable rock is reached. There is no screen.

The top of the borehole is sealed to prevent the ingress of surface water polluting the borehole.

The borehole surroundings

The pump platform directs spilt water to a drain which carries water to a soakaway, 3 metres from the borehole.

The handpump is mounted on top of the borehole in such a way that spilt water cannot pass back down into the borehole but drains away.

The platform is designed for convenient operation of the handpump by users who are mainly women and children.

The borehole site is surrounded by a fence with a gate.

The handpump

The handpump is rigidly mounted on holding down bolts in the concrete platform.

The handpump is of the reciprocating type with a lever arm which is operated in an up and down motion.

The handpump is of the VL0M type in which the below ground moving parts (the piston and valves) can be withdrawn from the surface without removing the rising main.

The rising main is made of PVC plastic

2. Description of O & M Activities

Daily

Carry out an early morning test to check if the foot valve holds water in the rising main overnight.

Check whether the pump delivery is normal or low.

Check if the handpump is firmly fixed in place.

Check for loose nuts and bolts on the handpump.

- Clean the platform and drain.
- Check the fence is in sound condition and the gate will close.

Weekly

- Carry out daily checks and in addition
- Tighten all the above-ground nuts and bolts with a spanner.
- Clean the accessible moving parts.

Monthly

- Carry out the weekly checks.
- Collect* and record contributions to the water committee.

Yearly

- Dismantle the pump head parts.
- Remove the connecting rods, piston assembly and foot valve.
- Inspect all the parts.
- Replace worn or defective parts.
- Replace piston seals.
- Straighten bent connecting rods, or replace.
- Replace rods with badly corroded threads.
- Replace corroded or missing connecting rod lock nuts.
- If connecting rods show severe corrosion, remove the rising main.
- Check the rising main and replace badly corroded pipes - check the threads in particular.
- Clean pipe threads and install the rising main.
- Re-assemble and replace the below-ground parts.
- Assemble the pump head.
- Check the pump operation and pump until the water delivered is clean.
- Record all significant actions.

Irregular

- Repair cracks with cement mortar in the pump platform and drain.
- If pump mounting bolts become loose in the concrete platform, remove pump, breakout old bolts, and remount in fresh concrete.
- Arrange to clean the borehole if the pump delivers cloudy water with silt.

* The time interval for the collection of payments will depend on local circumstances such as the seasonal income pattern.

3. Description of O & M Requirements

Labour

Unskilled

- Users can carry out the daily activities.
- Water committee to organise maintenance and collect, record and dispense funds for spares and repairs.

* The time interval for the collection of payment will depend on local circumstances such as the seasonal income pattern.

Semi-skilled

- Caretaker can carry out the weekly checks and carry out preventive maintenance on the connecting rods, piston assembly and foot valve.

Skilled

- Private or water agency mason for concrete work.
- Water agency maintenance team to carry out work requiring the removal of the rising main.
- Water agency to clean the borehole when necessary.

Materials & Equipment

Available within the community

- Sand for mixing cement mortar.
- Fencing materials.
- Brush for cleaning platform and drain.
- Record book and pen.

Available within the country

- Cement for platform repairs.
- Spare parts for pump repairs.
- Tools for preventive maintenance and repairs.
- Pipes for the rising main.

Only available from outside the country

- Vehicle for the water agency maintenance team.

Finance

Community funds

- Labour and materials for platform repair.
- Purchase of handpump spare parts.

Government funds

- Maintenance team.

4. Identification of Tasks

O&M TASKS: COMPONENTS	Supervision & monitoring	Operation	Preventive maintenance	Minor repairs	Major repairs
Borehole	*	--	--	--	**
Rising main	*	--	*	**	--
Handpump	*	**	**	*	**
Platform	*	--	*	*	*
Fence	*	--	*	*	--

** essential for sustainability

* preferable for sustainability

-- not relevant

Example 2

Gravity piped distribution of a spring supply to standposts

1. Description of scheme



Spring box

- A concrete spring box to protect the source.
- A delivery pipe to the gravity main.
- An overflow pipe to divert excess water away from the spring box.
- An access hole with inspection cover.

Reservoir

- A stone masonry, reservoir tank.
- A roof of corrugated galvanized steel sheet.
- Three pipes with an isolation valve on each:
 - inlet from the source;
 - outlet to the standposts;
 - washout.
- An overflow pipe.

Main distribution pipeline

- The pipeline material is a combination of PVC (for buried sections) and galvanized steel (for exposed sections, difficult terrain and connections to tanks and standposts).
- Pipe is buried to a depth of 0.6 metre.
- Valve boxes protect control valves at the reservoir, on each branch of the system, and at each standpost.

Service pipes

- The service pipes to each standpost are galvanized steel.
- A valve on the service line isolates the flow to each standpost.

Standposts

- The standpost comprises an upright galvanised steel pipe encased in a concrete pillar.
- A concrete platform directs spilt water to a drain.
- The drain directs water to a soakaway, situated at least 3 metres from each standpost.
- There are two taps per standpost.

2. Description of O & M Activities

Daily

- At each standpost:
 - Unlock taps and open the valve on the service line.
 - Check the tap operates correctly.
 - Check the flow of water is normal.
 - Attend to any dripping tap.
 - Attend to any leaking valve.
 - Clean the standpost platform, drain and surroundings.
 - Inspect standpost structure, platform and drain - repair any cracks with cement mortar.

Weekly

- Check at the reservoir:
 - for leaks;
 - the overflow is in good order;
 - valves are in the correct position;
 - clear water is flowing into the reservoir at the required rate.
- Walk the route of the distribution pipeline:
- Check for pipeline leaks.
- Look for any disturbed sections of pipe e.g. erosion around gulley crossings.
- Check valves are not leaking and are correctly set.

Monthly

- Collect water committee contributions

Yearly

- Inspect spring box and repair if necessary.
- Drain reservoir, clean and inspect.
- Repair any damage to the reservoir tank.
- Plaster and make good any cracks in the walls and floor of the reservoir.
- Check the operation of valves and inspect internal parts if a valve is stiff to operate. Repair or replace parts as necessary.
- Open 'wash-outs' to flush pipeline.
- Check air release valves operate correctly.
- In the dry season, remove soakaway stones and clean soakaway pit and stones before replacing.

Irregular

- Repair pipeline leaks, taps and valves as necessary.
- Inspect the pipeline after heavy rain and control erosion around pipes.

3. Description of O & M Requirements

Labour

- Unskilled
- Users carry out daily checks at the standposts.
 - Users assist in annual activities.
 - Users assist in the repair of pipeline leaks and erosion control.
 - Water (tap) committee collects, records and dispenses funds for tap and valve spares, etc. or replacement.
 - Water committee officials keep records of leaks and repairs.

Semi-skilled Caretaker carries out daily and weekly activities on the distribution system.

Skilled Water agency pipefitters to assist in major pipeline leaks.
Water agency or private mason to repair reservoir and spring box.
Private mason to repair standpost structures.

Materials & Equipment

Available within the community

Sand for cement mortar.
Brush for cleaning platform and drain.
Stone for erosion control.
Tools for digging up broken pipe.

Available within the country

Cement for reservoir and standpost repairs.
PVC and steel pipe for major pipeline repairs.
Spares for taps and valves.
Tools for maintenance and repair.

Only available from outside the country

Finance

Community funds

All labour and material costs of tap, valve and minor reservoir and pipeline repairs.

Government funds

Cost of the pipefitters and materials for major pipeline, reservoir and spring box repairs.

4. Identification of Tasks

O&M TASKS: COMPONENTS	Supervision & monitoring	Operation	Preventive maintenance	Minor repairs	Major repairs
Spring box	*	--	*	*	**
Reservoir	*	--	*	*	**
Pipelines	**	--	**	*	**
Valves	**	*	**	*	*
Standposts	**	**	**	**	*

** essential for sustainability

* preferable for sustainability

-- not relevant

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