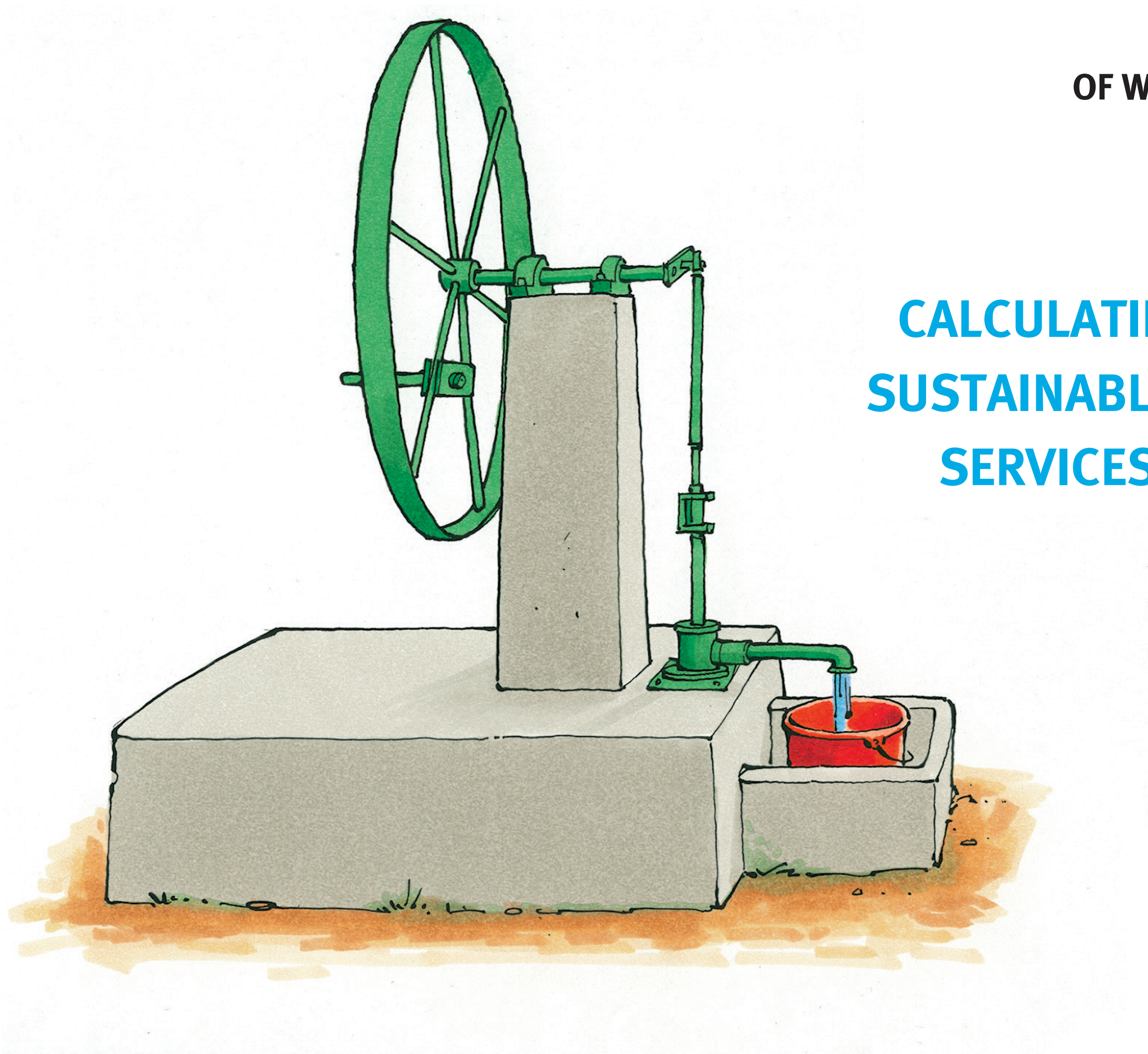

A HANDBOOK FOR
SOCIO-ECONOMIC ANALYSIS
AND MANAGEMENT
OF WATER-SUPPLY FACILITIES

VOLUME 3

CALCULATING THE COSTS OF SUSTAINABLE WATER-SUPPLY SERVICES IN RURAL AREAS

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A HANDBOOK FOR

SOCIO-ECONOMIC ANALYSIS

AND MANAGEMENT OF WATER FACILITIES

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Preface

At the end of the International Drinking Water Supply and Sanitation Decade (1981–1990), the World Health Organization and the United Nations Children's Fund established a Joint Monitoring Programme for Water Supply and Sanitation. According to the report of the programme, published in 2010[1], 2.6 billion people (39% of the world's population), mainly in Asia and Africa, do not have access to proper sanitation, and 886 million lacked access to clean water. Unhygienic disposal of waste and improper treatment of grey and black water pollute water bodies. Eighty percent of disease cases in developing countries are water-borne.

Since its inception in 1958, MISEREOR, whose primary objective is to fight hunger and disease the world over, has been facilitating projects in Asia, Africa and Latin America for providing access to potable water.

As a result of the long periods of drought in the early 1970s and 80s in the Sahel, India, and northern Brazil, increased efforts were undertaken to make water accessible to the afflicted populations. In the beginning, MISEREOR was content with financing infrastructure projects such as shallow wells, deep boreholes, other water-retention structures, spring catchments or gravity water distribution systems.

During the United Nations' International Drinking Water Supply and Sanitation Decade (1981 to 1990), MISEREOR supported several projects which provided technical solutions for problems related to water supply. However, it became apparent that technical solutions were not enough to solve problems related to water supply and distribution. Not enough attention had been paid to the socio-economic environment of the beneficiaries, leading to a situation where the beneficiaries were not maintaining wells and other water-supply facilities.

This was a missed opportunity – for involving the beneficiaries in the planning process, training them in the use of equipment, and creating awareness among them about the need to manage these structures on their own.

[1] Progress on Sanitation and Drinking-Water – Update 2010; published in 2010 by the Joint Monitoring Programme for Water Supply and Sanitation from the World Health Organisation and the United Nation Children's Fund; online available from http://www.unwater.org/downloads/JMP_report_2010.pdf [7th March 2013]

The assumption was that people were too poor to be able to contribute financially to the installation and maintenance of water-supply facilities for improving their living conditions. However, there were no conclusive figures to support this assumption.

To get to the root of the problem, MISEREOR conducted socio-economic studies for water-supply projects between 1999 and 2004, in collaboration with experts and partners in Africa and Haiti.

The findings of these studies in some of the world's poorest countries were astonishing: in the majority of the cases, the poorest of the poor not only were able to contribute towards the cost of water supply, but were ready to do so. This money would cover the installation as well as the costs of the day-to-day management of the water-supply facilities, provided the supply was regular, safe and dependable.

This means that socio-economic studies should be the first, indispensable step towards finding a socially viable and sustainable solution for supplying water to the economically deprived segments of the population.

This handbook provides concrete, practical guidance for conducting socio-economic surveys, calculating the actual costs of water-supply facilities, and evaluating ways of making the water price cost-effective, affordable and viable for the direct beneficiaries.

The book is intended for professionals and field workers in the water sector, with the objective of enabling communities to improve their living conditions and take charge of their own water-supply facilities on a sustainable basis.

Dr Martin Bröckelmann-Simon

Foreword

A perspective on water and sanitation: An Afro-Asian view-point

The three volumes of the '*Handbook for socio-economic analysis and management of water facilities in rural areas*' have been primarily written for field workers and persons working in the field of water supply in rural areas. The main objective of the handbook is to increase the sustainability of water-supply facilities by providing detailed procedures for conducting socio-economic surveys prior to the physical installation of a water-supply system in a village or village cluster, procedures for establishing a management and institutional framework, and methods for calculating costs and revenues so as to determine tariffs for the water-supply services and ensure that the water-supply facility is financially, technically and organisationally sustainable.

The premise for preparing such a handbook was that a large number of water supply and sanitation systems in Afro-Asian countries either stop functioning within a few years or run sporadically and inefficiently, even though, in terms of the installation of infrastructure and technology input, they are usually seen to be satisfactory. This is usually because insufficient efforts were made to set up institutional mechanisms to manage the facility and to establish financial procedures for collecting revenue through water-supply fees. Often, large investments are made in infrastructure, but such projects fail to deliver the services or benefits commensurate with the investment.

The original French version of this handbook (2007) dealt with water supply and its costing and management for determining fees. Although the handbook focuses on water supply for drinking and agriculture, a similar methodology could be applied for sanitation and wastewater disposal facilities. The reader can adapt the approaches described as required.

Water and sanitation and the Millennium Development Goals

In 2000 the international community promised to reduce poverty and injustice through eight Millennium Development Goals (MDGs). Under Target 7c, part of Goal 7 on environmental sustainability, it was agreed to halve the proportion of population living without access to safe water. Technically, this target is considered to have been achieved, since the proportion of people without access to safe drinking water has been reduced by almost half of the percentage in 1990. But in absolute numbers worldwide, 783 million people still do not have access to potable water and an astounding number of 2.5 billion people do not have access to decent sanitation facilities[2]. Sub-Saharan Africa and South Asia are the regions that have lagged behind the most. In addition, the distribution of benefits has been highly skewed and inequitable, with the rich urban residents gaining the most, while the rural poor have been largely left out, even though water and sanitation was recognised as a human right by the UN General Assembly in 2010. The Joint Monitoring Programme for Water Supply and Sanitation of the World Health Organization and the United Nations Children's Fund[3] estimates that 40% of the population in sub-Saharan Africa do not have access to reliable potable water, while in other developing countries less than 15% are still to be covered by improved facilities.[4] In case of sanitation, the target was not met even technically in 2010, and is not likely to be met even by 2015 if the current trends persist. Coverage improved from 49% (1990) to 63% (2010).

Over the years, investments in infrastructure provided many villages and informal urban settlements with water-supply and sanitation facilities. But many have fallen back into the ‘no access’ category because the institutional framework for operating, maintaining, financing and involving local communities in the facilities was neglected by both governments and donor agencies.

These slippages are also often the result of non-availability or erratic and unreliable basic data, poor management, malfunctioning of water systems, and sometimes due to the water source being depleted or drying up during dry seasons.

Anticipating and rectifying such issues is possible only if there is a well-designed organisational and management framework based on reliable basic data.

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[2] *The Millennium Development Goals Report 2012*; published in 2012 by the United Nations in New York, United States of America; online available from http://www.un.org/en/development/desa/publications/mdg-report-2012.html [7th March 2013]

[3] *Progress on Drinking Water and Sanitation: 2012 Update,* published in March 2012 in the United States of America by UNICEF and WHO, www.unicef.org/media/files/JMPreport2012.pdf

[4] WHO/UNICEF defines ‘improved’ drinking water sources as those that by nature of their construction are protected from outside contamination, particularly faecal matter.

Inequitable distribution of benefits

In South Asia, although there was considerable progress, there were very severe inequities in the distribution of benefits. In India, Nepal and Bangladesh, the richest 20% of the population benefited the most, while the poorest 80% got practically no benefits.

In sub-Saharan Africa where rainfall ranges between 200 to 800 mm a year, equity issues are all the more pronounced. Regarding sanitation, barring a small minority of richer households, almost the entire rural population practises open defecation.

Geographical and ecological boundaries

Geographical and ecological boundaries must be considered as the natural units for planning, rather than as merely units for administrative convenience. This would help to ensure the long term sustainability of water-supply schemes as well as transboundary surface and groundwater resources, especially in the light of climate change. When determining the availability of water in a single village, a cluster of villages, or a water-supply programme as a whole, a hydrological assessment of water availability needs to be done at the appropriate scales (micro or mini catchment, sub-basin or tributary). Such an assessment would provide information about the availability of water per person, per village or per catchment etc.

Integration

Interdependencies across policy areas and between levels of government should be taken into consideration while planning a water-supply facility. The process of setting up a management framework should go hand-in-hand with integrating village-level, bottom-up planning. Water and sanitation issues involve multiple stakeholders at the watershed, municipal, regional, national and international levels. It is important to link all of them.

Think globally, act locally

Water is essentially a localised issue, so the local and national political situation and existing laws and policies must be taken into consideration to put efficient systems in place. Local environmental conditions, such as actions taken upstream, affect the water quality and availability downstream. If too much water is extracted or a river is polluted upstream, the water in downstream settlements may be less safe.

Ecosystem approach and international norms related to water supply

Since land and fresh water are finite resources, and there are ecological limits to the use of these resources, a long-term, watershed perspective needs to be adopted while implementing any Water Sector Programme. Standards for water needs vary from country to country. In general, a person needs at least 20 litres per capita per day for drinking and cooking for short-term survival. At least 70 litres is required to satisfy basic domestic needs personal washing, laundry, cleaning, growing food and sanitation.[5] International water-quality, hygiene and sanitation standards have to be respected as well. Standards are available from the World Health Organization and others. Therefore a sustainable water resource management and the protection of water resources against contamination are crucial aspects for a safe water supply.

Rural and marginalised communities

Rural communities are rarely homogenous: they have clans, caste groupings, religious divisions and class and social distinctions. The equitable distribution of cost burdens and benefits are therefore important. In India for example, marginalised communities like forest dwellers and tribals struggle to maintain their land rights. Basic facilities like drinking water and sanitation have not reached all remote areas, although the availability of water *per se* is not a constraint. This aspect has been included in the socio-economic surveys recommended in this handbook.

Approach

Rural situations are complex. An approach that is purely sociological, technological or environmental is not adequate. The institutions and mechanisms for managing water resources are at different stages in different countries, even though there may be some common factors. So the combination and complementary use of different methods is highly recommended. To name a few, the socio-economic approach presented in this book can be combined with a rights-based approach, participatory rural appraisal methods, a negotiated approach,[6] conflict-sensitive project

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[5] B.J. Reed (n.d.): *Minimum water quantity needed for domestic uses. Technical Note 9,* WHO/SEARO Technical Notes for Emergencies. World Health *Organisation*, New Delhi. www.who.or.id/eng/contents/aceh/wsh/water-quantity.pdf

[6] This involves decision makers of various levels of government and sectors and all stakeholders in negotiating decisions to achieve consensus.

implementation instruments, etc. It is also important to take stock of recent experiences related to water and sanitation in developing countries and identify good practices.

The guidelines in this handbook are indicative, and do not claim to be exhaustive. The methods described here for ensuring financially viable and technical and organisationally sustainable water-supply facilities in rural areas in Africa and Asia could be further enriched by inputs from field workers who have experience in water-sector programmes in their respective areas.

Translator's and content editor's note

The original French version of this handbook was published in 2007. It was intended mainly for practitioners in the water sector in francophone countries in Africa. It aimed to promote the financial viability and technical and organisational sustainability of rural water-supply systems through socio-economic studies of the project area and the target groups, using appropriate management procedures.

The English version, published in 2013, has been prepared keeping in mind English-speaking developing countries in both Africa and Asia. It has been modified and updated to take into account the wider geographic, economic, political and socio-cultural context of the intended beneficiaries. It could also be applied in other locations worldwide wherever similar conditions exist.

The English version includes elements related to water quality and hygiene. It also takes into consideration social configurations, existing or potential conflict situations, and local and national laws related to the water sector.

The handbook provides a methodology for setting up sound economic, financial, and management procedures, without advocating any specific technology, to ensure the long-term sustainability of a project. The same framework could be applied, with a few modifications, to sanitation facilities and grey-water disposal.

For the sake of convenience, the US dollar has been used as the standard international currency. It should be replaced by the currency of the country where the handbook is used. Since currency exchange rates, prices and wages fluctuate and vary from country to country, we request readers to treat the costs and revenues given merely as illustrative examples.

Choosing appropriate equivalent terms is one of the main challenges a translator faces. In view of the wider coverage of the English version, which spans two continents, it is quite likely that many readers may not be familiar with some of the ideas or items described. For instance, the 'barrel', 'pot' or 'jerry can' used to measure water amounts in rural areas may be different sizes in different regions. This would affect the calculations for charging for water supplies. Similarly, terms for structures such as 'borehole' which is used in East Africa, might be better understood in Asia as 'bore well' or 'tube well'. The term 'farm pond' may not have the same connotation in Africa as it does in India. Wherever possible, such differences have been taken into account, but readers would need to treat these options as being indicative. They should substitute the local term for the one we have used.

Volume 3 contains a number of terms from economics. See the Glossary for explanations.

Acknowledgements

The editorial team thanks all those who have contributed individually to the preparation of this handbook on strategies for making water supply economically viable and sustainable.

Special thanks to Anjali Paranjpye for her translation of the book and to Vijay Paranjpye for contributing to the editorial work and for his engagement in professional discussions and questions during the review of the text.

We would also like to express our gratitude to Rolf Bunse for his creative illustrations, Paul Mundy for editing, as well as Annegret Schroif of MVG (Medienproduktion & Vertriebsgesellschaft mbH) for the meticulous management of the production process.

Our sincere thanks to all the partners in Benin, Burkina Faso, Haiti, Senegal and elsewhere, who contributed their ideas and valuable information, so making the original French version of the handbook possible. For this English version, we would like to express our gratitude especially to the programme partners from Kenya, Tanzania, Cameroon and India who contributed information and experiences to the process of reviewing the handbook.

The editorial team thanks all the village water projects in Burkina Faso, Senegal, Benin and Haiti as well as in Kenya, Tanzania and Cameroon for applying the methodology described in this handbook.

Last, but not the least, the editorial team would like to express its sincere thanks to Mohamed Tayeb Kasmi, the main author of the French version of this handbook, for his personal commitment and professional skills.

Jean-Gérard Pankert
Jutta Himmelsbach

Introduction

This handbook deals with the **socio-economic analysis and management of water-supply facilities** in the context of rural water supply.

It has been prepared keeping in mind the framework of water-sector programmes. It is a working tool and guide meant not only for partners of MISEREOR, but also for all communities facing similar situations in developing and managing water-supply facilities in rural areas.

Applying this framework in urban or peri-urban areas may be possible in some countries. However, these areas usually have pre-established systems for water supply and sanitation which are usually the responsibility of the local government or city council.

Complications may arise due to the prevailing administrative set-up, legal mandates, prices, etc. It may not be possible for voluntary agencies to set up a separate water-supply system and charge independent prices for supplying water.

On the other hand, this handbook could easily be applied for providing sanitation facilities and systems for the disposal of grey water in rural areas, since water availability, water quality, sanitation and disposal of waste water are interdependent.

This handbook consists of three separate volumes:

Volume 1: Socio-economic analysis of the environment.

Volume 2: Management of water-supply facilities.

Volume 3: Calculating the costs of sustainable water-supply services in rural areas.

Volume 1 deals with:

- Socio-economic analysis of the intervention zone and the village environment,
- Specially designed surveys of households and local village leaders/resource persons, and

- Procedures for verifying and approving applications made by the community for support for a water-supply facility.

Volume 2 presents:

- Methods and tools of analysis for the utilisation and management of existing and proposed water-supply facilities,
- Approaches to administrative, technical and financial management of water-supply facilities in rural areas, and
- The methodology for adapting social animation to the management of water-supply facilities.

Volume 3 describes:

- Methods and tools for calculating the investment and implementation costs of the project,
- Methodology and instruments for calculating the cost of water supply, and
- Illustrative examples for calculating the cost of supplying water from different types of facilities and structures.

The original handbook, written in French, was prepared on behalf of MISEREOR by a consultant, Mohammed Tayeb Kasmi. Valuable inputs were obtained from water-sector professionals belonging to partner organisations at a workshop conducted at Ouagadougou (Burkina Faso) in July 2005, and the international seminar on ‘Better management of water-supply facilities with the participation of, and for the benefit of, the poor’, organised by MISEREOR at Saly in Senegal in November 2005.

The handbook builds upon the experiences gathered through socio-economic studies and advisory meetings related to the management of water-supply facilities conducted mainly in Senegal, Burkina Faso, Benin and Haiti under the umbrella of water-sector programmes.

The English version, published in 2013, has been vetted at two workshops in Nairobi, Kenya, in December 2011 and September 2012, attended by several MISEREOR partner organisations from Africa and South Asia. These organisations tested the instruments presented in the book in the field, and enriched the English version with information and recommendations from their respective contexts. As a result, some of the content has been adapted to reflect current perceptions and needs related to dependable, safe and sustainable water supply.

This handbook uses the US dollar as the standard currency. Replace with the local currency as appropriate.

Summary of Volume 3

Volume 3 of the *Handbook for socio-economic analysis and management of water facilities* deals with calculating the costs of sustainable water-supply services in rural areas.

Water for **drinking and domestic uses** is a **human right**, so it cannot be bought and sold. But that does not mean it is free. Wells have to be dug. Pumps and pipes are needed to get the water from the source to the consumer. The water may have to be treated to make it safe to drink. The whole system has to be maintained, leaks repaired, fuel bills paid. In some countries, the government charges a fee or tax for water extraction.

Even if the water itself is free, it is quite legitimate to charge consumers for supplying it to them. Indeed, it is necessary to charge fees to recoup the costs of building and maintaining the supply. These fees are not the price of water per se; rather, they are to cover the costs of the **service** of impounding, purifying, pumping and distributing it.

Water used for **commercial purposes**, on the other hand, can be seen as a **commodity** that has to be paid for. Such purposes include farming, livestock-raising and industry. On the other hand, water for such uses may not have to be as pure as drinking water – so it may be cheaper to supply. These considerations mean that fees for domestic water may be different from water intended for commercial use.

A good knowledge of the investment and running costs of water facilities is essential to work out their overall cost. These must include charges for infrastructure development and depreciation.

Calculating the costs of supplying water is indispensable to ensure efficient, continuous and sustainable management of the facilities. It also makes it possible to establish ways to set user fees and calculate how much beneficiaries should contribute financially. Without this, it would not be easy to motivate the beneficiaries to pay for water or to explain why fees must be charged.

Volume 3 consists of three chapters:

1. How to calculate the **investment costs** of a water-supply facility or project.
2. How to calculate the **cost of supplying water**.
3. **Examples** of calculating water-supply costs for different types of facilities.

Chapter 1 covers calculating the investment costs of a water-supply facility or project. It covers calculations for the:

- **Preliminary costs:** feasibility studies, socio-economic surveys, etc.
- **Direct capital costs:** construction materials, labour, equipment installed and hired
- **Indirect capital costs:** transport of materials, set-up and dismantling of the site, site operations and management.

Calculating the investment costs is essential for determining the overall cost of supplying water.

Chapter 2 describes how to calculate these overall costs. They include:

- A percentage of the investment costs (described in Chapter 1). This is known as **depreciation**.
- The **running costs** of the water facility.
- The **reinvestment costs** of the facility

This chapter also describes how to use the cost calculations as a basis for setting water fees.

Chapter 3 gives examples of calculating of costs for different types of water-supply facilities:

- Village water supply
- Dug well with a pump
- Dug well without a pump
- Dams and other water-retaining structures
- Agricultural land.

Figure 1 depicts the approach for calculating the cost of water supply below.

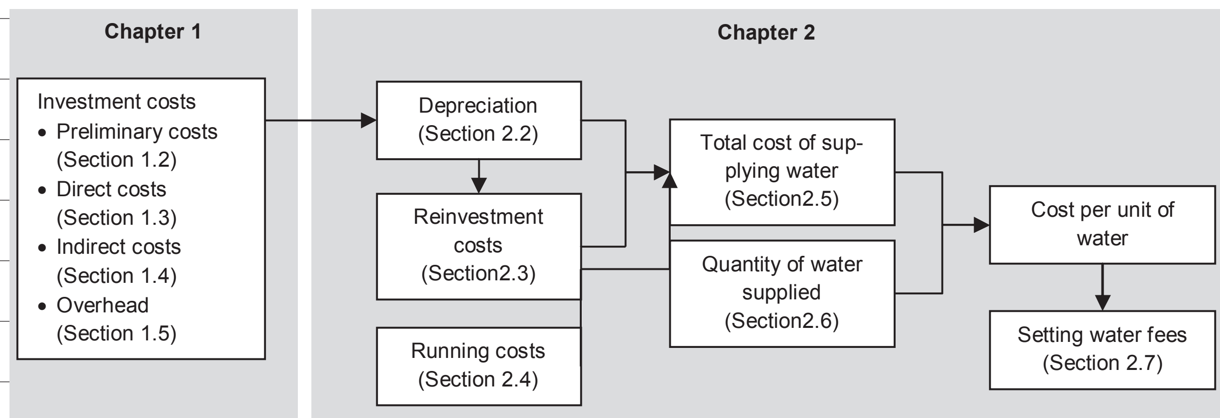


Figure 1. Calculating the costs for water supply

1 Calculating investment costs

1.1 Overview

This chapter describes how to calculate the costs of building a water-supply facility. To do this, we must find out four types of costs, which we then add together. These are:

- Preliminary costs (Section 1.2)
- Direct costs (Section 1.3)
- Indirect costs (Section 1.4)
- Overhead (Section 1.5).

The total investment cost will depend on the type of structure and equipment installed. Some of the cost items are listed in Table 1.

Table 1. Types of water-supply structures and equipment

Structures	Wells (shallow dug wells or drilled wells, deep wells, with manual or electric water extraction equipment, including piping for tube wells, etc.) Water-retaining structures (dams, rainwater harvesting facilities, drainage systems, artificial ponds, percolation ponds or wells, etc.) Source catchments Storage structures (reservoirs, tanks, for drinking water, etc.) Supply and distribution structures (gravity schemes, pipelines, collection chambers, air valves, washout valve chambers, taps, break pressure tanks, pressurized tanks, drinking troughs for animals, etc.) Buildings/shelters (for generator, offices, stores for the equipment, spare parts, etc.) Water purification plant

Equipment	Electricity lines or other energy sources Generators/electrical equipment Submersible pumps/manual pumps Dosing pumps Meters Bio-digesters for converting effluent waste to fertiliser Filtration equipment Fencing

1.2 Preliminary costs

Preliminary costs are all expenses incurred before construction begins. They include:

- **Studies:** ground-level studies, technical studies and planning, assessment of water availability, research, data collection and analysis, chemical and biological analysis, economic and socio-economic studies
- **Tendering:** Call for tender
- **Community work**, orientation of the target group
- **Training** for building, operating and repairing the facility.

Add these costs together to get the preliminary costs.

1.3 Direct costs

The direct costs are composed of:

- **Costs of acquisition** of the site.

- **Cost of construction materials** such as cement, sand, bricks, steel, iron and wood used in the construction. It includes the cost of buying the material, transport to the site, handling charges, etc.

- **Cost of labour**. These are costs for personnel (salaries, fees) employed at the site (workers, supervisors, executives, etc.).

- **Cost of equipment** installed at the site. It includes the cost of the equipment itself and transporting it to the site.

- **Cost of machinery**. These are costs of hiring or deploying equipment (vehicles, borers, compressors, etc.) used to construct the facility.

These are just examples, not an exhaustive list. The items will vary from case to case.

Formula A shows how to calculate the direct costs.

Formula A: Direct costs

Direct costs = Acquisition costs + Construction materials + Labour + Equipment + Machinery

We now look at how to work out each of these individual items.

1.3.1 Acquisition of site

The water project may have to pay for the land it uses, for example to build tanks. It is advisable for the land and structures to be owned by the project itself (or the community it serves). A written contract with the previous owner is recommended.

Add up all the compensation expenses to find the costs of acquiring the site.

1.3.2 Construction materials

Table 2 gives a form to use to calculate the daily use of construction materials.

Table 2. Cost of construction materials

Type of material	**Units** (e.g., kg, tons)	**Amount used**							**Total amount** (a)	**Unit price** (b)	**Cost of material used** (a × b)
		Mon	Tue	Wed	Thu	Fri	Sat	Sun			
Sand											
Gravel											
Cement											
Construction steel											
...											
Total											

Fill in this form each day for the amount of each type of materials used. At the end of the week, add up the total cost of all the construction materials that have been used.

At the end of each month, add up the total cost of materials used in that month.

1.3.3 Labour

Table 3 gives a form for calculating the cost of labour.

Table 3. Cost of labour

Name of worker	Days worked							Total days worked	Pay per day	Cost of labour
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	(a)	(b)	(a × b)
Total										

Fill in this form each day for each of the workers employed. At the end of the week, add up the total cost of labour for that week.

At the end of each month, add up the total cost of labour for that month.

1.3.4 Equipment installed

Table 4 gives a form for calculating the cost of equipment and installing it. See Table 1 for the types of equipment to list in the rows in this form.

Include only those costs that not already covered in Table 3.

- For example, if the equipment was installed by an outside contractor, include the cost of installing one unit in column (c) in Table 4.
- If the equipment was installed by workers already covered in Table 3, put a zero in column (c).

Table 4. Cost of equipment installed

Type of equipment	Number installed (a)	Unit cost of equipment ($) (b)	Unit cost of installing the equipment by outsider ($) (c)	Total cost ($) (a × (b + c))
Total				

At the end of each month, add up the total cost of equipment installed in that month

1.3.5 Machinery

Table 5 gives a form for recording the machinery and other equipment used for construction.

Table 5. Cost of machinery used

Type of equipment	Number of hours work per day							Total hours (a)	Cost per hour ($) (b)	Cost of equipment used ($) (a × b)
	Mon	Tue	Wed	Thu	Fri	Sat	Sun			
Total										

Fill in this form each day for each of the types of machinery used. At the end of the week, add up the total cost of machinery for that week.

At the end of each month, add up the total cost of machinery used in that month.

If the machinery is hired, the hiring cost can be used.

If the machinery belongs to the water-sector programme, then you have to calculate the cost of using it on this particular project. The rate to use depends on the cost of the machinery, how many years it is expected to last, fuel, maintenance, operators, insurance, etc. Many water-sector programmes have set rates for the use of machinery.

1.3.6 Summary of direct costs

Make an annual summary of the direct costs (Table 6).

Table 6. Summary of direct costs

Type of cost	**Month**												**Total ($)**
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Acquisition of site													
Construction materials													
Labour													
Equipment													
Machinery													
Total													

1.4 Indirect costs

Indirect costs are other costs that are not covered in the previous sections. They include:

- **Cost of transporting machinery and equipment.** These include the cost of bringing machinery and equipment to the site, and taking it away again after the work is finished.
- **Cost of setting up and dismantling the site.** This includes the costs of building access roads, sheds, stores, fencing, etc. – and of dismantling them afterwards.
- **Costs at the site.** This covers expenses for electricity, water, sanitation, etc.
- **Costs of monitoring and inspection.** These are expenses for staff and others to monitor progress and check on quality.

Large-scale projects may have to take into account “externalities” such as the social cost of displacing people to make way for a dam. For most water-sector programmes, such costs are fairly small, so can be ignored.

1.4.1 Calculating indirect costs

Formula B shows how to calculate the indirect costs.

Formula B: Indirect costs

Indirect costs	=	Transport of machinery & equipment	+	Installing & dismantling site	+	Costs at site	+	Monitoring & inspection

The indirect costs are many and varied. The types of costs will vary from site to site, and will depend on the type of project. The list above and in Formula B is just an example of the types of costs that may arise.

Table 7 gives a form to record these costs.

Table 7. Indirect costs

Costs	Costs incurred							Total costs ($)
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Transporting equipment to site								
Setting up site								
Electricity								
Water supply								
Fuel								
Removing equipment from site								
Dismantling of site								
Monitoring and inspection								
Others (to be specified)								
Total								

At the end of each month, add up the total cost of materials used in that month.

1.4.2 Summary of indirect costs

Make an annual summary of the direct costs (Table 8).

Table 8. Summary of indirect costs

Type of cost	Month												Total ($)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Transport to and from site													
Site installation and dismantling													
Costs on-site													
Monitoring and inspection													
Total													

1.5 Overhead

Overhead is the cost of administration, operation and management of the water-sector programme during the implementation phase, not covered above. These are costs that the programme will incur regardless of where the site is. They include the costs of personnel (administrative staff and those working indirectly for the project) and various administrative costs (electricity, telephone, fuel, vehicle insurance, etc.).

A project will incur various costs after the end of the construction phase: monitoring, training, follow-up, etc. These should be included under running costs (see Section 2.3). If this is not possible, they should be regarded as a donor contribution and not included in the cost calculations.

A water-sector programme typically has a range of individual projects – some big, some small. So we have to allocate the costs fairly among these projects. This section describes how to do this.

We first calculate the total overhead costs for the whole water-sector programme for one year.

We then divide the overhead costs among the various projects, depending on the size of each project. We allocate more overhead to big projects than to small ones.

How do we determine the size of each project? By calculating the direct and indirect costs of each one. Table 9 shows how to do this.

Example

A water-sector programme currently has only two projects running: a borehole project in Smallhill village, and a village water-supply project in Bigvale. The overhead costs of the programme this year were **$80,000**. How should they be allocated between the two projects?

For each project, we add up the expenditure in the current year for preliminary costs, direct and indirect costs, following the guidelines in this chapter. We find that the Smallhill project cost $100,000, while the Bigvale project cost $300,000.

The Smallhill project was 25% of the year's expenditures, while the Bigvale swallowed 75% of the costs.

We can therefore allocate 25% of the $80,000 overhead (or $20,000) to Smallhill. We allocate 75% (or $60,000) to Bigvale.

Note that next year, the expenses for the two projects may be different, so there will be a different overhead allocation.

Table 9. Example of allocating overhead costs within a water-sector programme

Costs	Project		Total ($)
	Smallhill borehole ($)	Bigvale water supply ($)	
Preliminary costs	5,000	20,000	25,000
Direct costs	70,000	180,000	250,000
Indirect costs	25,000	100,000	125,000
Total	**100,000**	**300,000**	**400,000**
Percentage of total	25%	75%	100%
Overhead allocated	**20,000**	**60,000**	**80,000**

1.6 Total investment costs

We can now calculate the total investment costs of the water facility. This is the total of the preliminary, direct, indirect and overhead costs (Formula C).

Formula C: Total investment costs

$$\text{Total investment costs} = \text{Preliminary costs} + \text{Direct costs} + \text{Indirect costs} + \text{Overhead}$$

1.7 Summary of investment costs

When the water facility is completed, a sheet summarizing the costs can be drawn up (Box 1).

Box 1. Summary sheet of investment costs for a water-supply facility

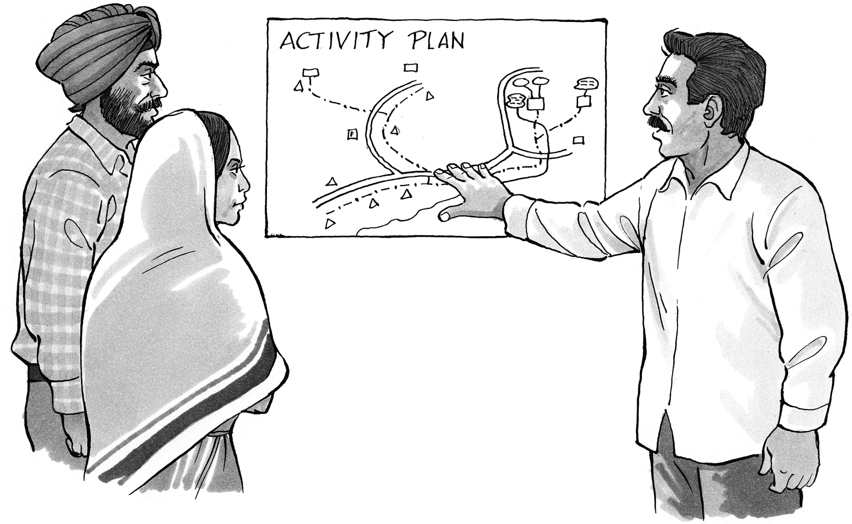
Commune, village: District/State/Region:

1. Name of the water-supply facility:
2. Year of execution:
3. Capacity of water-supply facility (m^3 per hour):
4. Summary of investment costs

Type of cost	Total cost ($)	Observations
Preliminary costs		
Direct costs		
Indirect costs		
Overhead		
Total		

Remarks about facility and costs :

Prepared on: Name: Signature


ACTIVITY PLAN

2 Calculating the costs of supplying water

2.1 Overview

This chapter describes how to calculate the cost of supplying 1 cubic metre of water to users. To do this, we will need the following information:

- The **total investment costs** of the water facility (see Chapter 1).
- The **annual depreciation** rate for the facility. This is the amount that has to be set aside each year to pay for replacing the facility and its equipment when it wears out (Section 2.2).
- The **reinvestment costs** of the facility (Section 2.3).
- The **running costs** of the facility (Section 2.4).
- The **volume of water supplied** (and the volumes **actually consumed** and **paid for** by users) (Section 2.5).

This chapter describes how to calculate these items.

2.2 Annual depreciation charge

2.2.1 Calculating the depreciation charge

Even the best-built water-supply facility will not last forever. Pipes leak. Pumps break down and have to be replaced. A well may have to be deepened, or it may collapse. Buildings need new roofs, and wooden fences rot. Eventually even a seemingly permanent structure like a reservoir will silt up and have to be dredged.

We cannot predict exactly when these items have to be fixed, and we do not know how much they will cost. But the water-management committee has to set aside money to cover these costs when they do occur. How much should be set aside each year?

The idea is to guess how many years a piece of equipment or part of the facility will last. We then divide the cost of this item by the number of years. This gives the annual **depreciation charge** for that item.

Note that the depreciation charge is not the same as the cost of maintaining the facility and repairing minor items such as leaky pipes. These costs are included in the running costs (Section 2.4).

Some pieces of equipment (such as a frequently used pump) are likely to wear out or break down quickly. Others (such as a dam or canal) are likely to last a long time. So we have to factor these different life expectancies into our calculations.

How many years should we use for the lifespan? That will depend on the type of structure or equipment, the location and individual situation. Masonry buildings tend to last longer than wooden buildings or equipment such as pumps and generators. In good conditions and with regular maintenance, equipment can last far longer than expected. In poor conditions, if it is badly maintained, or if an accident occurs, it may fail far sooner.

Table 10 gives examples of the expected lifespans of various structures and equipment. These lifespan figures are examples only: they should be adjusted to suit particular situations.

Table 10. Examples of lifespan of various structures and equipment

Structure	Lifespan (years)
Water-retaining structure (e.g. dam, weir)	30
Building Machinery shed	25

Storage reservoir	20 – 25
Pond	15 – 30
Drinking water trough	15 – 25
Borehole/well Dug well Supply and distribution network Water-retaining structure (e.g. tank, water tower, etc.) Water purification plant Electricity line Toilet block	15 – 20
Artificial water pond, pan	10 – 15
Fencing	5 – 10
Equipment	
Equipment/piping for borehole/dug well	10 – 20
Generator	10 – 15
Submersible pump Manual pump Meter	10
Dosing pump	5 – 10

If an item is expected to last less than 1 year, the cost of replacing it should be included in the annual running costs (Chapter 2.3).

As indicated in Table 10, different items wear out at different rates. In a small water-supply facility with only a few components, it is probably enough to estimate the average lifespan of the components, and then check Table 10 for the annual depreciation rate.

In more complex facilities with several components with different expected lifespans and costs, it may be necessary to work out the total investment costs of each major component (following the same procedure as in Chapter 1), estimate the lifespan of each one, and then calculate the annual depreciation charge for each component.

Table 11 gives a form to calculate the depreciation charge.

Table 11. Annual depreciation cost for a project

Component (structure or equipment)	**Lifespan (years)** (a)	**Total investment costs ($)** (b)	**Annual depreciation charge ($/year)** (b / a)
Structures			
Total structures (c)			
Equipment			
Total equipment (d)			
Total structures + equipment (c + d)			

2.2.2 Including depreciation in the water fee

The annual depreciation charge should be included (in total or in part) in the fee that beneficiaries pay for the water-supply services. How much is included will depend on the socio-economic situation of the beneficiary groups, the technical and operational aspects of the facility, and the water-sector programme's policy.

All the same, it is recommended that in addition to running costs, at least the costs for replacement of mechanical and/or electro-mechanical equipment be included in the cost of water supply, so as to ensure a perennial supply of water to the communities.

2.3 Annual savings for reinvestment

Calculating the depreciation means we know how much money that has to be saved to pay for a new water facility of about the same size. But looking (say) 20 years into the future, the population will have gone up, so many more people will have to be served. Plus, as people become better off, they tend to use more water. We need to take this into account. We need to save enough money in the meantime to be able to pay for a much larger water-supply facility in the future to replace the one now being planned. This is called the **savings for reinvestment**.

It is impossible to predict exactly what the population will be in (say) 20 years' time, or know how much water will be needed. So we have to guess. In many developing countries, the population is growing by around 2.5% a year. At this rate, it will double in around 20 years (Table 12). If we plan to build a replacement water facility in 20 years' time, it will have to supply twice as much water as the one currently planned.

Table 12. Population of a village of 1,000 people after 20 years at different annual growth rates

	Population growth rate per year						
	0%	**0.5%**	**1.0%**	**1.5%**	**2.0%**	**2.5%**	**3.0%**
Population after 20 years	1,000	1,105	1,233	1,394	1,602	1,878	2,262

How much will a new, bigger water-supply facility cost in 20 years? Again, it is impossible to know. So we have to guess again. If the facility has to serve twice as many people as the one currently planned, it is likely to cost double the amount. That means we should save the same amount every year as the annual depreciation charge we have calculated in Section 2.2.

If the population growth rate is significantly lower than 2.5% a year, the annual savings for reinvestment will be less than this. If the population growth is a lot faster, it will have to be higher.

Formula D: Annual savings for reinvestment

Annual savings for reinvestment = Annual depreciation costs

2.4 Annual running costs for operations and maintenance

The annual running costs for a water-supply facility include the following costs for one year (Formula E):

- Personnel costs (salaries, wages, benefits, etc.)
- Maintenance costs
- Energy costs

- Water-treatment costs
- Management costs.

Formula E: Annual running costs

Annual running costs	=	Personnel costs	+	Maintenance costs	+	Energy costs	+	Treatment costs	+	Management costs

We will examine each of these in turn.

2.4.1 Personnel costs

These include all the costs of remuneration for the people who run the water facility (technicians, community workers, guards, etc.), plus allowances paid to members of the management committee.

2.4.2 Maintenance costs

These include all expenses for maintaining the works and equipment (replacing parts, operations and maintenance costs).

Before the water facility has started operations, it is not possible to tell exactly how much the maintenance costs will be. So instead, we can estimate them based on the investment costs of the components. See Section 1.6 for how to calculate this.

Table 13 shows the percentages to use when estimating the costs of maintenance. Multiply the percentages in column (a) in the table by the total cost of investments (column (b)) to get the annual maintenance costs of that item. Sum all the costs at the bottom of the table for the total maintenance cost.

Table 13. Calculating maintenance costs

	Total cost of investments ($) (a)	**Estimated cost of maintenance (%)** (b)	**Annual maintenance costs ($)** a × b/100
Structures			
Borehole/well		5 – 6,66	
Dug well		5 – 6,66	
Storage reservoir		4 - 5	
Supply and distribution network		5 – 6,66	
Building or machinery shed		4	
Drinking water trough		4 – 6,66	
Garden basin for irrigation		3,33 – 6,66	
Dam		3 – 3,5	
Artificial water pond or pan		5- 6,66	
Other water-retaining structures		6,66 - 10	
Electricity line		5 – 6,66	
Fencing		10	
Toilets		10	
Water purification plant		3 – 5	
Others (to be specified)			
Total maintenance cost of structures (d)			

Equipment			
Equipment/ piping for borehole		5 - 10	
Generator		5 - 10	
Submersible pump		10	
Manual pump		10	
Dosing pump		10 - 20	
Meter		10	
Others (to be specified)			
Total maintenance cost of equipment (e)			
Total maintenance cost (structures + equipment) (d + e)			

Each water-sector programme must establish its own scale for maintenance. The rates in Table 13 are only indicative. Adjust them as required to suit the local situation.

2.4.3 Energy costs

These include the costs of electricity from the public grid and from generators.

If the electricity comes from a public grid, the cost equals the number of kilowatt hours consumed, multiplied by the cost per kilowatt hour, plus any additional fees. Check the bill from the energy supplier.

If the energy is produced locally, the cost equals the number of litres of fuel and lubricants consumed, multiplied by their price per litre. Make sure you include the cost of delivering them to the site.

2.4.4 Water-treatment costs

Most village water facilities do not treat the water. But if they do, their cost must be taken into account. Also include the cost of testing the water quality.

2.4.5 Management costs

These include all expenses incurred by the management committee (meetings, travel, training, water, energy, office stationery, etc.).

2.5 Total annual cost of supplying water

We can now calculate the total cost of the water-supply facility for one year. This is made up of:

- The annual depreciation charge
- The annual running costs.
- Annual savings for reinvestment

Formula F: Total annual costs

Total annual costs	=	Annual depreciation charge	+	Annual savings for reinvestment	+	Annual running costs

Table 14. Form for calculating the annual cost of supplying water

		Annual cost ($)
Depreciation charge (a)		
Annual saving for reinvestment (b)		
Running costs	Personnel	
	Maintenance	
	Energy	
	Water treatment	
	Management	
	Other running costs	
	Total running costs (c)	
Total (a + b + c)		

2.6 Cost of supplying 1 cubic metre of water

We have now calculated the total cost of running the facility and supplying water to users for one year. We can now work out how much it costs to supply one cubic metre of water. Once we know this, it is easy to work out how much to charge for supplying a litre, or a jerry can, of water. That makes it possible to set realistic fees for water use.

Remember that it is not the water that is priced: it is the cost of providing it.

We need to know the following:

- Total annual costs (see above)
- Volume of water supplied

- Volume of water consumed
- Volume of "revenue water" (the water that users actually pay for).

2.6.1 Volume of water supplied

The volume (in cubic metres) of water supplied in 1 year can be measured (or estimated) as follows:

- By using water meters to measure the bulk amount supplied
- By multiplying the hourly discharge from the pump by the number of hours of pumping
- By measuring or estimating the amount consumed (see below), then multiplying by a factor to account for losses. This factor will be estimated depending on experience with wastage, the accuracy of measurements, etc.

2.6.2 Volume of water consumed

The volume of water supplied is almost always bigger than the volume consumed. This is because of:

- **Physical losses**, caused by leaks, seepage, overflows and evaporation
- **Administrative losses**, caused by unauthorized connections and faulty water meters.

The volume of water consumed can be measured (or estimated) as follows:

- By using water meters or gauges on distribution outlets (distribution pipes, water troughs, irrigation weirs, ponds, etc.).
- By estimating the quantity provided based on consumption for various uses (human consumption, sanitation, livestock, irrigation). For this, one must

have data on the amount each type of use consumes, and the number of users for each type.

2.6.3 Revenue water

Not all of the water consumed is actually paid for. Some is used to flush the system, fight fires, or is given to the poor for free. These are all legitimate uses, approved by the management committee.

The volume of water that is supplied and that users actually pay for is called **revenue water**. It can be estimated using the same methods as for the volume of water consumed (see above), but leaving out the non-paying legitimate uses.

The volume of water that is supplied but that users do not pay for is called **non-revenue water**.

2.6.4 Cost of supplying 1 cubic metre of water

We can now calculate the cost of supplying 1 cubic metre of water. We may be interested in three different types of costs:

- The cost of supplying 1 m^3 of water
- The cost of supplying 1 m^3 of water that is **consumed**
- The cost of supplying 1 m^3 of water that is **paid for**.

Formula G shows how to calculate these.

Formula G: Cost of supplying 1 m^3 of water

$$\text{Cost of }\textbf{supplying}\text{ 1 m}^3\text{ of water} = \frac{\text{Total annual costs}}{\text{Volume of water }\textbf{supplied}\text{ in 1 year}}$$

$$\text{Cost of supplying 1 m}^3\text{ of water }\textbf{consumed} = \frac{\text{Total annual costs}}{\text{Volume of water }\textbf{consumed}\text{ in 1 year}}$$

$$\text{Cost of supplying 1 m}^3\text{ of water that is }\textbf{paid for} = \frac{\text{Total annual costs}}{\text{Volume of }\textbf{revenue water}\text{ in 1 year}}$$

Table 15 gives a form for calculating these costs. The management committee should complete this form once a year as a summary of the costs of supplying water.

Table 15. Form for calculating the cost of water supplied

Water volumes		**m^3**
Water supplied	(a)	
Water consumed	(b)	
Water paid for	(c)	
Costs		**$**
Depreciation charge		
Annual savings for reinvestment		
Running costs (operation and maintenance)		
Total costs	(d)	

Costs per cubic metre		$/m³
Cost per cubic meter of water **supplied**	(d / a)	
Cost per cubic meter of water **consumed**	(d / b)	
Cost per cubic meter of water **paid for**	(d / c)	

Which of these three costs is the appropriate one to use?

Answer: The last one – the cost of supplying 1 m^3 of water that is **paid for**.

Why? Because the managers of the water facility want to cover all the costs of supplying water. They have to do this with the revenue that users actually pay. The example below shows why.

2.6.5 Example

A water facility has total annual costs, including running costs and depreciation and savings for reinvestment costs, of **$45,000**.

- According to pump records, it supplies **100,000 m^3** of water a year.
- According to meters attached to the distribution pipes, residents consume **80,000 m^3** of water a year. That means that 20,000 m^3 is lost.
- The management thinks that **70,000 m^3** can be charged for. The remaining 10,000 m^3 is used for fire-fighting and use in public facilities.

How much should the management charge per cubic metre in order to cover its costs?

Answers:

- Cost of **supplying** 1 m^3 of water $= \dfrac{\$45,000}{100,000\ m^3} =$ **$0.45/$m^3$**
- Cost of supplying 1 m^3 of water **consumed** $= \dfrac{\$45,000}{80,000\ m^3} =$ **$0.563/$m^3$**
- Cost of supplying 1 m^3 of water that is **paid for** $= \dfrac{\$45,000}{70,000\ m^3} =$ **$0.643/$m^3$**

If the management charges users the cost of **supplying** 1 m^3 of water, it will earn only 70,000 × $0.45 = $31,500. This is not enough to cover all the costs, depreciation and reinvestment needs.

To cover the full costs, it has to charge the cost of supplying 1 m^3 of water that is **paid for**. That will let it earn 70,000 × $0.643 = $45,010. This is just enough to cover the total annual needs.

It should, of course, try to bring down the amount of water lost. If it does so, it can reduce the fees it charges users.

2.7 Setting water fees

2.7.1 Considerations

Once we know how much it costs to supply water, we are in a better position to set the fees to charge.

Things to consider:

- **The cost of supplying water that is paid for** (see above).
- **The capacity of the households to pay for water supplies.** The internationally accepted norm is that expenditure for water supply must not exceed 4% of the household's total income. Volume 1 describes how to calculate the household's total income and capacity to pay for water.
- **The capacity of non-domestic users to pay for water.** Water for domestic use is a human right, so we can charge only the cost of supplying it. But water for other uses is a commodity, so it may be justified to charge more for it. Volume 1 describes how to ask local people how much they would be willing to pay for water.
- **The availability of water** (especially in areas where water is seasonally scarce). During the season when water is scarce, the management committee may decide to add a **scarcity surcharge** (say, 5–7%) to the normal fee. This is to encourage users to use less water and to cover the extra cost, for example of pumping from greater depths. Since it uses less water, each household will probably pay about the same for water as during normal months. The management committee should not impose such a surcharge unilaterally; rather, it should discuss these issues with the community beforehand to get their agreement. It should also look for other ways to reduce water use when it is scarce.
- **Users' motivation and willingness to pay for water.** This will depend on the type of water facility, how the water is used, and how the supply is managed. If the management committee is open and participatory, people are likely to be more ready to pay than if the committee is regarded as top-down and dictatorial.

2.7.2 Covering the full cost

In general, the fee should be set at a level that covers the **full cost of supplying water that is paid for**, including all the running costs, depreciation and savings for reinvestment. That will allow the committee to keep the water facility running, keep the equipment maintained, and replace it when necessary.

If the fee is less than this, the management committee must consider how else it can raise the money to cover the shortfall. If the fee is less than the running costs, the water-supply facility will continuously lose money. If it cannot generate funds from other sources, it will eventually go bankrupt. Without adequate administration, maintenance or repairs, the facility will not be able to supply water to the users.

Depreciation and the savings for reinvestment can be a large part of the actual cost of the water supply (see the examples in Chapter 3). So it is tempting to leave it out, or to underestimate it, so as to keep the water fees low.

But if the fee does not cover depreciation and savings for reinvestment, the management committee will not be able to save the money needed to do large repairs and to replace the equipment and structures at the end of its life. It will have to find other ways of paying for these.

If they do include depreciation and savings for reinvestment in the fee, they must make sure to save the money, and not spend it! They should open a separate bank account and pay the share of depreciation into it regularly. When something major goes wrong, they can draw on this money to pay for the repair or replacement.

2.7.3 Pricing water for different uses

The management committee may choose to charge different fees for different types of water use, or for different types of users.

For example:

- It may charge less for low-quality water to be used for **irrigation**, since this does not have to be treated or kept clean. Irrigation water can be supplied by canal rather than in pipes.
- It may charge higher fees for **watering livestock, irrigation or industry** in order to subsidise the fees for poor households.
- It may charge less for **poor consumers** than for richer ones.
- It may charge a low fee for a limited amount of water for household use, and a **higher fee** if a household uses more than this.
- It may supply certain types of consumers **for free**.

The management committee must charge fees that together cover the total costs of supplying water. Table 16 gives a form for working this out. The total of the fees (a) should equal the total cost of supplying water (b), so that the difference between them is zero.

Table 16. Different fees for different users

Type of use (or type of consumer)	Volume supplied (m^3)	Fee ($/$m^3$)	Total ($)
• Domestic consumption			
• Drinking water for livestock			
• Agricultural usage			
• Others			
Total fees (a)			
Total cost of supplying water (b)			
Difference (b– a)			

2.8 Other measures

Various other measures are useful for managers of water-supply facilities. The most important of these are unaccounted-for water and water that is not paid for ("non-revenue water").

2.8.1 Unaccounted-for water

The unaccounted-for water is the volume of water supplied minus the volume consumed (Formula H).

Formula H: Unaccounted-for water

$$\text{Unaccounted-for water} = \text{Volume of water supplied} - \text{Volume of water consumed}$$

$$\text{Percentage of water unaccounted for} = \frac{\text{Unaccounted-for water}}{\text{Volume of water supplied}} \times 100$$

In general, well-managed systems have small volumes of unaccounted-for water. The percentage of water unaccounted for should be below 25%.

In our example above (section 2.6.5), the unaccounted-for water was:

- **Unaccounted-for water** $= 100{,}000\ m^3 - 80{,}000\ m^3 = 20{,}000\ m^3$
- **Percentage of water unaccounted for** $= \dfrac{20{,}000\ m^3}{100{,}000\ m^3} \times 100 = 20\ \%$

2.8.2 Water not paid for (non-revenue water)

The volume of water that is not paid for is called **non-revenue water** (Formula I).

Formula I: Water not paid for (non-revenue water)

$$\text{Non-revenue water} = \text{Volume of water supplied} - \text{Volume of water paid for}$$

$$\text{Percentage of non-revenue water} = \frac{\text{Non-revenue water}}{\text{Volume of water supplied}} \times 100$$

In our example above (section 2.6.5) the non-revenue water was:

- **Non-revenue water** $= 100{,}000\ m^3 - 70{,}000\ m^3 = 30{,}000\ m^3$
- **Percentage of non-revenue water** $= \dfrac{30{,}000\ m^3}{100{,}000\ m^3} \times 100 = 30\%$

2.9 Technical support on costs and fees

The water-sector programme must give technical assistance to the beneficiaries and management committees on:

- Calculating and determining the costs of water supply and services
- Calculating fees for access to water for various usages
- Recommending a scarcity surcharge.

This assistance must be of several types: training, community work, technical advice, and accompaniment over a long enough period (e.g., 3 years).

Few water-sector programmes currently have enough expertise in calculating costs and fees. The programme team may need training so they can advise and guide communities and management committees.

3 Examples of calculating water-supply costs

This chapter gives some examples of the calculations described above. The figures used are hypothetical. Real prices and costs differ significantly from country to country.

1.1 Village water supply (borehole)

The water supply in Village V supplies water to several sub-villages with thousands of inhabitants. It consists of:

- A borehole which supplies water
- A storage reservoir
- A distribution network delivering water to standpipes, drinking troughs and garden ponds.

The electricity comes mainly from a generator and sometimes from the public electric supply grid.

The equipment includes a generator, a submersible pump, and flow meters. Some of the equipment is protected by fences.

The water is meant for human consumption, livestock, small-scale commercial activities and kitchen gardens.

3.1.1 Annual depreciation charge

This is calculated according to Section 2.2 (Table 11). The figures for Village V are given in Table 17.

Table 17. Annual depreciation cost for Village V (borehole)

Component	Lifespan (years) (a)	Total investment costs ($) (b)	Annual deprecia-tion charge ($/year) (b / a)
Structures			
Borehole	20	$12,000	$600
Storage reservoir	25	$25,000	$1,000
Distribution network	20	$55,000	$2,750
Building for development activi-ties	25	$4,000	$160
Drinking trough	20	$1,000	$500
Fencing	10	$2,000	$200
Total structures		**$108,000**	**$5,210**
Equipment			
Equipment and pipes for borehole	20	$2,000	$100
Generator	10	$12,000	$1,200
Submersible pump	10	$6,000	$600
Meters	10	$200	$20
Total equipment		**$20,200**	**$1,920**
Total structures + equipment		**$128,200**	**$7,130**

The annual depreciation charge for Village V is $7,130.

3.1.2 Annual savings for reinvestment

This is estimated as the same as the annual depreciation charge, or $7,130.

3.1.3 Running costs

The running costs are shown in Table 18. Note that the amounts may change from year to year, so have to be recalculated each year.

Table 18. Annual cost of supplying water for Village V (borehole)

		Annual cost ($)
Depreciation charge (from Table 17) (a)		**$7,130**
Annual savings for reinvestment (b)		**$7,130**
Running costs	Personnel	$1,200
	Maintenance	$1,500
	Energy	$2,400
	Water treatment	0
	Management	$800
	Other running costs	0
	Total running costs (c)	**$5,900**
Total (a + b + c)		**$20,160**

The annual costs for Village V are $20,160.

3.1.4 Volume of water supplied, consumed and paid for

According to calculations based on the capacity of the pump and the number of hours it worked, the facility supplied 18,000 m^3 of water a year.

According to flow meters on the distribution pipes, users consumed 16,000 m^3.

For some uses, the water is free, so the management committee is able to charge for only 11,000 m^3.

3.1.5 Cost of supplying 1 cubic metre of water

Table 19 shows the calculations for the cost of supplying one cubic metre of water.

Table 19. Cost of water supplied for Village V (borehole)

Water volumes		**m^3**
Water supplied	(a)	18,000
Water consumed	(b)	16,000
Water paid for	(c)	12,000
Costs		**$**
Depreciation charge		$7,130
Annual savings for reinvestment		$7,130
Running costs (operation and maintenance)		$5,900
Total costs	(d)	$20,160
Costs per cubic metre		**$/$m^3$**
Cost per cubic meter of water **supplied**	(d / a)	$1.12
Cost per cubic meter of water **consumed**	(d / b)	$1.26
Cost per cubic meter of water **paid for**	(d / c)	$1.68

The cost of **supplying** 1 m^3 of water is $1.12.

The cost of supplying 1 m^3 of water **consumed** is $1.26

The cost of supplying 1 m^3 of water that is **paid for** is **$1.68**. This is the fee that the management committee should set.

The same procedure can be used for similar types of installations.

3.2 Dug well with pump

The water supply in Village W consists of a dug well with a pump, surrounded by a fence to keep animals and children away. There are no distribution pipes or other installations.

The water is used for domestic consumption, livestock and small-scale garden use.

3.2.1 Annual depreciation charge

The calculation for the annual depreciation for Village W is shown in Table 20.

Table 20. Annual depreciation cost for Village W (dug well with pump)

Component	Lifespan (years) (a)	Total investment costs ($) (b)	Annual depreciation charge ($/year) (b / a)
Structures			
Dug well	15	$6,000	$400
Fencing	10	$1,200	$120
Total structures		**$7,200**	**$520**

Equipment			
Equipment and pipes	20	$780	$39
Pump	10	$1,760	$176
Total equipment		**$2,540**	**$215**
Total structures + equipment		**$9,740**	**$735**

The annual depreciation charge for Village W is $735.

3.2.2 Annual savings for reinvestment

These are set to be equal to the depreciation charge, $735.

3.2.3 Running costs

The running costs are shown in Table 21. Note that the amounts may change from year to year, so have to be recalculated each year.

Table 21. Annual cost of supplying water for Village W (dug well with pump)

		Annual cost ($)
Depreciation charge (from Table 20**) (a)**		**$735**
Annual savings for reinvestment (b)		**$735**
Running costs	Personnel (technician)	$240
	Maintenance	$240
	Energy	0
	Water treatment	0
	Management	$240

	Other running costs	$10
	Total running costs (c)	**$730**
Total (a + b + c)		**$2,200**

The annual costs for Village W are $2,200.

3.2.4 Volume of water supplied, consumed and paid for

Because the pump has no water meter, it is impossible to tell exactly how much water it supplies in one year. However, based on the number of people using the water and the types of use, the management committee estimates the water supply at 7,000 m³ a year.

Some of this is spilled, used for cleaning the surrounding area, etc. The management committee estimates that a total of 6,000 m³ is consumed.

The management committee wants to charge households a flat rate based on the number of cubic metres of water they are likely to consume in a year. It knows that some people are likely to use more than this amount, and it is not practical to charge certain groups (such as the very poor or visitors to the village). Overall, it estimates that it will be able to charge users for a total of 4,500 m³.

3.2.5 Cost of supplying 1 cubic metre of water

Table 22 shows the calculations for the cost of supplying one cubic metre of water.

Table 22. Cost of water supplied for Village W (dug well with pump)

Water volumes		**m³**
Water supplied	(a)	7,000
Water consumed	(b)	6,000

Water paid for	(c)	4,500
Costs		**$**
Depreciation charge		$735
Annual savings for reinvestment		$735
Running costs (operation and maintenance)		$730
Total costs	(d)	$2,200
Costs per cubic metre		**$/m^3**
Cost per cubic meter of water **supplied**	(d / a)	$0.31
Cost per cubic meter of water **consumed**	(d / b)	$0.37
Cost per cubic meter of water **paid for**	(d / c)	$0.49

The cost of **supplying** 1 m^3 of water is $0.31.

The cost of supplying 1 m^3 of water **consumed** is $0.37.

The cost of supplying 1 m^3 of water that is **paid for** is **$0.49**. This is the fee that the management committee should set.

The same procedure can be used for similar types of installations.

3.3 Large-diameter dug well with no pump

Village X has a large-diameter dug well without a pump. People draw the water out using a rope and bucket. They use it for home consumption and to water livestock and gardens.

3.3.1 Annual depreciation charge

The calculation for the annual depreciation for Village X is shown in Table 23.

Table 23. Annual depreciation cost for Village X (dug well without pump)

Component	Lifespan (years) (a)	Total investment costs ($) (b)	Annual depreciation charge ($/year) (b / a)
Structures			
Dug well	15	$5,900	$393
Total structures		**$5,900**	**$393**
Equipment			
		0	0
Total equipment		**0**	**0**
Total structures + equipment		**$5,900**	**$393**

The annual depreciation charge for Village X is $393.

3.3.2 Annual savings for reinvestment

These are set to be equal to the depreciation charge, $393.

3.3.3 Running costs

The running costs are shown in Table 24. Note that the amounts may change from year to year, so have to be recalculated each year.

Table 24. Annual cost of supplying water for Village X (dug well without pump)

		Annual cost ($)
Depreciation charge (from Table 23**) (a)**		**$393**
Annual savings for reinvestment (b)		**$393**
Running costs	Maintenance	$240
	Energy	0
	Water treatment	0
	Management	$120
	Total running costs (c)	**$360**
Total (a + b + c)		**$1,146**

The annual costs for Village X are $1,146.

3.3.4 Volume of water supplied, consumed and paid for

The management committee does not have an estimate of the amount of water supplied. But based on the number of people who use the well and the number of buckets and jerry cans filled each day, it estimates that consumption is 3,000 m^3.

The management committee thinks it can charge for 70% of this (2,100 m^3).

3.3.5 Cost of supplying 1 cubic metre of water

Table 25 shows the calculations for the cost of supplying one cubic metre of water.

Table 25. Cost of water supplied for Village X (dug well without pump)

Water volumes		m^3
Water supplied	(a)	?
Water consumed	(b)	3,000
Water paid for	(c)	2,100
Costs		**$**
Depreciation charge		$393
Annual savings for reinvestment		$393
Running costs (operation and maintenance)		$360
Total costs	(d)	$1,146
Costs per cubic metre		**$/$m^3$**
Cost per cubic meter of water **supplied**	(d / a)	?
Cost per cubic meter of water **consumed**	(d / b)	$0.38
Cost per cubic meter of water **paid for**	(d / c)	$0.55

The cost of **supplying** 1 m^3 of water is not known, as the committee has no estimate of the amount supplied.

The cost of supplying 1 m^3 of water **consumed** is $0.38.

The cost of supplying 1 m^3 of water that is **paid for** is **$0.55**. This is the fee that the management committee should set.

The same procedure can be used for similar types of installations.

1.2 Water-retaining structures and dams

Village Y has a dam on a river to supply water to fields and drinking water for livestock. It also recharges the water table, so keeps enough water in the villagers' wells further down the slope. The villagers use the water from the dam to irrigate their kitchen gardens and tree nurseries.

The dam has a capacity of 100,000 m³ of water.

3.3.6 Annual depreciation charge

The calculation for the annual depreciation for Village Y is shown in Table 26.

Table 26. Annual depreciation cost for Village Y (dam)

Component	Lifespan (years) (a)	Total investment costs ($) (b)	Annual depreciation charge ($/year) (b / a)
Structures			
Dam	30	$156,000	$5,200
Total structures		**$156,000**	**$5,200**
Equipment			
		0	0
Total equipment		**0**	**0**
Total structures + equipment		**$156,000**	**$5,200**

The annual depreciation charge for Village X is $5,200.

3.3.7 Annual savings for reinvestment

These are set to be equal to the depreciation charge, $5,200.

3.3.8 Running costs

The running costs are shown in Table 27. Note that the amounts may change from year to year, so have to be recalculated each year.

Table 27. Annual cost of supplying water for Village Y (dam)

		Annual cost ($)
Depreciation charge (from Table 26**) (a)**		**$5,200**
Annual savings for reinvestment (b)		**$5,200**
Running costs	Maintenance	$3,120
	Energy	0
	Water treatment	0
	Management	$230
	Total running costs (c)	**$3,350**
Total (a + b + c)		**$13,750**

The annual costs for Village X are $13,750.

3.3.9 Volume of water supplied, consumed and paid for

When it is full, the reservoir behind the dam can hold 100,000 m³ of water. The stream that was dammed carries a lot more than this in a year (the excess water flows out over the dam's spillway).

The engineers who designed the dam estimated that about 200,000 m³ of water could be withdrawn from the reservoir each year.

The management committee thinks it can charge users for 70% of this (140,000 m³).

3.3.10 Cost of supplying 1 cubic metre of water

Table 28 shows the calculations for the cost of supplying one cubic metre of water.

Table 28. Cost of water supplied for Village Y (dam)

Water volumes		**m^3**
Water supplied	(a)	200,000
Water consumed	(b)	?
Water paid for	©	140,000
Costs		**$**
Depreciation charge		$5,200
Annual savings for reinvestment		$5,200
Running costs (operation and maintenance)		$3,350
Total costs	(d)	$13,750
Costs per cubic metre		**$/m³**
Cost per cubic meter of water **supplied**	(d / a)	$0.07
Cost per cubic meter of water **consumed**	(d / b)	?
Cost per cubic meter of water **paid for**	(d / c)	$0.10

The cost of **supplying** 1 m^3 of water is $0.07.

The cost of supplying 1 m^3 of water **consumed** is unknown because the management committee do not know how much is consumed.

The cost of supplying 1 m^3 of water that is **paid for** is **$0.10**. This is the fee that the management committee should set.

The same procedure can be used for similar types of installations, including bunds and weirs.

1.3 Vegetable plots

The residents of Village Z have a 2-hectare piece of land where they grow vegetables and fruit trees. They water this land from four large-diameter dug wells. They draw water from the wells using ropes and buckets. The wells are fenced to keep animals and children away.

3.3.11 Annual depreciation charge

The calculation for the annual depreciation for Village Z is shown in Table 29.

Table 29. Annual depreciation cost for Village Z (vegetable plots)

Component	**Lifespan (years)** (a)	**Total investment costs ($)** (b)	**Annual depreciation charge ($/year)** (b / a)
Structures			
Dug well	15	$24,000	$1,600
Fencing	10	$1,200	$120
Total structures		**$25,200**	**$1,720**

Equipment			
		0	0
Total equipment		**0**	**0**
Total structures + equipment		**$25,200**	**$1,720**

The annual depreciation charge for Village X is $1,720.

3.3.12 Annual savings for reinvestment

These are set to be equal to the depreciation charge, $1,720.

3.3.13 Running costs

The running costs are shown in Table 30. Note that the amounts may change from year to year, so have to be recalculated each year.

Table 30. Annual cost of supplying water for Village Z (vegetable plots)

		Annual cost ($)
Depreciation charge (from Table 26**) (a)**		**$1,720**
Annual savings for reinvestment costs (b)		**$1,720**
Running costs	Maintenance	$230
	Energy	0
	Water treatment	0
	Management	$20
	Total running costs (c)	**$250**
Total (a + b + c)		**$3,690**

The annual costs for Village Z are $3,690.

3.3.14 Volume of water supplied, consumed and paid for

The management committee has checked how many buckets of water the vegetable-growers use a day. It estimates that they use about 8,000 m^3 of water a year.

The management committee thinks it can charge for 70% of this (5,600 m^3).

3.3.15 Cost of supplying 1 cubic metre of water

Table 31 shows the calculations for the cost of supplying one cubic metre of water.

Table 31. Cost of water supplied for Village Z (vegetable plot)

Water volumes		**m^3**
Water supplied	(a)	8,000
Water consumed	(b)	8,000
Water paid for	©	5,600
Costs		**$**
Depreciation charge		$1,720
Annual savings for reinvestment		$1,720
Running costs (operation and maintenance)		$250
Total costs	(d)	$3,690
Costs per cubic metre		**$/$m^3$**
Cost per cubic meter of water **supplied**	(d / a)	$0.46
Cost per cubic meter of water **consumed**	(d / b)	$0.46
Cost per cubic meter of water **paid for**	(d / c)	$0.66

The cost of **supplying** 1 m^3 of water is $0.46.

The cost of supplying 1 m^3 of water **consumed** is also $0.46 (the management committee ignores any spillage).

The cost of supplying 1 m^3 of water that is **paid for** is **$0.66**. This is the fee that the management committee should set.

The same procedure can be used for similar types of installations.

4 Glossary

Depreciation charge

An amount of money that represents the annual wear and tear on a fixed asset. This amount is calculated as the cost of the asset divided by the number of years in its expected lifespan.

Direct costs

The costs for construction materials, manual labour, materials used at the site, equipment installed, etc.

Indirect costs

The costs for transporting material to and from the site, setting up and dismantling the site, costs incurred at the site (such as water and energy), and costs of monitoring and inspection of the work.

Non-revenue water

The volume of water (measured in cubic metres) supplied by the water facility but which is not paid for. It includes water that is lost for various reasons, as well as authorized usage (such as fighting fires and water given for free to the poor).

Overhead

The cost of administration, operation and management during the investment phase.

Preliminary costs

Expenses incurred before construction begins (e.g., for studies and surveys), and for training and community work.

Revenue water

The volume of water (measured in cubic metres) that is actually paid for (so generates income for the water-supply facility).

Running costs

All on-going costs which arise after the facility has been constructed and the equipment installed. These are also known as “operation and maintenance costs”

Scarcity surcharge

A fee added when water is scarce to encourage consumer to use less water, and to cover the additional costs of pumping from greater depths.

Social costs

The costs of displacing or inconveniencing people as a result of the project. For most water-supply programmes these are fairly small (and are far outweighed by the benefits of the project), so can be ignored.

Total investment costs

The costs of developing the water facility, from initial survey to completion. They include preliminary costs, direct costs, indirect costs and overhead.

Unaccounted-for water

The difference between the quantity of water supplied to a distribution network and the quantity of water used by consumers. It has two components: physical losses due to leakage and seepage, and administrative losses due to illegal connections and faulty water meters.

Volume of water consumed

The volume of water (measured in cubic metres) that users consume for various purposes (domestic use, irrigation, livestock watering, etc.). It is less than the volume of water supplied because of physical losses (caused by leaks, seepage, overflows and evaporation) and administrative losses (caused by unauthorized connections and faulty water meters).

Volume of water supplied

The volume of water (measured in cubic metres) supplied by the water facility.

Water fee

The fee levied for the supply of water. It may consist of a fee per cubic metre of water supplied to each user, or a lump sum for the right to use water from a particular source. The water itself is free (as it is a human right); the fee is to cover the cost of supplying it.

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MISEREOR – The German Catholic Bishops' Organisation for Development Cooperation

MISEREOR was founded by the German Catholic Bishops' Conference in 1958 as an overseas development agency "against hunger and disease in the world". It cooperates with partner organizations in Africa, Asia and Latin America, whose work it supports. Since its foundation, more than 98,000 projects have been funded and carried out.

The mandate of MISEREOR is:

- to fight the causes of hunger and disease,
- to support the poor in their efforts to lead a life of human dignity,
- to promote justice, freedom, reconciliation and peace in the world.

The three pillars of work by MISEREOR

1. Support for partner organizations in the South

MISEREOR supports self-help among the poor in order to help improve their living conditions in a sustainable way and to enable the under-privileged to claim their civil, social, cultural and economic rights. The partners of MISEREOR are organizations working with people in distress, irrespective of ethnic background, gender, creed or nationality.

2. Spiritual renewal

MISEREOR calls upon Catholics, and everyone else in Germany, to open their eyes to poverty and injustice in this world, to see the world as the poorest of the poor and the oppressed see it, and to empathise with them as Jesus did: "Misereor super turbam" – "I suffer with the people" (Mk 8:2).

The annual Lenten Campaign organized by MISEREOR invites Catholic communities and other interested people to help, share with the poor, and undergo a process of spiritual renewal through solidarity and community with the poor. It also calls for a commitment to ensure the responsible development of our own society in order to create "One World" which is more just and where people can live in peace.

3. Lobbying, advocacy and campaigning

Hunger, poverty and injustice cannot be overcome by development cooperation alone. The underlying root causes also have to be addressed. That is why the activities of MISEREOR include lobbying and advocacy work and campaigning in Germany and at the international level on various topics such as climate change, world trade, debt relief, HIV/AIDS, intellectual property rights, "fair play" in the toy industry, etc.

Funding

The financial resources of MISEREOR are threefold:

- Donations from German Catholics, in particular through the annual MISEREOR Lenten Campaign, and other private donations,
- Funds allocated from German diocesan budgets through the Association of German Dioceses, and
- Public funds provided by the Federal Republic of Germany and the European Union.

For further information, please visit our website, www.misereor.org.

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