

Manual on METER-BASED WATER MANAGEMENT SYSTEM



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Preface

You are no doubt aware of the perennial complaints in rural water supplies in Kenya to the effect that water service is unreliable and available water is often inadequate and insufficient.

Many solutions have been suggested and tried. Hundreds of water projects have increased their production capacities by for example, increasing the diameter sizes of their pipes; others have moved intakes farther and farther upstream in efforts to tap more and more water; while others have invested heavily in additional storage tanks or bigger capacity pumps. Yet, in practically all cases, these solutions have provided only some short term respite. The problem of water shortage, inadequate quantities and unreliable service never really goes away. At times, it appears as if the greater the amount of capital investment in physical works, the worse the situation seems to get.

This Manual proposes that your scheme introduces the well tested *meter-based* water management system which has come to be accepted, world wide, as *the* solution to the problem of perennial water shortages and inadequacies.

Section I of the Manual discusses why it is necessary for water consumers in schemes to pay for water, a matter which is often misunderstood in rural Kenya. Hopefully, this Section will convince you why your project should start regular charges for water if you have not started already. Section II contrasts the two most common forms of regular charging for water in rural Kenyan schemes -- the flat rate and metered charges. These two Sections advocate for the meter and are targeted at committees, water project staff and very importantly, the general membership.

Section III describes the principal features of a metered charging system while the last Section, IV, contains instructions on how to operate each of the principal features. These two sections are more technical and are really targeted at committees and scheme operators who are expected to operate the management system.

SECTION I: WHY SHOULD WE PAY FOR WATER?

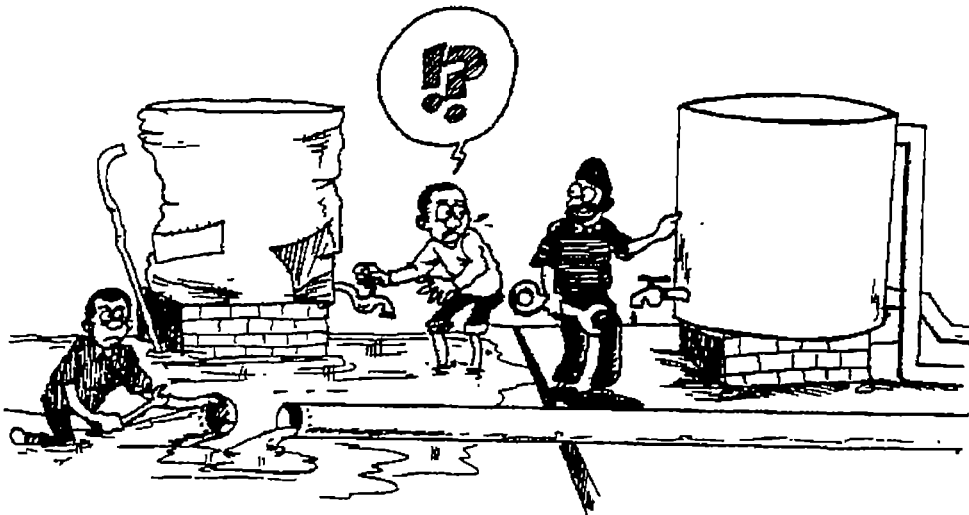
- 1.1. Four members of Gaki Water Project were overheard discussing some matters which were about to be debated at the Project's General Meeting that day. The conversation went as follows:-

<i>Baba Warutere:</i>	This committee has become too much! ..Too Much! .. They now want to start charging for water after all the amount of money we have already contributed to the project. We must vote them out today! .. today!..
<i>Baba Muthee:</i>	They have eaten too much!.. They have no shame! They now even want to charge for God's water. We must throw them out! .. Out!.
<i>Mama Maina:</i>	But, Baba Warutere, God's water is at the river. What I don't understand is why we should pay after having contributed Shs. 5,000/- each and our own labour.
<i>Baba Muthoni:</i>	I can explain that. When we attended a seminar at Gakwa, a teacher told us that pipes burst, wear out over time and shall need to be replaced. Another pointed out that rather than all of us coming out to carry out repairs every time there is a burst, it would be wise if we employed a skilled person who would be doing this. We would spend our time doing other more profitable things. I was convinced. Maybe this committee has a point.
<i>Baba Muthee:</i>	There should be no payment for water at all! It is God's gift to man!...
<i>Mama Maina:</i>	I agree that I should not pay for water at the river, but the water at home is something else. Come to think of it, Baba Muthee, even the water at the river is paid for, only that we do not notice it. Imagine the amount of time I take to fetch water from the river. And I have to have eaten some <i>ugali</i> to climb up that hill.
<i>Baba Warutere:</i>	Now that you say that Mama Maina and Baba Muthoni, may be there is something worth thinking about in this payment suggestion.

All the arguments for and against charging and payment for water are contained in the above conversation. Mama Maina recognizes that there is simply no resource, man-made or God-made, which is free! Everything, repeat, everything has a cost. *Hakuna cha Bure!*

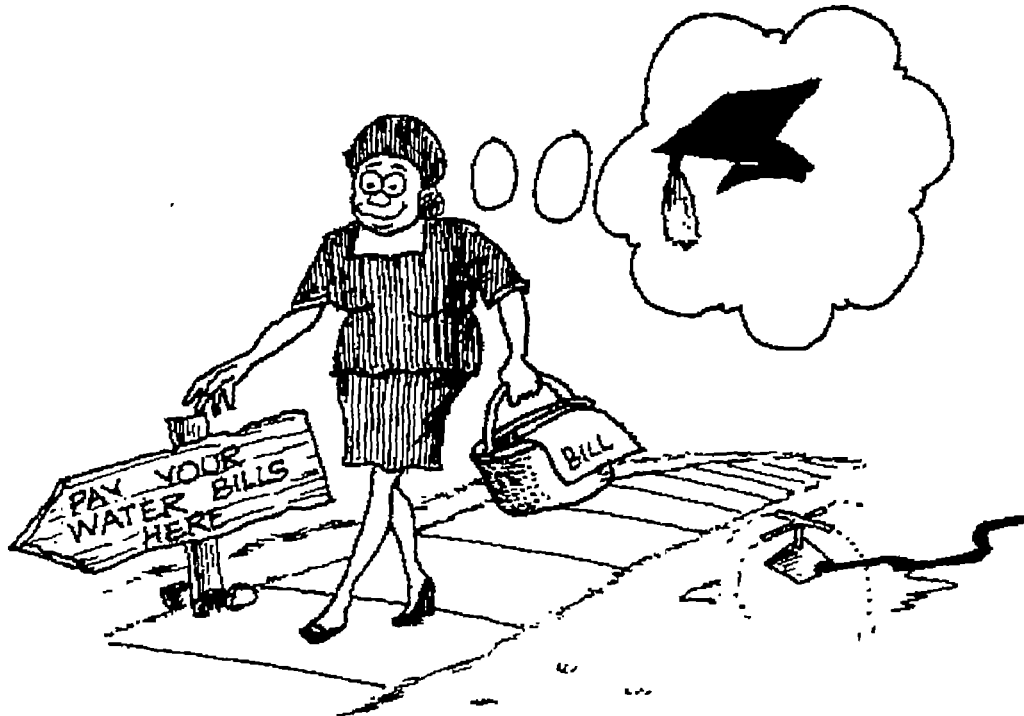
- 1.2. Some water consumers, especially those in self-help gravity-flow schemes believe that once they have fully paid the amount of cash assessed, contributed the required number of labour days, and obtained a connection, then they have absolutely no other financial obligation to the project except at times of breakdowns and emergency repairs. To them payment of capital and labour assessments amounts to *purchase of a lifetime access* to all the water which can flow through the pipes to their homesteads. They believe that they have made a one-time irrevocable purchase of the river which they have shifted to their homesteads from the natural waterway.

This belief is misplaced. The pipes they have purchased and laid burst and wear out; intake works and tanks need to be repaired and maintained. Provision, therefore, needs to be made for repair, maintenance, replacing of worn out parts, and renewing the installations when they finally collapse. Such provisions are most easily made when small, but regular payments, are made over time and into a kitty from which the project can draw when the need arises. Similarly, it is often much easier when a project has engaged skilled personnel to run its operations, than depend on the voluntary services of committee members to undertake the often arduous tasks. You can never demand performance from a volunteer. But an employee is hired to perform! Many projects actually spend much more money through volunteers than they would on employees.



Therefore, one does not pay for water as such, one pays for water coming to the homestead rather than remaining at the natural waterway.

- 1.3. But, Baba Warutere may object that sticky fingers may find their way into the kitty and misuse the funds collected, such that at the time of need there may be no money. This is a legitimate objection. But, we do not stop paying school fees because money may be "eaten". What we normally do is set rules and procedures for expenditure and institute transparent accounting. Payment for water is like payment for education: you pay for the service.



- 1.4. Later, members of Gaki Water Project debated the committee's proposal to introduce regular monthly water charges. By a narrow margin 160 against 140 members resolved to start charging themselves Shs. 60 monthly per connection.

SECTION II: FLAT RATE Vs. METERED CHARGING SYSTEMS

2.0 Introduction

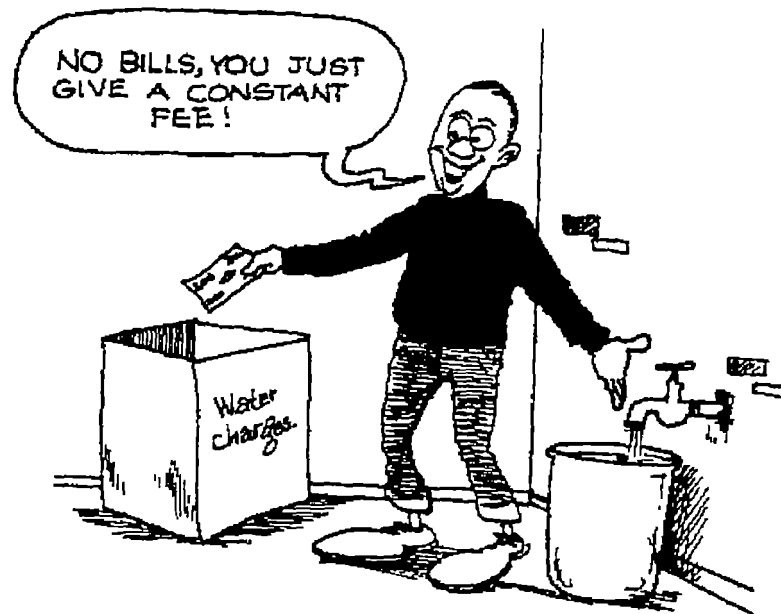
There are many different forms of charging found in Kenyan rural water schemes. Some are more appropriate than others. The one adopted by Gaki members is known as a flat rate.

2.1. Flat-Rate Charging

Under the flat-rate system adopted by Gaki Water Project, each of the 300 consumers would be charged the same amount monthly irrespective of the volume they use.

2.1.1. This form of charging has some advantages:

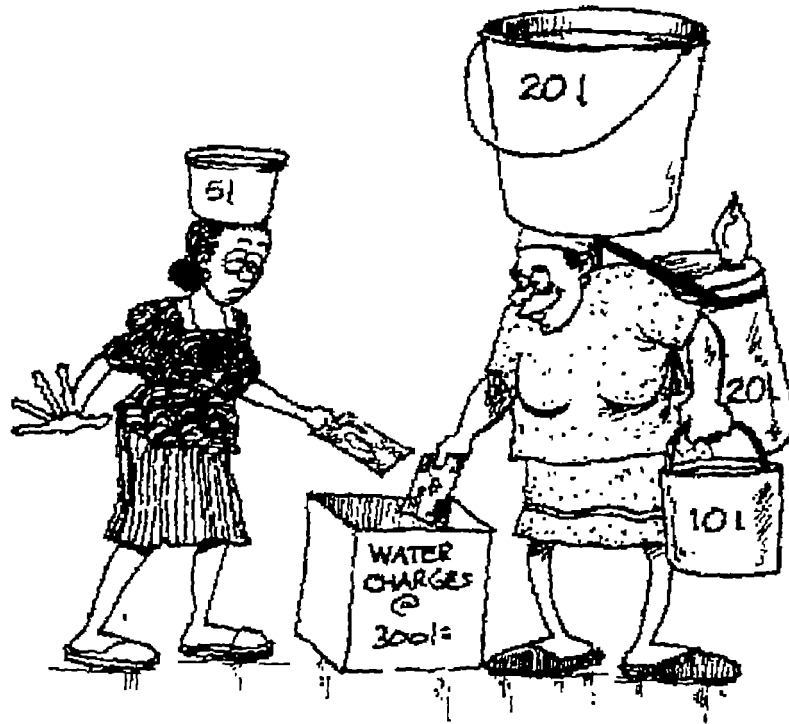
- It is simple to administer. Each and every connection holder is charged the same amount meaning that it avoids complicated calculations. To calculate Gaki's expected total monthly income one simply multiplies the number of consumers with the rate: $(60 \times 300) = \text{Shs. } 18,000/-$. Very simple records would suffice as there would be no need for preparation of bills or ledgers.



- Management need not worry very much whether water was actually available at the taps or not. It expects to charge whether water was used or not.
- It generates Operational and Maintenance funds for the project.

2.1.2. Flat rate charging has some major disadvantages as well:

- It is unfair to the smaller consumer who subsidizes the larger consumer. Baba Warutere and Baba Muthee with their large herds of cattle and pigs would be charged the same amount as Mama Maina who has only 5 chickens. So would other large consumers such as institutions and businesses.



- It does not encourage conservation of water. To the contrary, it encourages wastage, misuse and misapplication of water.
- Resulting from the wastage and misuse of water, some consumers suffer severe shortages while others have more water than they need.



2.1.3 Many of these disadvantages came out in the following discussion between members of Gaki Water Project and a committee member two years after adopting the flat rate charge.

Gaki Water Project	
Discussion between members and a committee official	
<i>Committee Member</i>	I have asked that we meet because our line is wasting a lot of water and some other members are complaining that they are not getting enough water. The committee has decided that something has got to be done to stop wastage of water. ...The committee has sent me to Baba Muthee and Mama Maina to inform them that it has noticed that their taps leak and that they leave their taps open overnight...Others cannot get water because of you.
<i>Baba Muthee:</i>	Oh no! ... I can't accept that! .. My tap got broken two months ago and I do not have money to buy another one. ... I will buy a new one when we receive our milk payments.
<i>Mama Maina:</i>	I also cannot accept that! My tap does not leak... Let's go home and check.
<i>Committee Member</i>	Our information about you, Mama Maina, is that you leave your tap on overnight watering your grass... Is that correct or not?..
<i>Mama Maina:</i>	That is correct. But I am only irrigating my grass.. Just as Baba Warutere irrigates his coffee and Baba Muthee his vegetables. Why pick on me? .. Why? .. I do not even use as much water as these two!!.. This committee has a lot of <i>fitina</i> . We paid the same amount to get the connection and now we are charged the same amount per month. My grass is only taking my share of the water...My grass is my coffee, my pigs and my cattle!
<i>Committee Member</i>	But, Baba Muthee and Mama Mama, other members cannot get water when you are wasting so much.
<i>Baba Muthee:</i>	The Project should put in bigger pipes to increase the amount of water for all of us!!.. Don't come messing us again.
<i>Mama Maina:</i>	I suggested that at the General Meeting but the committee refused to consider it.. Go tell the committee that there is no wastage here We are only using water for our purposes. .. Tell them also to stop <i>fitina</i> and <i>kichini chini</i> !. The committee needs to visit some connections where over-flowing water is channeled back into the river. Further, we do not use the same amount of water! Baba Warutere has 20 heads of cattle and I have only 5 chickens. Surely, it wouldn't be fair that we pay the same amount. Or what do you think Baba Muthee?
<i>Baba Muthee:</i>	May be.... I agree. All should pay the same amount. How else would we be able to establish the different consumptions?
<i>Baba Muthoni:</i>	Eh ...Eh ... Remember the other day I was telling you Mama Maina, Baba Warutere and Baba Muthee that when we visited Gakwa Water Project we learnt that they used to have similar problems. They solved them by requiring every consumer to have a meter. Each consumer is charged according to how much he/she uses. I think we should do the same.
<i>Mama Maina:</i>	I agree with Baba Muthoni. Why should we pay the same amount? Tell me Baba Muthee, why should we be charged the same amount? You have 10 heads of cattle and 30 pigs while I have only 5 chickens! Why?.. Tell me why. We have to be fair to all. We should pay as we consume!

Mama Maina and Baba Muthoni are suggesting that the monthly charge be linked to the volume used. The two are advocates of the meter-based water management system. The problem of water wastage while many other consumers faced shortages persisted at the Gaki Water Project. At a Special General Meeting held two years after adoption of flat rate charging, members of the project passed by a wide margin, a proposal to introduce metered charges as described below.

2.1.4 Historically, Kenyans have associated meters with urban water supply while the flat rate system has been more prevalent in rural water supplies. In typical urban situations, main uses of water among households consist of domestic consumption. Water is not often used as an input into production except in industries. In contrast, rural households use most of the water, about 80%, for watering livestock and irrigation. Government rural schemes often operate, simultaneously, flat rate and metered charging systems. Such a combination of charging systems favours unmetered consumers¹. The prevalence of flat rate charging avails cheap water to consumers and influences all to resist meters.

2.2. Meter-based charging

A meter-based water management system is one in which the consumer is charged on the basis of the *quantity* of water used and *at a price* per unit.

2.2.1. Metered charging has the following advantages:

- it helps to regulate water flows within the system,



- By linking the amount of payment to the volume of water used, this method is fair to all consumers. This would seem to be the contention of Mama Maina and Baba Muthee in the conversations encountered above,
- If the price is “right”², metered charges encourage conservation, proper usage, and application of water. This is the most important contribution of a metered system.

Meter-based charging encourages the connection holder to:

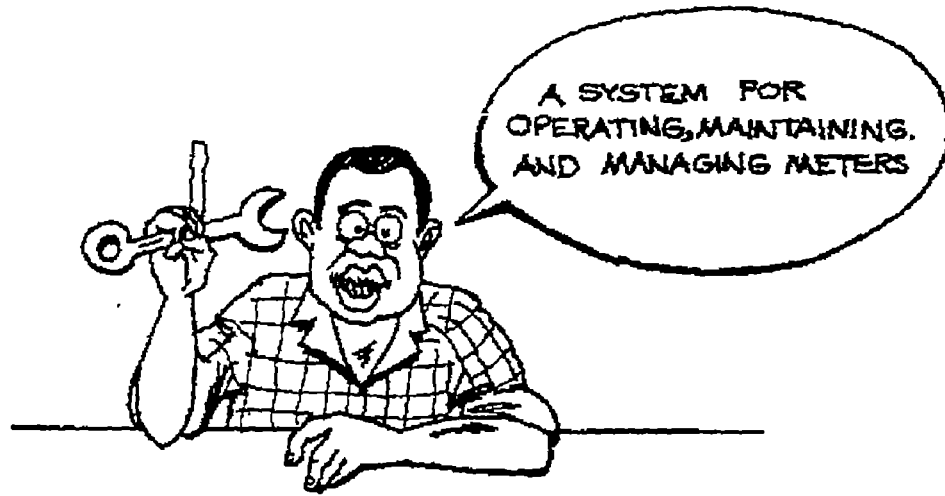
- adopt stringent steps to avoid/reduce waste, and,
- carefully gauge that any irrigation would yield sufficient returns to recover the cost of water.

Mama Maina would, under metered charging, assess carefully whether it is financially worth her while to irrigate her grass and Baba Muthee would repair his leaking tap speedily.

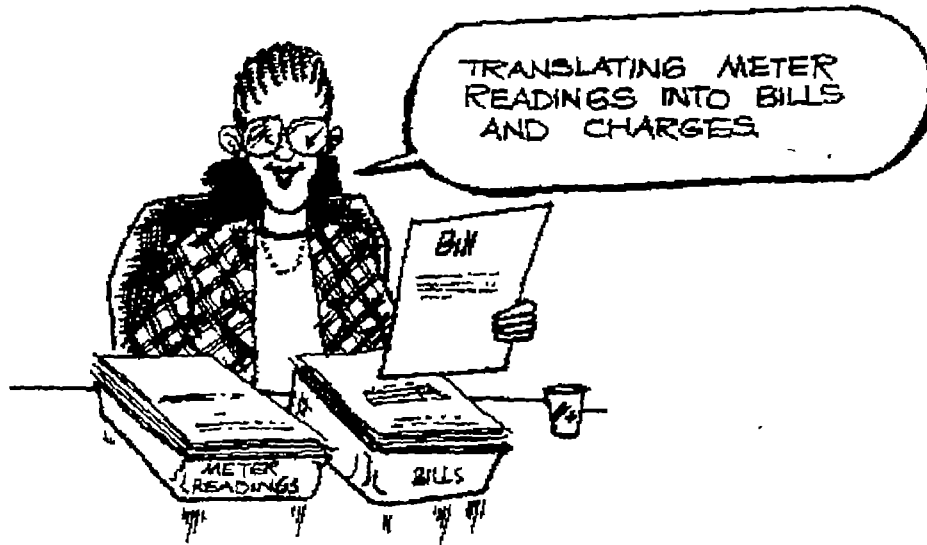
¹ Studies have shown that in schemes operating the two systems simultaneously, consumption among unmetered connections is five times that of metered ones.

² Manual No 2 discusses how to arrive at a right price.

- Consumer confidence that the meter, its readings, and the charge are accurate measures and reflections on volume of consumption,
- a system for operating, maintaining and managing meters,

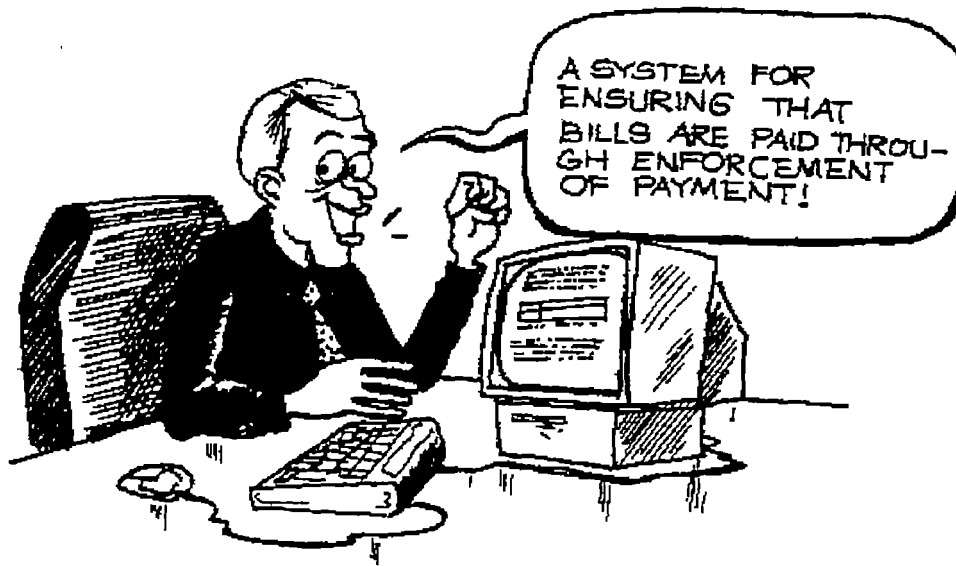


- collection of accurate water data on production, distribution and consumption,
- translating meter readings into bills and charges,



- utilizing meter-generated data into information for making management decisions to improve scheme performance,

- a system for ensuring that bills are paid through enforcement of payment,

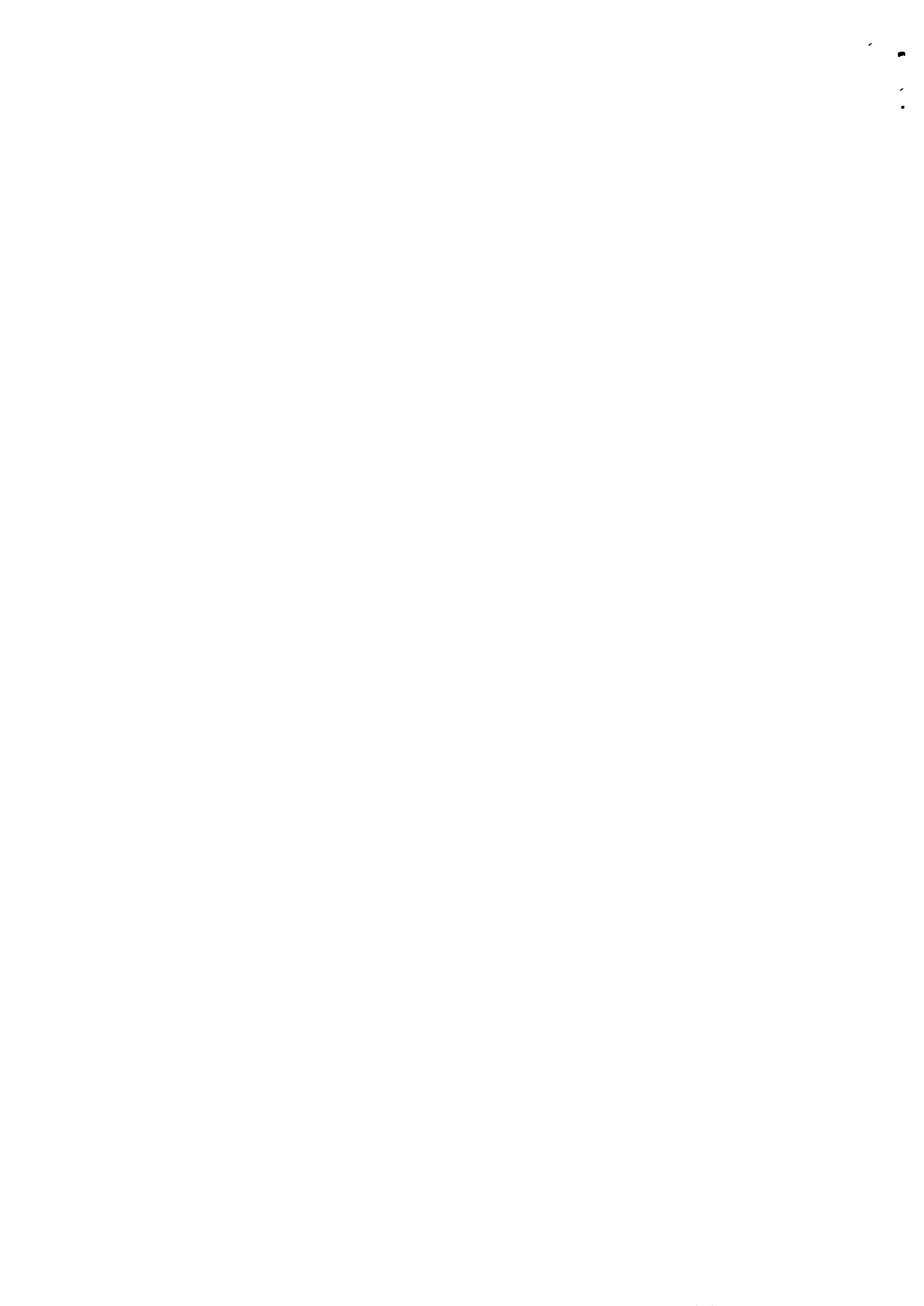


- A suitable and effective financial management and accounting system,
- discipline by staff, leaders and consumers.





**SECTION III PRINCIPAL FEATURES OF THE METER-BASED
WATER MANAGEMENT SYSTEM**



3.1. Universal Metering

The basis for the meter-based water management system is that *all* water entering the scheme and *all* water used is measured, quantified and accounted for. To make this possible it is necessary to install meters at a number of key points:

- point of production where a water production master meter is fitted, to measure the quantities of water produced,
- points of distribution main where each principal main is similarly fitted with a meter to measure the amount of water distributed through a distribution main⁵,
- points of consumption which are fitted with consumer meters whose purpose is to measure the quantity of water the consumer receives. It is essential that *all* consumer outlets are fitted with a standardized⁶ meter at the outset⁷. The consumer meter may need to be protected from damage using a meter box.

Unauthorized Connections

A meter management system is greatly undermined by unauthorized connections. Such connections result into loss of all the advantages of a metered system such as regulating flows, loss of revenue, water shortages as well as loss of confidence by the metered connection holders.



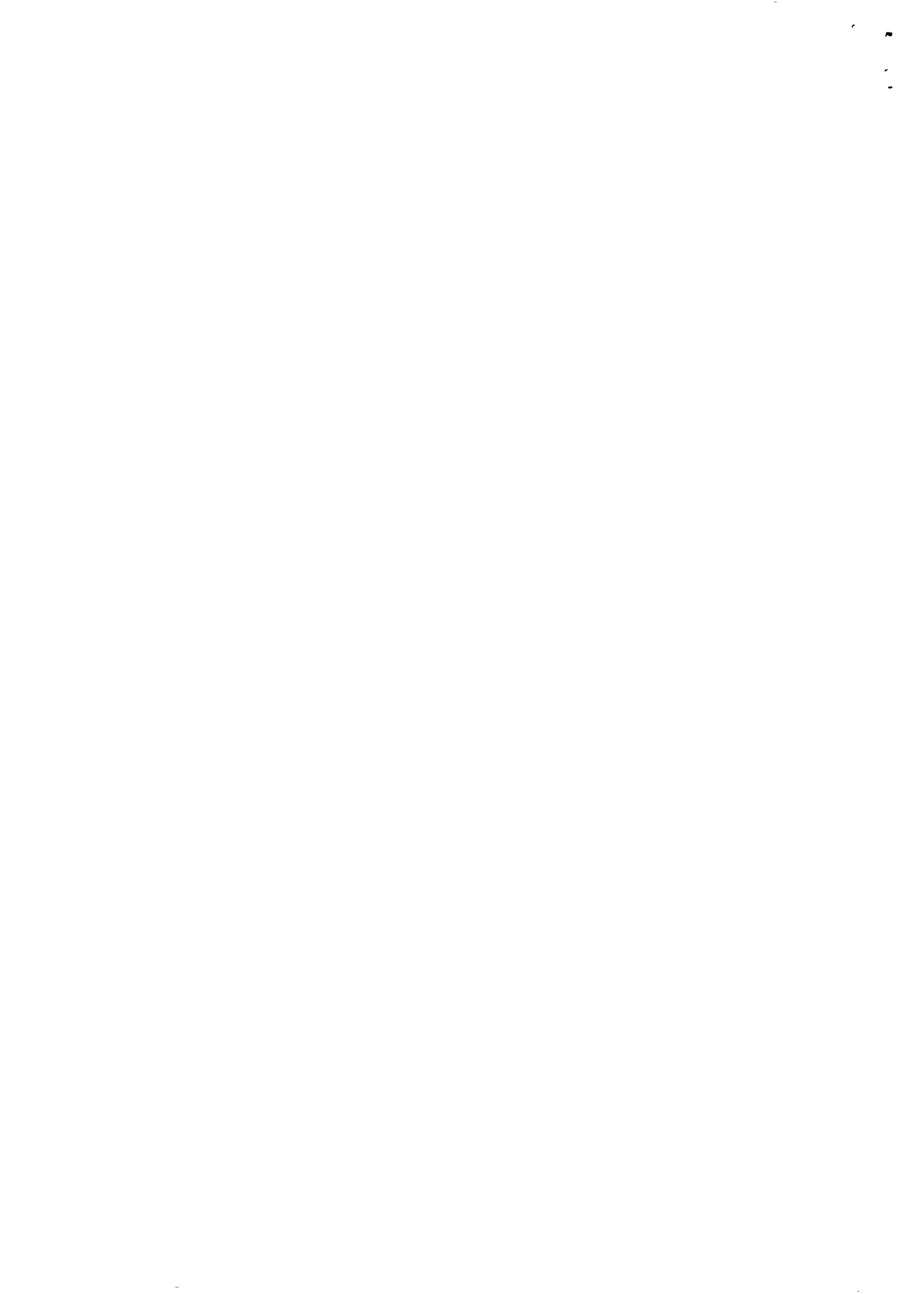
Authorized connection holders must guard against unauthorized users. The authorized holders should be made to understand that covering up for the unauthorized ones amounts to paying for the water that the later consume.⁸

⁵ Some large schemes have branches taking water from distribution mains and may consider installing branch meters. Each distribution main should be metered.

⁶ Standardization of meters in a particular scheme ensures that all the meters are of similar quality, easier and cheaper to repair, as well as to acquire spares.

⁷ All connections should be metered at the outset: there should be no unmetered connections along with metered ones.

⁸ This is more apparent in pumping schemes where the operational costs (particularly energy costs) are more visible and direct to consumers and the extent to which the authorized holders subsidize the unauthorized ones is easy to discern.



Different types of meters are available in the market, some suitable for measuring fully treated water, while others can tolerate substantial dirt and are, therefore, more suited to untreated water. The KENT PSM is the most common consumer meter installed in Kenya⁹. It must be recognized that the meter is a delicate gadget which cannot be expected to perform well if too much silt and debris is allowed in. As such, the intake chamber needs to be fitted with suitable screens to keep out branches, leaves and pebbles especially when the water source is surface.

The size of production and distribution meters is normally determined by the diameter of the pipe on which the meter is to be fitted. In rural Kenya the half-inch consumer meter seems to be the norm.

3.2. Systems for operating and maintaining meters

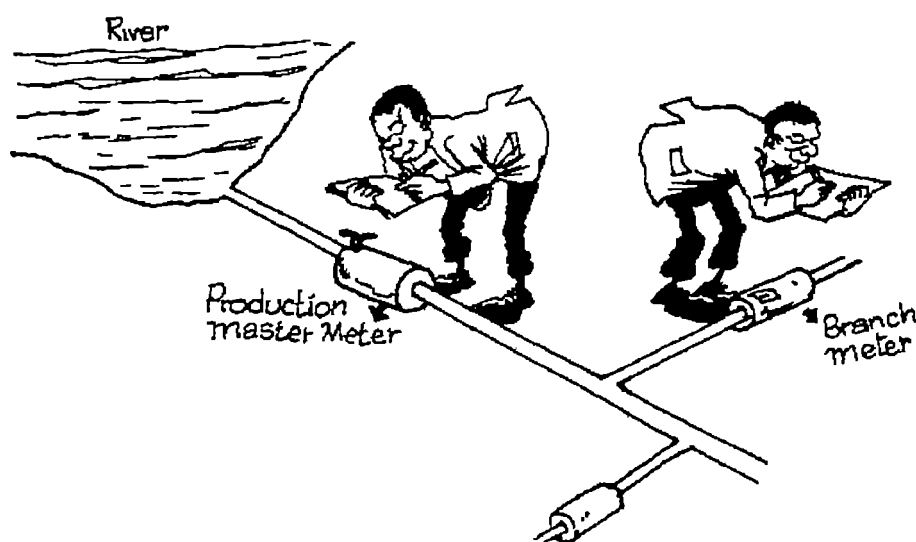
The meter is installed to provide readings which form the basis for managing the water available. To do so the scheme needs to establish a system which would effectively operate and maintain the meters in the scheme. Such a system would have the capability for:

- reading all meters regularly,
- maintaining, servicing and repairing meters.

3.2.1. Regular reading of meters

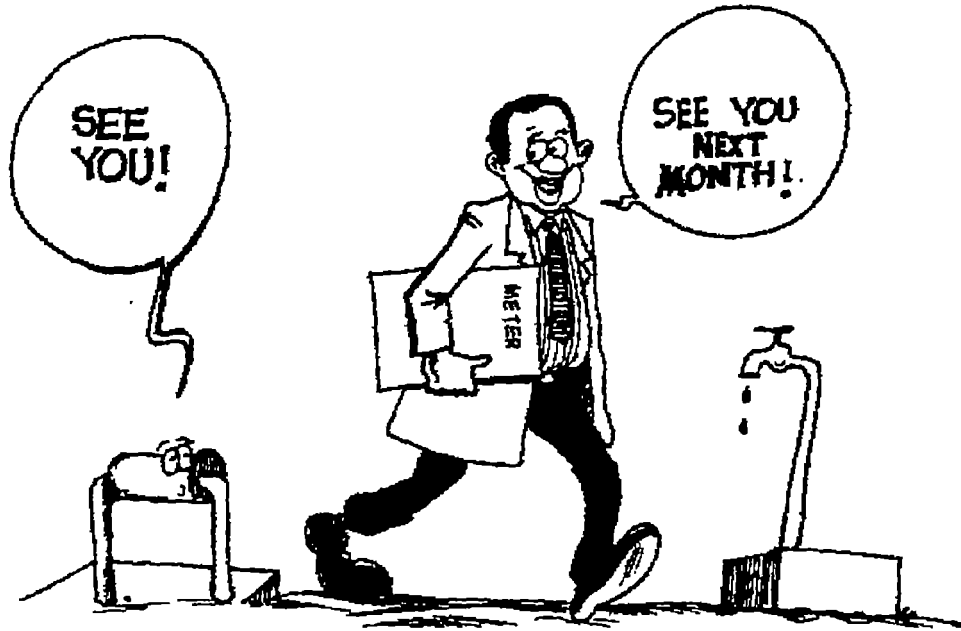
Disciplined regularity in reading meters is an essential element of the meter-based water management system. Through regular and accurate readings the required water production and consumption data is generated. To ensure that all meters are read as required, a number of preliminary steps need to be taken:

- The first task is to establish the Meter Reading Load taking into account the following basic requirements for the various meters;
 - the production master meter is normally read *twice* every 24 hours and the readings recorded in Production Meter Readings Book.
 - the Distribution meter is normally read *once* every 24 hours. A Distribution Meter Book is maintained for each distribution meter.



⁹ There are numerous types of meter brands available on the market. Scheme operators and leaders should be alert and avoid poor quality meters.

- the consumer meter is normally read *once* a month. Consumer Meter Readings are maintained for each connection in the entire scheme.



- On the basis of the defined load, management should prepare a *schedule for reading* all meters. A schedule of staff who would be reading meters should be prepared, guided by the defined load¹⁰.

Management must ensure that all meters are read as per the readings schedule without fail. Where this is not the case, it must be reported at once and corrective action taken without delay. It should be readily evident that if the meters are working well, it should be possible to account for the water which has been produced over a certain period of time.

¹⁰ Staff requirements for meter readings will, of course, be determined by the number of consumer meters, the terrain, and the size of the scheme. Experience has, for instance, shown that in a densely peopled rural scheme, one meter reader can take readings at 150 meters per day. It is recommended that the staff which reads consumer meters is shuffled often and without prior warning to minimize the potential for collusion, corruption and to help detect incompetence.

3.2.2. **System for testing, servicing, repair and replacement of meters**

The entire system depends on the accuracy of meter readings and the confidence the consumer has that the meter is correctly recording his/her consumption. It is essential, therefore, that staff are alert to detect any meter malfunction quickly and undertake the needed repair or replacement at once.

The most common problem with meters in rural schemes is stoppage of readings due to silting and clogging. Simple cleaning is often all that is required. Scheme staff should be trained on how to service consumer meters and how to test the accuracy of their readings. The larger size production and distribution meters may need to be taken to other workshops for repair¹¹ and testing¹².



A metered scheme should also have a simple accuracy testing facility for checking out new meters and those whose readings are disputed.

3.2.3 **Rules for Protecting meters from Interference**

Rules should be developed to protect the meter from interference by unscrupulous consumers. Penalties for interference should be stiff. Staff should be on the look out for tampering and where cases are discovered maximum deterrence, including expulsion, should be invoked.

¹¹ For instance to workshops that may have more sophisticated repair equipment and staff.

¹² Kenya Bureau of Standards offers such testing facilities.

3.3.

System for Translating Consumer Meter readings into Water Bills

The monthly meter reading of the consumer meter establishes the quantity of water that the owner of the connection has used. Under the meter-based management system, the quantity established is charged as per the existing tariffs and prices structure¹³.

There are two different metered price and tariff structures found in Kenya. In one type the price remains constant per cubic meter. In the other, the price per cubic meter increases as consumption rises. This later one is known as progressive pricing. The basis for progressive pricing is to ensure maximum conservation, equity and most economic application of water.

Gaki has a progressive tariff as follows:

Volume m3	Price (Shs/m3)
1-6	6.00
7-10	7.00
11-15	8.00
16-30	10.00
30+	17.00

- Water for human consumption is often charged as cheaply as possible. In the Gaki tariffs, consumption bracket upto 6m³ is priced at Sh. 6.00/m³¹⁴ and is assumed to satisfy the human consumption needs of a family of 6 persons.
- consumption range 7 - 10m³ per month assumes that in addition to using water for human consumption, the household also waters 1-3 heads of cattle. Rearing of cattle generates some income to the household. This range is charged KSh. 7.00 per m³.
- consumption range 11 - 15 m³ per month is charged at KSh. 8.00/m³. This volume of consumption includes households which use water for human consumption as well as watering about 6 heads of cattle.
- consumption range 16-30m³ per month is priced at KSh. 10.00/m³. This volume of consumption includes watering of 10 heads of cattle and limited garden irrigation.
- consumption range above 30m³ per month is charged at KSh. 17.00/m³.

¹³ Manual No. 2 describes how water prices and tariffs are set.

¹⁴ Six cubic meters per month is sufficient to provide water for a family of 6 at 30l/h/d, including wastage.



Minimum and Standing Charge

Other stipulations in a price structure may also be found. Many consumers in government schemes are charged a fixed amount for a minimum level of consumption, under the so-called minimum charge category.¹⁵ Consumption above this minimum is charged progressively. Other schemes have placed a standing charge¹⁶ on every connection. This charge is paid simply for having access to water service. Consumption is progressively charged over and above the standing charge. As indicated in Section IV, Gaki has a standing charge of Sh. 70.00 per connection per month.

Due to their tendency to consume large volumes of water, institutions such as schools, clinics, hospitals, and other users like cattle dips usually have higher standing charges due to the higher costs of maintaining their connections. In many cases also, their connection charges are higher than those of households due to larger outlets than the commonly installed 1/2" for households.

Whatever type of tariff and price structure is in place, a metered scheme must have staff who translate, through calculations, the quantity of water consumed at each connection into a charge. This function is known as **billing**. The clerk who prepares the water bill needs to have some knowledge in simple accounts as the information in the bill would also be entered into a ledger. The ledger carries all transactions relating to each consumer¹⁷.

15 The current minimum charge for 0-10m³ is Sh. 120.00. This means that two consumers who use up 5m³ and 10m³ both pay Sh. 120.00.

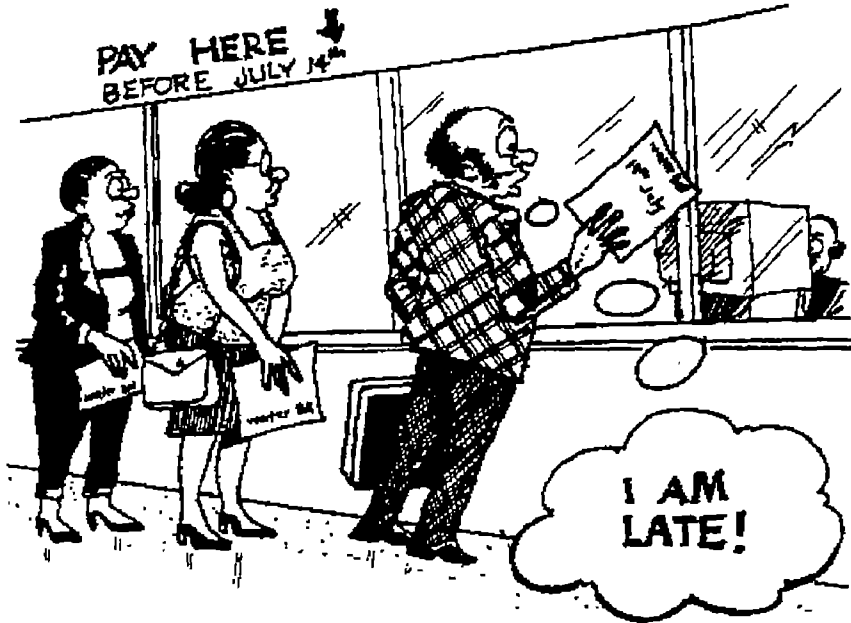
16 Standing charges are found in public utilities such as Kenya Posts & Telecommunications, Kenya Power & Lighting Co. and the Nairobi City Council.

17 Manual No. 3 describes Ledger transactions.



3.4. **Collecting and Enforcing Payments from Consumers**

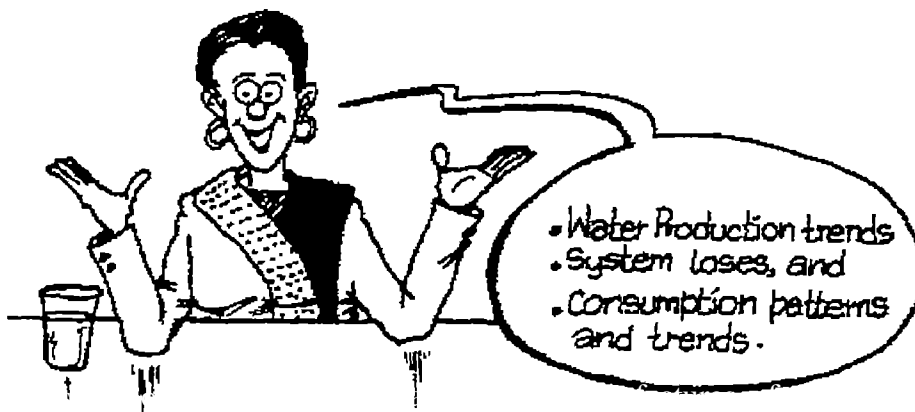
The project should have in place convenient arrangements such as pay points and payment dates to guide consumers' payment of water bills. The meter-based water management system also requires clearly known rules, procedures and penalties for enforcing payments¹⁸.



3.5. **System for Translating Meter readings into Water Management Information**

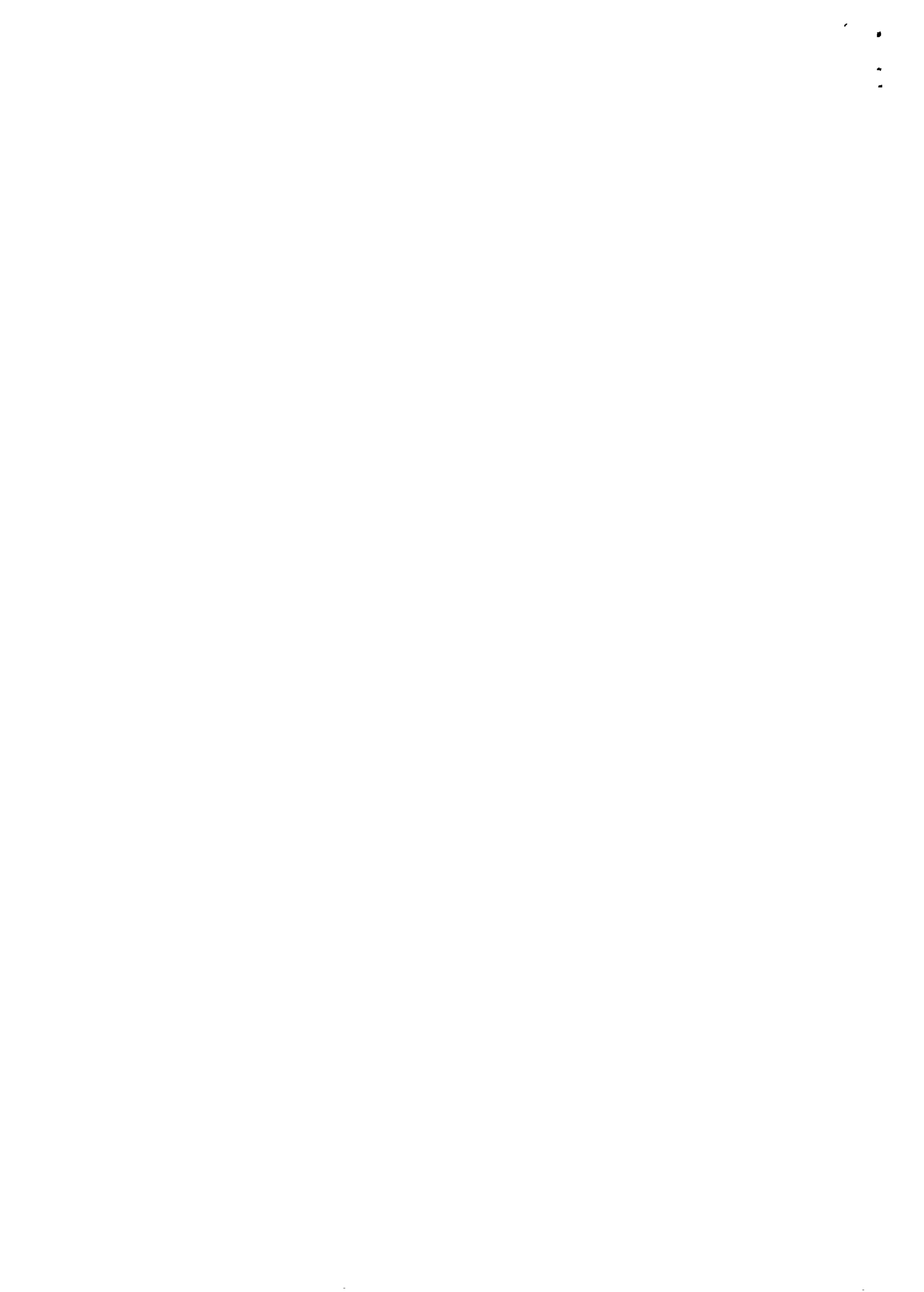
Meter readings provide the scheme manager with useful information which assists in taking management decisions such as:

- water production trends,
- system losses, and
- consumption patterns and trends.



3.6 Instructions on how to operate the different features of the meter-based system are described the Section IV.

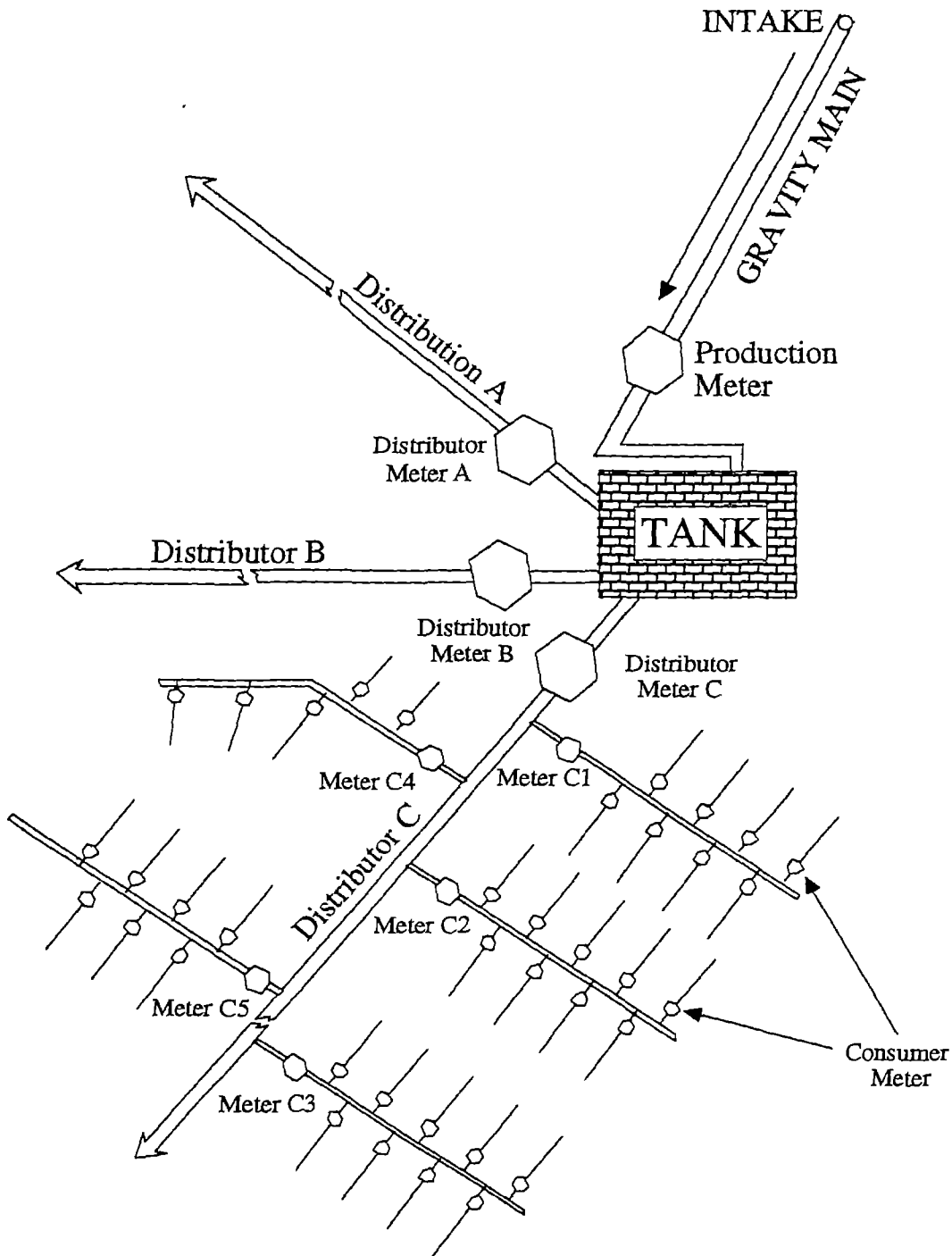
¹⁸ This aspect is discussed in Manual No. 3.



**SECTION IV: INSTRUCTIONS ON HOW TO OPERATE A METER-
BASED WATER MANAGEMENT SYSTEM**

4. In this section we provide some instructions on how to operate the different features of the meter-based system described in the previous section. Map 1. provides the basic layout of the Gaki Water Project which we shall use to illustrate our examples.

GAKI WATER PROJECT



Map 1.



4.1. Meter installation:

The points at which the production and the three distribution meters should be installed are shown on the map. Care must be taken while installing the meter to avoid damage. The following points should be observed while fitting a consumer meter:-

- The PSM meters may be installed in horizontal, vertical or sloping position without affecting their accuracy.
- Flush out the pipes thoroughly before connecting the meter.
- Ensure that the Arrow on the counter housing coincides with the direction of the flow.
- Do not use pipe-wrenches on the meter housings.
- Always connect the meter by using proper meter unions on both sides of the meter.
- Do not install the meter just next to a bend or an elbow. There should be a minimum of 10cm, (4") straight section before and after the meter.

4.2. Regular reading of meters:

4.2.1. The determination of the meter reading load should be made as follows:

Gaki Water Project
Meter Readings Requirements

Schedules	Meter	Regularity	Time	Nos.
Schedule A	Production	Twice Daily	appointed hours	1
	Distribution	Daily	appointed hours	3
	Branch	Daily	appointed hours	20
Schedule B	Consumer	Monthly	On same dates	300

• **Production Master meter**

The production master meter is normally read twice every 24 hours and the readings recorded in a Production Meter Readings Book as shown below.

Gaki Water Project
Production Master Meter Book

Date	Reading at 6.00 A.M.	Reading at 6 00 P.M.	Output m3	Observations
1/8/97	1205	1305	100	
2/8/97	1800			
2/8/97	1800			
2/8/97				
.....				
.....				
26/8/97	6000	6000		meter stopped, gravity main under repair, pump break down, no electricity, etc.
.....				
31/8/97		7205	6000	

From the readings, the total production for the month of August, 1997 is 6000m3.

- **Distribution Meter**

The Distribution meter is normally read *once* every 24 hours. A Distribution Meter Book is maintained for each distribution meter.

Gaki Water Project
Distribution Master Meter Book

Date	Reading at 6.00 A.M.	Output m ³	Observations
1/8/97	1205	395	
2/8/97	1800		
2/8/97	1800		
2/8/97			
.....			
.....			
.....			

- **The Consumer Meter:**

The consumer meter is normally read *once* a month. Consumer Meter Readings are maintained for each connection in the whole scheme.

Gaki Water Project
Consumer Meter Readings Book

Connection No.		Meter No..... Date Meter Installed.....		Size.....
Date	Index Reading	Units Consumed	Reader	Remarks
24/2/97	0000	0	Kimani	new meter
24/3/97	0005	5	Kimani	
24/4/97	0008	3	Wanjiru	
24/5/97	0008	0	Wanjiru	meter stopped

If the meter provides similar reading, make a notation in the observations column as has been done for 24/5/97 or 26/8/97. The reader should also make a note if the current meter reading is lower than the previous one.

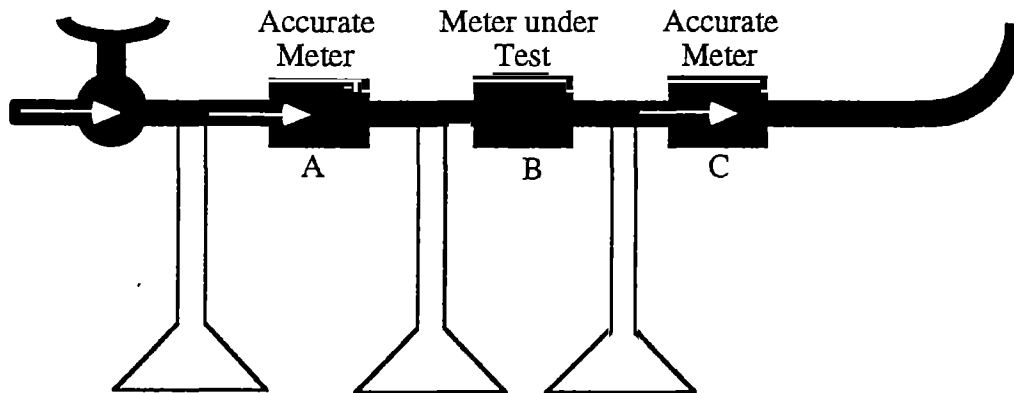
4.3. **Testing, Servicing and Cleaning of Meters**

The integrity of the meter-based management system rests, to a large extent, on the accuracy of meter readings.

4.3.1 **Meter Testing**

Where a consumer meter is new or is suspect, it should be tested at once using the simple testing unit described below and along the following steps:-

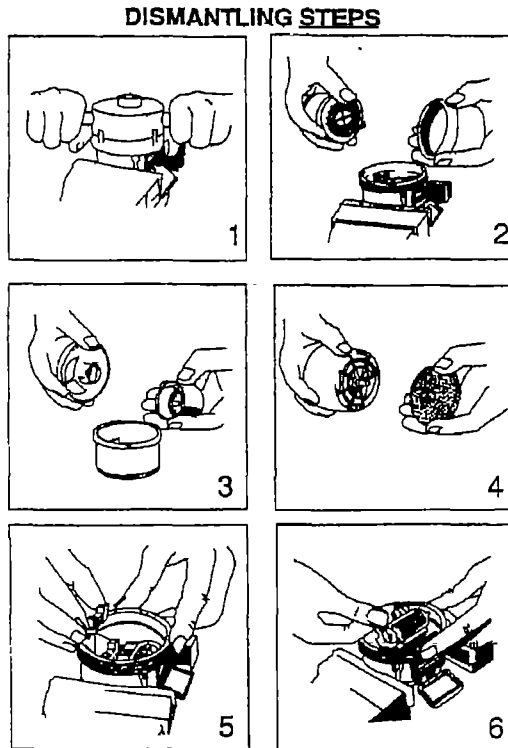
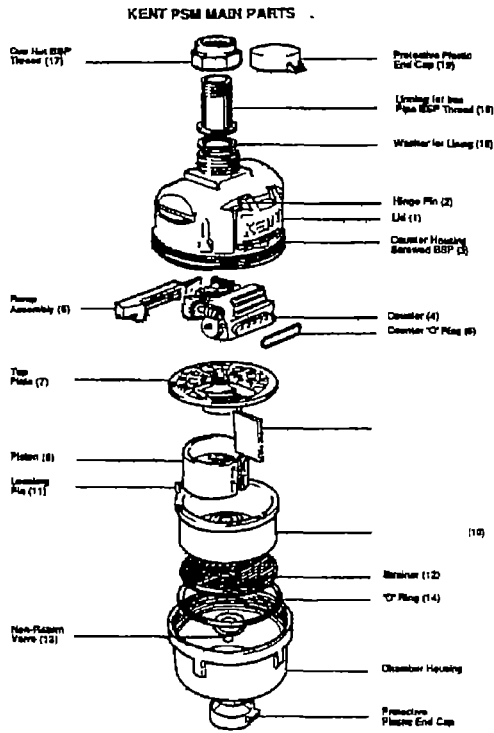
Simple Meter Accuracy Testing Unit



- the meter under test is fitted in series between two meters with accurate readings,
- the readings on each of the three meters are taken,
- the tap is opened rapidly letting in water at normal pressure and letting it run for at least one hour,
- at the end of the hour the readings on the three meters are taken,
- the test is repeated two more times,
- at the end readings from the three meters are compared and the results recorded.
- a difference of upto 5% between the average of the two accurate meters and the meter under test is acceptable.

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4.3.2. Repair, Cleaning and servicing
 To service and clean a KENT PSM meter the steps described in the following paragraphs should be followed.



Dismantling

Pictures 1 to 6 of the "Dismantling Steps" refer.

1. Secure the counter housing of the meter in a bench vice by Gripping the flats on the counter housing body. Do not tighten the vice too hard. Unscrew the chamber housing, using the special water meter wrench.
2. Lift out the whole working chamber assembly and remove the housing 'O'-ring.
3. Remove the top plate from the working chamber and lift out the piston.
4. Remove the strainer (There may be a circlip securing it). Remove non-return flow disc, if fitted.
5. Release and remove the ramp-assembly.
6. Withdraw carefully the counter unit and remove the counter 'O'-ring.

Counter Assembly

Ensure that the rubber sac is unpunctured and not completely deflated. (It should be noted that counters which have been stored dry for an excessive period may have deflected sacs, but this is self-correcting in service). Small air bubbles in the counter are not detrimental. Check gearing for excessive wear. Gently rock the counter unit to check for free movement of number wheels.

Ramp Assembly

Ensure free movement of the tapered wedge on the ramp body and that the spring is undamaged. Check that the flat is not distorted.

Working Chamber top plate

- (a) Examine the top plate for undue wear, or scoring of the flat surface.
- (b) Check for side play of the drive spindle. If wear is apparent in (a) or (b) replace the top plate. Slight wear on the side of the driving bar contact face is not unusual and is of no significance.

Working Chamber

- (c) Examine the Chamber walls centre post and shutter for excessive wear or scoring. Should severe wear be apparent, replace. If only the shutter is worn, replace with a new shutter.
- (d) Ensure that the piston is free from scoring on the outside wall, or excessive wear on the moulded centre post. If wear is apparent and play within the chamber excessive, replace.
- (e) Check that the strainer is entirely free from dirt or deposits.

O-rings

Although the 'O'-rings may appear to be undamaged they should be replaced.

Counter and Chamber Housing

Ensure that all threads are free from burrs, and that the counter housing face, which makes contact with the 'O'-ring is undamaged. Ensure that the non-return valve seating in the bottom of the chamber housing is free from deposits and not scored.

Cleaning

- Clean all parts by brushing in water and thoroughly rinsing.
- Hard deposits can be removed by very careful use of an abrasive cleaning pad.

Re-Assembly

Ensure that all parts are perfectly clean and that the work bench is free from dirt and grit.

Secure the counter housing in a bench vice by gripping the flats provided on the body, ensuring that the lid is on the left hand side. Hold the counter unit between the right index finger and thumb (with the drive coupling uppermost) and place it in position with the window located in the aperture of the counter housing. Hold firmly in this position.

Take the ramp assembly between the thumb and forefinger of the right hand by the lugs provided, with the flat face towards the two webs of the counter housing, compress the lugs together and place between the base on the counter and the two webs of the counter housing, ensuring that the ramp is central and inserted to the full depth. Release the lugs and gently and equally press outwards to ensure that the counter is firmly and squarely pressed against its 'O'-ring.

The counter housing may be left in the bench vice while the assembly of the working chamber is carried out.

Place the strainer in position over the shaft at the bottom of the working chamber and press it in position. On the larger sizes a retaining circlip is required. Examination of the shutter will reveal two ridges on one edge, the shutter should be positioned so that these ridges are at the bottom of the slot in the chamber wall when the shutter has been pushed fully into this slot and with its other edge located in the centre hub slot. Place the piston in the chamber with the moulded peg facing down and check that the piston moves freely around the working chamber. Insert locating pin in the top of the chamber. Fit the top plate on the working chamber ensuring that the driving bar engages with the nickel piston peg and that the groove in the hub of the top plate locates on the shutter. Ensuring that the locating pin in the working chamber engages with its slot in the top plate will assist this operation. Press firmly into position. Test again for piston free movement by holding the chamber on its side and slowly rotate. This piston should fall around by its own weight. If it does not, remove the top plate and check for dirt.

Place the complete working chamber assembly on to the counter housing with the driving coupling engaged with the counter coupling. To ensure minimum head loss, the outlet port in the top plate should be placed over the counter ramp. Place the 'O' ring over the working chamber if a non-return valve is required. This should be placed on the shaft at the strainer end of the working chamber.

Screw the working chamber housing on the counter housing and tighten the joint securely without using excessive force. Blow through the meter. A steady clicking sound is a sign that all is well.

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4.4. Rules for Protecting Meters

The General Meeting of members should set rules for protecting the meter from interference. Some examples are given below:

- The project shall supply, at cost, a 1/2" meter together with its protective box to a member upon that member's satisfaction of all entry conditions.
- No meter, other than the one supplied through the project shall be admitted into the project. This reduces the possibility of stealing meters.
- The management committee shall set rules governing the physical location of consumer meters in relationship to the main.
- Only authorized scheme staff are allowed to fix, remove, repair, service or clean a meter. Any member whose meter is found to have been tampered with shall be penalized as follows:
 - first instance, a cash fine of Shs. 1000
 - second time, 6 months disconnection of service plus a cash fine of Shs. 3000
 - third offense, expulsion from project.

4.5. Translating Consumer Meter Readings into Water Bills

Gaki Water Project has a progressive tariff and price structure with the following key features:

- standing charge per connection per month = Shs. 70.00
- progressively higher prices per cubic meter as described below.

Volume m ³	Price Shs/m ³
1-6	6.00
7-10	7.00
11-15	8.00
16-30	10.00
30+	17.00

June 1997 meter readings for Baba Warutere, Baba Muthee and Mama Maina indicated that their consumption was 30m³, 50m³ and 8m³ respectively. How would these different consumptions be translated into water charges and bills based on the Gaki tariffs?. Using Baba Warutere's consumption as an example, calculations for his bill would be done as follows:

Start by breaking down his total consumption into the various charging categories using the above table and multiply the consumption by the relevant price as explained below:

For the first 6m³	
6 X 6 (Sh. 6.00 is the charge per m ³ for this category of consumption)	= Sh. 36.00
For 7 - 10m³	
4X7 (Sh. 7.00 is the charge per m ³ for this category of consumption)	= Sh. 28.00
For 11 - 15	
5X8 (Sh. 8.00 is the charge per m ³ for this category of consumption)	= Sh. 40.00
For 16 - 30	
15X10 (Sh. 10.00 is the charge per m ³ for this category of consumption)	= Sh. 150.00
Water charge	= Sh. 254.00
Standing charge	= Sh. 70.00
Total bill for Baba Warutere	= Sh. 324.00

However, the manager of the project may prepare a table from which the billing clerk can read off rapidly the charge per level of consumption. The following table provides precisely that kind of information:

Gaki Water Project Billing Schedule				
Volume	Price	Water Charge	Standing	Total
m3	Shs/m3	Shs	Charge (Shs)	(Shs)
0	0	0	70	70
1	6	6	70	76
2	6	12	70	82
3	6	18	70	88
4	6	24	70	94
5	6	30	70	100
6	6	36	70	106
7	7	43	70	113
8	7	50	70	120
9	7	57	70	127
10	7	64	70	134
11	8	72	70	142
12	8	80	70	150
13	8	88	70	158
14	8	96	70	166
15	8	104	70	174
16	10	114	70	184
17	10	124	70	194
18	10	134	70	204
19	10	144	70	214
20	10	154	70	224
21	10	164	70	234
22	10	174	70	244
23	10	184	70	254
24	10	194	70	264
25	10	204	70	274
26	10	214	70	284
27	10	224	70	294
28	10	234	70	304
29	10	244	70	314
30	10	254	70	324
31	17	271	70	341
32	17	288	70	358
33	17	305	70	375
34	17	322	70	392
35	17	339	70	409
36	17	356	70	426
37	17	373	70	443
38	17	390	70	460
39	17	407	70	477
40	17	424	70	494
41	17	441	70	511
42	17	458	70	528
43	17	475	70	545
44	17	492	70	562
45	17	509	70	579
46	17	526	70	596
47	17	543	70	613
48	17	560	70	630
49	17	577	70	647
50	17	594	70	664

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From the schedule the charges for Baba Warutere, Baba Muthee and Mama Maina would be Shs. 324.00, Shs. 664.00 and Shs. 120.00, respectively. The June Water Bill for Baba Muthee would be:-

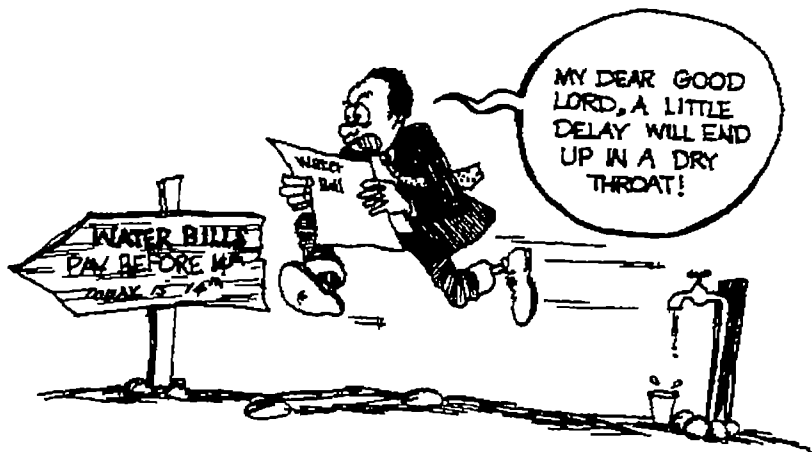
GAKI WATER PROJECT WATER BILL NO. 04560			
MonthJune..... Year 1997.....			
Name of Connection HolderMr. Muthee.....			
Connection No.25.....			
Current Reading	255	24/6/97	
Last Reading	205	24/5/97	
Consumption (m3)	50		
Item	Amount		
	Shs	Cts	
Water Charge	594	00	
Standing Charge	70	00	
Balance B/F	0	00	
Amount Now due	664	00	
Please pay the amount now due by 14/7/97 to avoid disconnection.			

4.6. **Collecting Payments from Consumers**

The project should define one convenient payment point. Such a point could be the project office or a bank if one is available nearby. In both cases the project office should maintain an upto date record of each consumer's water account transactions¹⁹. A receipt or a Bank Deposit Slip should be provided to the consumer at the time of payment.

The project should also set rules and regulations governing payment of water bills. A few examples may suffice.

- Last month's water bill must be fully paid on or before the 14th day of the month following,

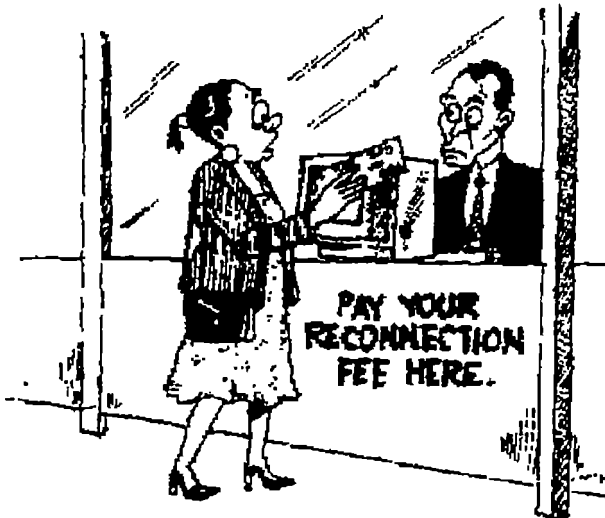


¹⁹ Manual No. 3 will provide the details of the Consumer Ledger which contains a consumer's financial transactions with the project.

- The service will be disconnected on the 15th day of the month following if full payment will not have been made by the 14th day.



- A reconnection fee of Shs. 200 will be charged on any connection disconnected for non-payment.



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4.7. **Obtaining data from meter readings for management decisions**

Meter readings data can assist informed decisions to be made. We would like to account for the water produced and used by Gaki Water Project in June 1997. The account would take the following form.

GAKI WATER PROJECT	
WATER PRODUCTION AND USE, June 1997	
From the production meter readings we calculate the amount of water produced from June 1 to June 30.	
•	Production Meter Reading at 6.00 am on 01/06/97 1200
•	Production Meter Reading at 6.00 am on 01/07/97 4200
•	Production for the month <u>3,000 m³</u>
From the readings of the meters on the three distribution mains we calculate the amount of water distributed.	
•	Distribution Line A Meter Reading at 6.00 am on 01/06/97 805
•	Distribution Line A Meter Reading at 6.00 am on 01/07/97 1415
•	Amount distributed during the month <u>610 m³</u>
•	Distribution Line B Meter Reading at 6.00 am on 01/06/97 420
•	Distribution Line B Meter Reading at 6.00 am on 01/07/97 1520
•	Amount distributed during the month <u>1,100 m³</u>
•	Distribution Line C Meter Reading at 6.00 am on 01/06/97 550
•	Distribution Line C Meter Reading at 6.00 am on 01/07/97 1350
•	Amount distributed during the month <u>1,000 m³</u>
•	Amount in storage tank <u>100 m³</u>
During the month of June 1997, a total of 2,710m ³ (610+1100+1000) was distributed to consumers out of the total production of 3000m ³ . Taking into account the 100m ³ at the storage tank, this suggests that 190m ³ of water (3000-2710-100=190) was somehow lost between production and distribution. This lost amount represents about 6% of the water produced. Scheme staff will need to examine the gravity main and the tank for possible leakage points.	

How much water reached the 300 members of the project? The following table indicates that a total of 2032m³ was registered by consumer meters.

Line	No. of Connections	Sum of meters
A	30	500
B	200	800
C	70	732
Total	300	2032

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This would suggest that 678m³ of the amount of water distributed was also somehow lost after the distribution meters. This lost water represents 25% of the volume distributed. One can determine the incidence of this loss by distribution mains as shown below.

Line	Amount distributed	Amount sold	% Lost
A	610	500	18
B	1100	800	27
C	1000	732	27
Total	2710	2032	25

While this level of water loss is within an acceptable range, there may be other months when the overall loss may exceed 30% and losses at any of the distribution mains may run as high as 65% indicating the need for management intervention to detect the causes of loss and rectify them.

Per Capita Consumption

Line	No. of Connections	Sum of meters	Average m3 per Connection
A	30	500	17
B	200	800	4
C	70	732	10
Total	300	2032	7

It should be apparent that consumers in Line A use about two and a half times more water than the average for the project and 4 times the average for consumers served by Line B.

