FINAL PROJECT REPORT

WATER CONSUMPTION AND POSSIBLE WATER SAVINGS IN APARTMENT BUILDINGS

by G.J. Malan

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CSIR

P O Box 395

PRETORIA

0001 South Africa

WATER RESEARCH COMMISSION

P O BOX 824

PRETORIA

0001

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The following persons were from time to time associated with the Steering Committee responsible for this project:

Mr H C Chapman	Water Research Commission (Chairman)
Mr P R Crabtree (CSIR)	National Building Research Institute
Mr G J Malan (CSIR)	National Building Research Institute
Mr J J de Kock	Dept of Public Works and Land Affairs
Mr N de V Loubser	Pretoria City Council
Mr P J Oberholzer	Pretoria City Council
Mr E Fox	Pretoria City Council
Mr J H Durieux	Dept of Water Affairs
Mr A P Bekker	Dept of Water Affairs
Mr H J Muntingh	Premier Investment Property Adminstration
Mr D Reed	Premier Investment Property Administration
Mr M J Els	Huurkor (Pty) Ltd
Mr K Vorster	Huurkor (Pty) Ltd
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WATER CONSUMPTION AND POSSIBLE WATER SAVINGS IN APARTMENT BUILDINGS

AIMS AND OBJECTIVES OF PROJECT

The Aims and Objectives as stated in the contract agreement are reprinted below for convenience together with the Description of Tasks, as follows:

i) To determine how the per capita water consumption of flat dwellers compares to that for individual householders of a similar income group;

ii) to assess variations in per capita consumption for different categories and sizes of flats, and

iii) to assess the practicality of individual metering in blocks of flats.

DESCRIPTION OF TASKS

The three main tasks included in this project are:

Task 1

Compare the water consumption of bulk metered flats with that of individually metered flats. Determine the per capita consumption in flats for comparison with the per capita consumption in houses. The flats will be categorised into 1 roomed flats, 2 roomed flats, 3 roomed and larger flats and on the basis of family size and income group of occupant. The basis for determining income group will be according to the rental per m^2 of the flat and will be categorised as low, middle or higher income groups. This will be done by analysing information made available by Premier Investment Corporation and Sanlam, as well as other data which can be obtained.

Task 2

Investigation existing individually metered installations in East London, and Bloemfontein with regard to installation and meter reading practices. Pros and cons of various systems will be evaluated including latest metering technology.

Task 3

Analyse the effect on water consumption, of installing individual meters in a flat complex which was previously only bulk metered. A flat complex in Pretoria will be selected which consists of twin blocks (approximately 50 flats in each). The water supply to the flats in one block will be individually metered, and the consumption of the bulk metered block will be recorded and compared with that of the individually metered block as well as the consumption prior to the installation of individual meters. In order to attain equity with house owners, an agreement between the flat owners and the local authority will be negotiated, whereby the individual meters will be read by the local authority so that occupants will receive a combined water/electricity bill similar to house owners.

SEPARATE WATER METERING OF FLATS

SYNOPSIS

Water restrictions and tariffing systems designed to reduce wastage of potable water in urban areas have proved only partially successful in the case of multi-dwelling complexes with bulk metering. An investigation into the effect of individual metering and billing on the consumption of water in apartment buildings in Pretoria and East London has revealed that savings of 20 to 30 per cent are attainable. Individual metering motivates tenants to attend to leaking fittings and is preferred by them to bulk metering. Individual metering would result in increased costs to the local authority, which may not be entirely offset by savings in the cost of water purchased from the bulk supplier. Retrofitting of individual meters in the great majority of existing multi-dwelling complexes is impractical; nevertheless, new buildings should be designed to allow for the installation of individual meters.

INTRODUCTION

Much of South Africa is not blessed with an abundant natural water supply. The efficient use of water and the prevention of waste are vitally important. The metering of water supplied to houses has long proved to be an effective means of curbing excessive use. Individual meters for separate dwelling units in apartment blocks are, however, seldom provided, either in South Africa or in other countries. A single bulk meter is normally used.

The Council for Scientific and Industrial Research through its National Building Research Institute undertook an investigation into possible saving in water use through the individual metering of flats under contract to the Water Research Commission (WRC).

THE WATER CONSUMPTION OF BULK-METERED FLATS COMPARED WITH THAT OF INDIVIDUALLY METERED FLATS

Per capita consumption in flats, compared with per capita consumption in houses

Data acquired during the NBRI/WRC project, Water Economy Measures in Urban Areas, are given in Table 1.

TABLE 1: Indoor water use in bulk-metered flats and houses without water restrictions (middle-income group)

CITY	Sample size (No. of persons)		indoor water use (ℓ/capita/day)	
	House	Flat	House	Flat
Port Elizabeth	351	207	148	176
Pretoria	76	2 268	154	224
Bloemfontein	128	45	145	270
Kiowa (Bulk metered)		83		170
Kiowa (Individual meters)		83		130

The occupancy of the dwelling units (expressed as occupants per unit for the samples in Table 1) is given in Table 2.

TABLE 2: Average occupancy of dwelling units in Table 1

City	Occupants per dwelling unit	
	Houses[1]	Flats
Port Elizabeth	4,4	1,9
Pretoria (excluding Kiowa)	4,0	2,17
Bloemfontein	4,1	1,45
Pretoria: Kiowa		2,36

[1] Includes living-in servant if any

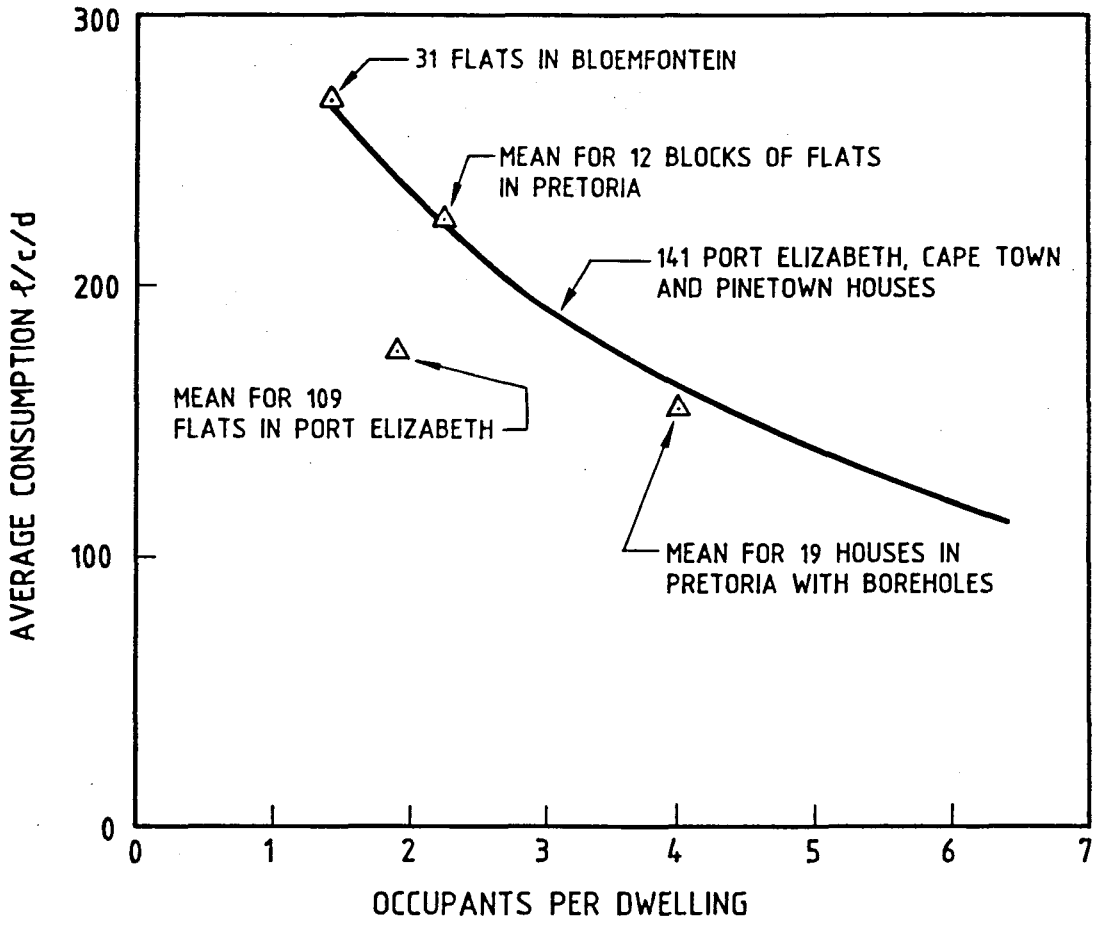

FIGURE 1: Average Internal water consumption for middle-income group dwellings (Source: Water Research Commission/NBRI project: Water Economy Measures in Urban Areas)

From Table 1 it can be seen that the per capita indoor consumption for houses is lower than that for flats. However Table 2 shows that the average occupancy of houses is higher than that of flats, and since certain common uses of water are spread amongst people in the same dwelling (e.g. for laundry, kitchen use and floor washing), the per capita consumption reduces the more occupants there are per dwelling (Figure 1).

Table 3 shows that for the sample of 11 multi-storey blocks in Pretoria 68 per cent of the flats are single-bedroom flats with an average occupancy of less than two, compared with more than four for houses. Because of certain shared categories of water use, water consumption per capita in flats is greater than that for houses. Factors contributing to this phenomenon are outlined below.

1. Since occupants of flats do not pay directly for their water consumption there is a lack of concern for repairing leaking fittings in flats.

2. Some overflow pipes from cisterns and expansion relief valves terminate in places such as service ducts where discharging water cannot be readily seen.

TABLE 3: Number of occupants in Pretoria flats of different sizes (middle-income group)

Name of apartment block	Date rental applicable	Rental per flat (R/month)	Total no of flats of each size (bedrooms)				Average no of occupants per flat for each size (bedrooms)			
			3	2	1	Bachelor	3	2	1	Bachelor
Alhari	Oct. 1984	185 - 320	-	14	42	7	-	2,57	1,60	1,0
Park Villa	June 1983	225	-	-	100	-	-	-	1,54	-
Meersburg	Mar. 1983	275 - 320	-	12	31	-	-	2,92	1,87	-
Zaalklap	Oct. 1984	215 - 235	-	-	42	14	-	-	1,33	1,0
Nedholm	Oct. 1984	280 - 451	48	-	8	-	3,40	-	1,88	-
Nedbank (Silverton)	Oct. 1984	230 - 285	-	16	128	-	-	2,94	1,98	-
Nedbank Plaza S	Mar. 1983	265 - 325	-	24	48	-	-	2,63	1,67	-
Nedbank Plaza N	Mar. 1983	255 - 325	-	22	50	-	-	2,09	1,86	-
Chebema	Oct. 1984	180 - 275	-	-	15	75	-	-	1,53	1,0
North Gardens			-	7	18	6	-	1,86	1,78	1,33
Kiowa			-	18	18	-	-	2,61	2,11	-
		Totals	48	113	556	102				
Percentage of total no of flats			6	14	68	12				
						Weighted means	3,40	2,54	1,74	1,02

Water consumption of bulk-metered flats compared with that of individually metered flats

Figure 2 shows the daily water consumption for flats in Pretoria, Johannesburg, Port Elizabeth and East London. Columns 1 - 3 show the water consumption without water restrictions where a flat tariff is charged for the water used. Columns 4 - 8 show the water consumption for apartment blocks in Pretoria with water restrictions and a stepped tariff system. Columns 9 and 10 show the water consumption in East London with water restrictions and a flat tariff.

From Figure 2 the consumption for blocks with individual metering can be seen to be significantly lower than that for bulk-metered blocks.

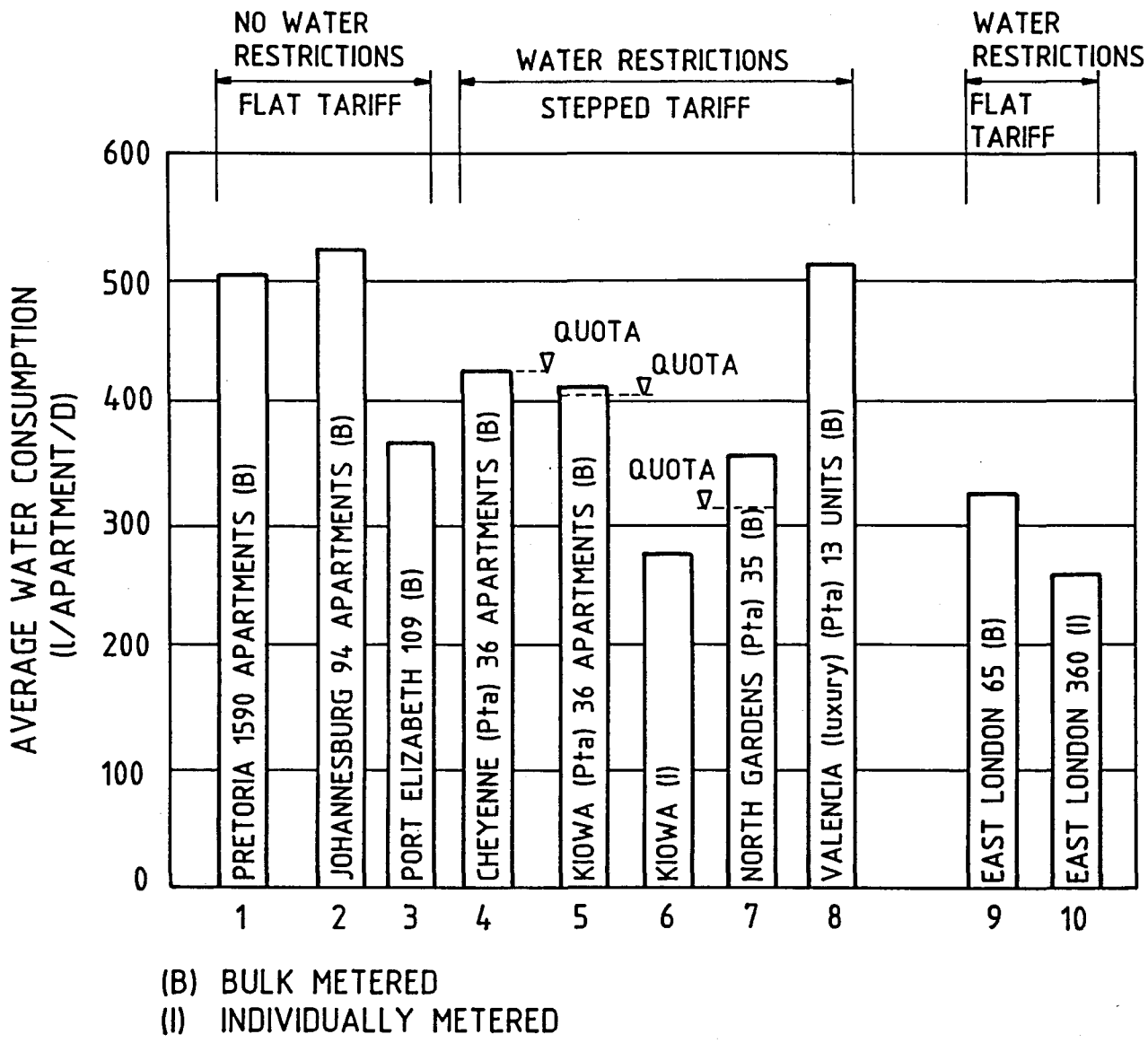

FIGURE 2: Water consumption for apartment blocks

Example of the effect of a water quota and stepped tariff on bulk-metered consumption

The limited effect on the water consumption of bulk-metered flats can be further illustrated by an analysis of the situation in Pretoria.

As a result of the prolonged drought, Pretoria introduced by-laws restricting the use of water for gardening and washing motor cars. In addition stepped tariffs are used for water consumed. The highest tariff in effect penalises the consumer for excessive water use.

In order to apply a stepped tariff the local authority has to establish limits for the quantities of water supplied at each tariff. Reasonable consumption is charged for at a low tariff, and excessive consumption at a higher tariff.

The method adopted by the Pretoria municipality was to analyse the monthly bulk-meter readings for each block for the 12-month period immediately preceding the introduction of water restrictions. A quota of 70 per cent of the average value was set for each block and a uniform stepped tariff applicable to all apartment blocks was worked out.

The 1986 tariff structure for apartment blocks in Pretoria is given in Table 4.

TABLE 4: Water consumption tariffs for bulk-metered apartment blocks in Pretoria

Consumption category (% of set quota)	Tariff Rand/kℓ	Tariff applied to
0 to 100	0,41	All water consumed.
100 to 150	0,55	Consumption from 100 to 150% of quota.
150 to 200	1,00	Consumption from 150 to 200% of quota.
>200	2,00	All water consumed.

A more recent (November 1985) analysis of the water consumption of apartment blocks in Pretoria shows the success of the quota and stepped tariff system to be somewhat limited. Figure 3 shows that while 58 per cent of the blocks do not exceed their quotas, 51 per cent of the total water consumed is in excess of the quota. Because the penalty is spread across all the units in an apartment block, its impact is largely lost, and occupants are only mildly motivated to reduce consumption.

Short of imposing even harsher water restrictions and heavier penalty tariffs, the only way to control wastage appears to be the use of individual meters.

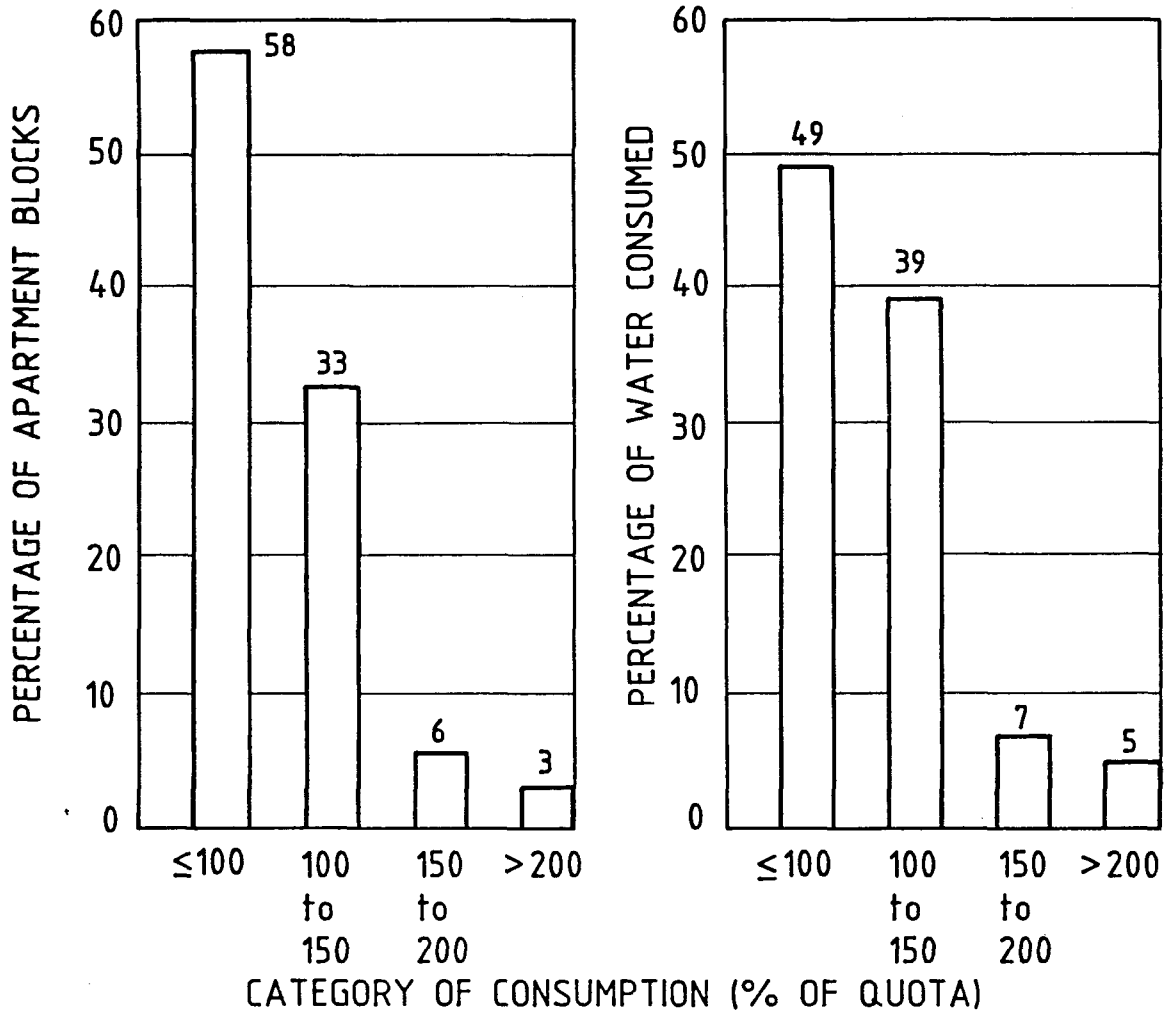

FIGURE 3: Water consumption for 1 213 apartment blocks in Pretoria - November 1985

INDIVIDUAL WATER METERING SYSTEMS

Existing installations

In East London, the owner of a property installs and is responsible for the water piping system from the municipal connection at the boundary to each flat. Assized standard water meters (provided by the local authority) are grouped together in the building or adjacent to it, and a pipe is taken from each meter to the particular flat it serves. A separate meter (marked 'yard') serving all external taps and communal water points is included with the battery of meters.

In the case of low-rise blocks of flats, all meters are grouped at ground level. In high-rise blocks they are grouped at intervals in the building - for example at three levels in the case of a 14-storey building.

The local authority bills individual tenants (flats) according to their consumption and the Body Corporate for the communal (yard) consumption.

Disadvantages of the system are:

- the meter reader may have to go up stairs or use a lift to get to meters in high-rise buildings;
- long individual pipes from each meter to a flat add to the construction and maintenance costs;
- any leakage from the pipe between the boundary and the meter cluster is not metered although the pipe is owned by the property owner.

According to senior officials of the local authority the reasons for individually metering flats in East London are:

- it is a traditional water-saving measure - East London has always had to conserve its limited water supplies;
- tenants of flats without meters have complained that they are subsidising other tenants in the block.

Holiday flats are not separately metered on account of the short occupancy and difficulties in obtaining deposits and payment of accounts.

The officials would like to make use of remote read-out meters for high-rise blocks, but do not at present on account of the higher cost of such meters.

Modern meter technology

Meter manufacturers in the United States have tried to improve the efficiency and accuracy of meter reading as has Kent Meters (UK).

Current developments fall under the following headings:

- hand-held microprocessors;
- remote read-out meters;
- automatic meter reading.

Hand-held microprocessors

Several cities in the United States as well as South Africa (for example Sandton, Durban and Mdantsane) are making use of hand-held microprocessors for meter reading.

Meter readings are keyed into the processor, and the device which has been programmed with the previous reading carries out an automatic check on the new consumption. The meter readings are automatically transferred from the processor to the mainframe computer which processes the data and prints the accounts. The processor is then automatically programmed with the next day's route information.

In Nashville, Tennessee, use of the system has enabled meter readers to read 315 to 320 meters per day (compared with 250 before their use).

The pay-back period for a microprocessor system has been as low as three months in some parts of the United States.

Remote read-out meters

Because of the freezing temperatures encountered in several parts of North America meters have to be located indoors. This has led to the development of two basic types of remote read-out systems, namely 'generators' and 'interrogators'.

Remote read-out meters comprise approximately 40 per cent of current domestic meter sales in the United States and approximately 90 per cent of these meters are of the generator type.

Automatic meter reading

This system is an advanced interrogator system and is fully automatic in that the local authorities' central computer can call up the data in the meter module, process it and print out the bill without any human intervention.

Technology appropriate for South Africa

Because of the relatively high cost and complexity of the 'interrogater' type of system and the consequent need for hi-tech maintenance facilities and skills, this system is not (in its present form) generally appropriate for South Africa.

The generator meter with remote reader has definite advantages when installed in apartment blocks. The system is not particularly complex and is independent of an external power source. Such meters are not yet manufactured in South Africa.

The generator read-out meters used in this project comply with the SA Trade Metrology Act and are consequently excessively accurate and expensive for use as 'proportioning' meters. 'Proportioning' means the division, by the owner of the block, of the bulk supply account into costs per flat according to individual consumptions.

A typical arrangement of a water installation serving a high-rise apartment block is given in Figure 4.

THE INSTALLATION OF INDIVIDUAL METERS

Retrofitting

Fifteen blocks of flats in Pretoria were inspected to assess the practicability of retrofitting water meters. In all cases it was found that

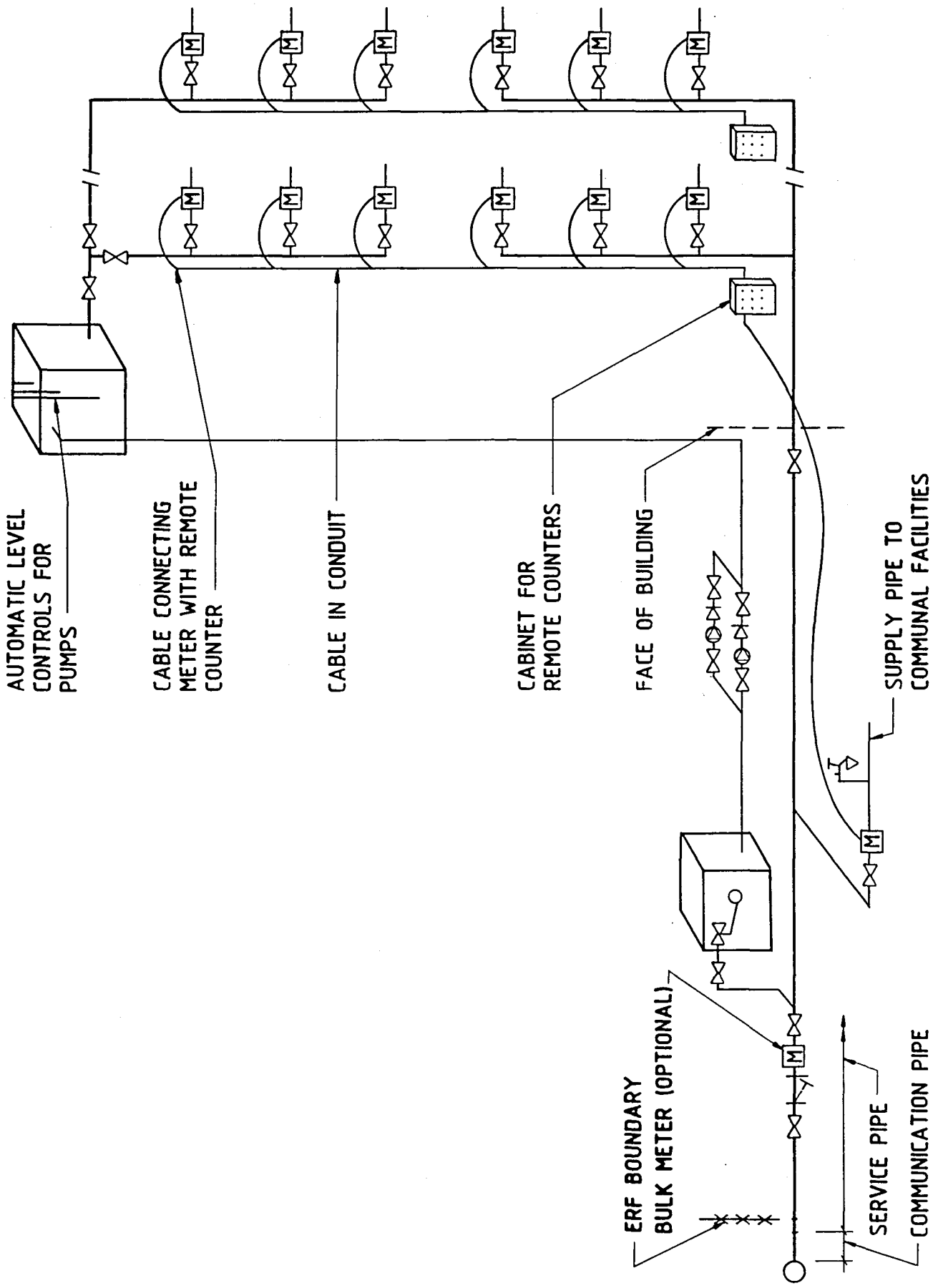

FIGURE 4: A typical arrangement of a water installation for an apartment block showing separate water meters

the water piping was virtually inaccessible, and in most cases individual flats were supplied from more than one point. One block (Kiowa) was eventually found with an accessible piping duct and a single supply point per flat. Fortunately, Kiowa has an identical twin block (Cheyenne) which could serve as a control. Each block comprised 36 flats (18 two- and 18 one-bedroom) and a communal laundry and servant's toilet.

The basis for billing Kiowa is given in Table 5.

Rentals and/or owners' levies have not been reduced as a result of the individual metering, but it can be assumed that future increases to the levies (as a result of other factors) will take into account the lower cost of communal water use.

TABLE 5: Basis for Kiowa water account

Meter No	Consumer	Party in receipt of the account
Kiowa 1	Flats 101, 201, 301, 401, 501 and 601	Huurkor (Pty) Limited (Letting agent) - for recovery from tenants of the 6 flats on a one-sixth basis
102 - 106 202 - 206 302 - 306 402 - 406 502 - 506 602 - 606	Flats numbered as per meter numbers	Tenants of each flat
Kiowa 2	Laundry, servants' WC and outside tap	Huurkor (Pty) Limited - for recovery from tenants of all flats on a one-thirty-sixth basis

The Council commenced reading the meters in the middle of March 1986, and combined water and electricity accounts were rendered towards the end of April.

The water quotas determined by the City Treasurer were 0,3 kℓ/d for one-bedroom, and 0,4 kℓ/d for two-bedroom flats.

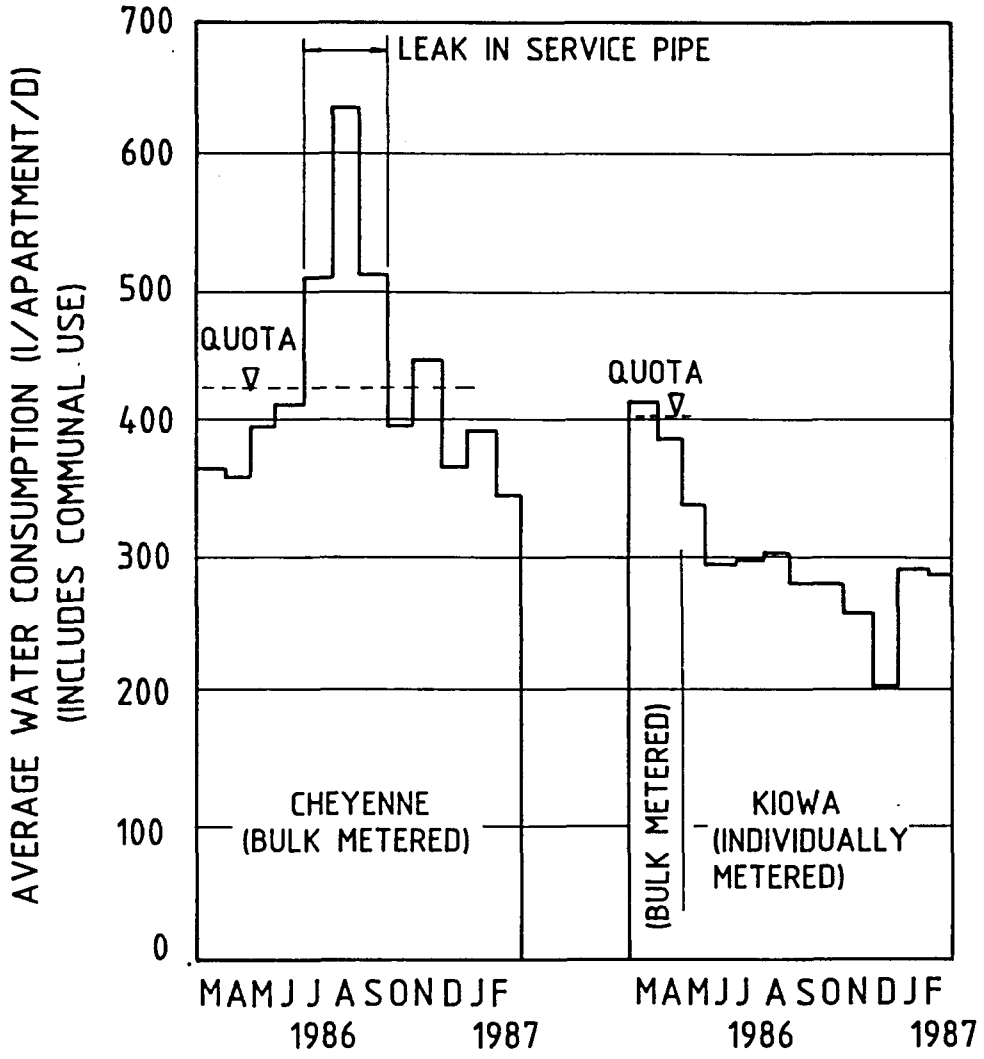

FIGURE 5: Water consumption for Cheyenne and Kiowa

Reaction in Kiowa to individual billing

The initial result of introducing individual meters was the identification of points at which water was being wasted.

Figure 5 shows a plot of the month-by-month overall (including communal use) water consumption by Kiowa and Cheyenne expressed as an average per occupied flat per day.

In the case of Cheyenne, the consumption was generally below the quota. In July 1986 a serious leak developed in the service pipe. By the time it was discovered and repaired, the consumption had exceeded the quota during July, August and September 1986.

Since the introduction of individual metering in Kiowa the number of units exceeding the quota is generally between two and four.

The caretaker reports that virtually all the tenants of Kiowa are in favour of separate metering. Some tenants in Cheyenne have also requested separate meters.

Discussion of results

The rapid increase in Cheyenne's water consumption in July 1983 pointed to a leakage (Figure 5). A damaged service pipe between the meter on the boundary and the building was found and the pipe replaced. High Density Polethylene (HDPE) piping was laid underground from the meter to the building, and Galvanised Mild Steel (GMS) run up the building and suspended under the parking area roof slab.

An analysis of water consumption for Cheyenne and Kiowa shows the following:

	(pop)	ℓ/flat/d	ℓ/capita/d
Average consumption for Cheyenne from March 1986 to May 1987 (July, August and September excluded)	85	372	158
Average consumption for Kiowa from May 1986 to May 1987	83	278	120
Difference between 372 and 278 expressed as a percentage of 372 ℓ/flat/d (Percentage saving)		25%	
Original quota for Kiowa (bulk meter)	83	406	176
Difference between 406 and 278 expressed as a percentage of 406 ℓ/flat/d (Percentage saving)		31%	

In the case of East London, two years' records of meter readings (meters are read three-monthly) between 1983 and 1986 were obtained from the municipality for 12 buildings (comprising 365 individually metered flats, and a single bulk-metered block of 65 flats).

The water consumption data is summarised in Table 6. In Year 1 the individually metered flats used, on average, 25 per cent less water than the bulk-metered units. In Year 2 this figure was 20 per cent.

The average consumption for all the individually metered one- and two-bedroom flats in the East London sample combined (251 ℓ/flat/d), was 90 per cent of that for Kiowa (278) (one- and two-bedroom flats individually metered).

The average consumption for the bulk-metered flats in the East London sample (324 ℓ/flat/d) was 87 per cent of that for Cheyenne (372). The last-mentioned two percentages indicate a reasonable correlation in the use of water by similar flats in East London and Pretoria.

A histogram of the water consumption pattern for the East London flats is given in Figure 6. Figure 6 shows that most consumed 200 to 300 litres per day.

A questionnaire completed by 40 tenants of individually metered flats in East London and Kiowa revealed their unanimous preference for their system over bulk metering.

COST CONSIDERATIONS AFFECTING INDIVIDUAL METERING

General

There is no doubt that the individual metering of flats will involve extra expense, which will ultimately be for the consumer's account.

- Plumbing. The pipe layout must be suitable for the installation of a meter. Any extra cost necessary to achieve this would be insignificant in most cases. This cost would be borne by the developer.
- Water meters. The purchase and installation of the meters and any inspection box or duct needed to house the meter and/or remote reader (counter) involves the greatest expense. The supply and installation of conduit and cable between the meter and its remote counter is associated with this cost. These costs would usually be borne by the developer.
- Meter reading. This includes processing readings and billing consumers. This cost is borne by the local authority.

TABLE 6: Average water consumption for flats in East London

Consumption (including communal use) for individually metered flats (ℓ/flat/d)					Total consumption for bulk-metered block (including communal use) (ℓ/flat/d)
Year 1					Year 1
Bachelor (sample = 46)	1 Bedroom (sample = 60)	2 Bedroom (sample = 239)	3 Bedroom (sample = 12)	All flats combined (sample = 357)	Block comprises : 7 x bachelor; 14 x 1 bedroom, 40 x 2 bedroom and 4 x 3 bedroom (Total = 65 flats)
216ℓ	207ℓ	252ℓ	351ℓ	243ℓ	323ℓ
Year 2					Year 2
(Sample = 46)	(Sample = 60)	(Sample = 244)	(Sample = 13)	All flats combined (Sample = 363)	(Total = 65 flats)
236ℓ	216ℓ	271ℓ	328ℓ	259ℓ	325ℓ

- Meter maintenance. The inclusion of additional meters in the maintenance programme of the local authority. This cost is borne by the local authority.

Where a bulk supplier of water sets a water quota for a local authority it supplies, the extra costs involved in individual metering could be set off against the reduced cost of water purchased resulting from such metering, and the avoidance of, or a reduction in, the penalty cost such local authority would have to pay for exceeding the quota.

In the case of Pretoria City Council, the penalty tariff for water obtained from the bulk supplier in excess of the quota is arrived at by increasing the basic tariff by 1,5 per cent for every 1 per cent that the quota is exceeded.

Plumbing

The cost of ensuring that the pipework in a block of flats allows for single supply point to facilitate metering would vary between practically nil in the case of flats with a single bathroom and kitchen abutting on the service duct, to perhaps as much as R500 per flat in the case of larger flats with a remote second bathroom.

With the possibility of using two generator meters with one remote counter, each dwelling unit could have two supply points and the cost of extra piping is eliminated. The cost of an additional meter would however have to be taken into account.

The cost per flat of taking a single pipe from a meter cluster (as is the case in East London) would vary considerably, depending on the distance involved.

Water meters

The supply and installation of a standard domestic meter and inspection box in a new building would cost approximately R120 (such as those in North Gardens).

Generator remote read-out meters are not yet manufactured in the RSA and are thus expensive to import. In the case of the retrofit of meters in Kiowa, the cost of a meter and remote-reader (ex UK), installing the meter, the cable and

CONSUMPTION RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13
ANNUAL AVERAGE CONSUMPTION (INCLUDING COMMUNAL USE) (l/APARTMENT/D)	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	>600

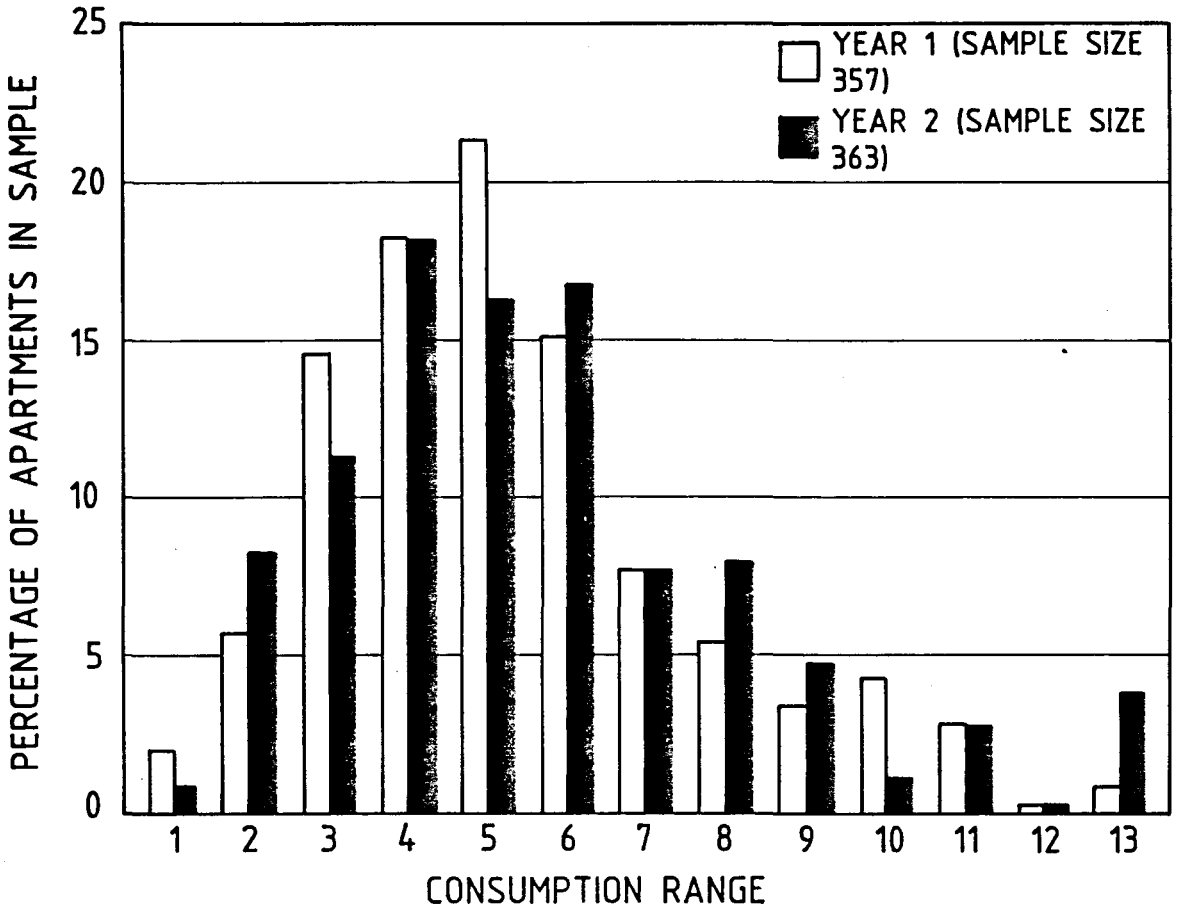

FIGURE 6: Water consumption for individually metered flats, East London - all flats together

the remote counter (including cabinets), was R350 per meter. Provided demand justified the manufacture of this type of meter in South Africa the generator type with remote counter would probably cost approximately R100. Supply and installation of the meter with its remote counter in a cabinet would probably cost approximately R210 in total.

The supply and installation of a single-jet 'proportioning' meter together with inspection box is approximately R105 in total.

With regard to the bulk meter for a block of flats, the Pretoria City Council (PCC) charges the developer for the cost of the connection (including the meter). The charge is based on the average daily domestic water demand, plus an allowance for fire-flow where hydrants and hose-reels are provided. The 1986 cost schedule applied by the PCC is given in Table 7.

TABLE 7: Schedule of water connection costs

Meter size (mm)	Flow rate (average domestic plus fire) (ℓ/s)	Cost of connection (includes meter) (R)
25	1,40 - 1,94	750
50 (combination)	1,95 - 11,11	2 560
80 (combination)	11,12 - 38,89	3 015
100 (combination)	38,90 - 55,56	4 200

For a hypothetical high-rise block of 60 flats comprising 48 small (bachelor, 1- and 2-bedroom) and 12 large (3- or 4-bedroom) units, and using a quota system similar to that applicable for Kiowa - say 0,4 kℓ/d for small flats (and external use) and 0,5 kℓ/d for larger flats - the total quota for the block would be (49 x 0,4) + (12 x 0,5) = 25,6 kℓ/d.

Converting the quota to ℓ/s, we get	0,3 ℓ/s
Adding fire flow	8,0
Total	8,3 ℓ/s

The meter required would be a 50 mm combination type, and the total connection cost to the developer would be R2 560.

Where flats are metered individually by the local authority, a bulk meter would not be required for the domestic supply, but would usually be required for the fire-flow.

The average cost of construction of a high-rise apartment complex was between R35 000 and R45 000 per dwelling unit in 1986. If the extra cost to the developer of providing individual remote read-out meters was R210 per unit and

the extra cost of plumbing was R500 (in the more expensive cases) giving a total of R710 per flat, such extra cost would have amounted to 1,6 per cent of the construction cost, which is practically insignificant.

Meter reading and billing

The cost to the PCC of reading meters monthly is averaged out as 76 cents per reading, and the cost of processing readings and billing consumers monthly is 91 cents per meter, giving a total monthly cost of R1,67 per meter.

Meter maintenance

No specific cost of meter maintenance in Pretoria has been assessed at this stage.

Should a municipality operate a meter-maintenance and replacement programme, the annual cost per meter would depend on the cost of the meter and its parts, and the intervals between replacement. At an estimated cost of R50 per meter for a conventional domestic meter, R100 per meter for locally manufactured generator meters and a 7-year replacement interval, the annual cost per meter would be about R7 or R14 per meter respectively.

Where proportioning meters are used, the cost of meter maintenance would have to be borne by the tenants through rents or levies. The local authority would still have the cost of maintaining the bulk meter at, say, R280 p.a. - depending on the size of the meter.

How individual metering affects the revenue and expenditure of the local authority

A cost analysis using a hypothetical block of flats and unit costs (excepting for the cost of meter maintenance), obtained from Pretoria City Council is given in Table 8.

Table 8 shows that on the basis of the unit costs used, the local authority would experience a monthly loss of R78 when the consumption by the block is equal to its quota. Should a 25 per cent saving on the quota (ie. consumption equal to 0,75 x quota) be achieved with individual meters, the loss to the local authority would be increased by 2,24 times - R175

TABLE 8: Effect of individual metering of flats on monthly income and expenditure of the local authority: Example using a hypothetical new building with 60 flats and standard type domestic water meters (1986 prices. Costs rounded off)

1	2	3	4	5	6	7	8	9
Consumption category in terms of monthly quota	Monthly consumption (kℓ)	Quantity of water purchased by the local authority[2] (kℓ)	Cost of water purchased by local authority (R)	Cost to supply water to the consumer (R)	Cost of meter reading (76c) and billing (91c) (R)	Cost of meter maintenance (R)	Revenue obtained from sale of the water (R)	Difference between costs and revenue (4+5+6+7-8) (R)
1,0 x Quota[1] (bulk-metered only)	720	806	806 x 28c =R226	720 x 17c =R122	1 x R1,67 = R2	23	720 x 41c = R295	78 Dt
1,5 x Quota (bulk-metered only)	1 080	1 210	1 210 x 31c[3] =R375	1080 x 17c = R184	1 x R1,67 = R2	23	(720 x 41c)+ (360 x 55c) = R493	91 Dt
0,75 x Quota (individual meters)	540	605	605 x 28c = R169	540 x 17c = R92	60 x R1,67 = R100	35	540 x 41c = R221	175 Dt

[1] Assumes a quota of 400 ℓ/flat/day.

[2] Includes 12% allowance for unaccounted-for water.

[3] Penalty tariff based on an increase of the basic tariff by 1,5% for every 1% quota is exceeded. Assumes quota exceeded by 6%.

TABLE 9: Comparison of Monthly/Annual Costs of Individual metering of Flats vs Bulk metering. Hypothetical building containing 60 units and standard type domestic water meters (1986 prices)

	Unit Consumption		Cost of Water		Meter Reading		Meter Maintenance		Total		Difference	
	Month (ℓ/fl/d)	Year (m^3)	Month (30 days)	Year (365 days)	Month (R)	Year (R)	Month (R)	Year (R)	Month (R)	Year (R)	Month (R)	Year (R)
Bulk metered	400	8760	324	3942	1.67	20	23	276	349	4238		
Individual meters	300	6570	243	2956.5	100	1200	35	420	378	4576.5	29	338.5

If, for example the debit of R 78 was to be eliminated by increasing the tariff for the sale of the water, such tariff would need to be 52c per kℓ. With the consumption at 75 per cent of the quota, the revenue would then be 540 x 52c = R280,8 The difference between cost and revenue for this case would be a debit of R115

The example illustrates that the individual metering of flats is not necessarily cost-effective. The municipality's motive for individual metering would therefore generally be solely for the purpose of reducing water consumption, an important enough goal when water supplies are scarce.

CONCLUSIONS

The following conclusions have been drawn from the investigation.

- Water restrictions and a stepped tariffing system have had a definite but limited effect on controlling water consumption in bulk-metered apartment complexes.
- Individual metering of flats in a multi-dwelling complex identifies any water-wasters who, under a bulk-metered system, would remain anonymous.
- Individual metering and billing highlights the existence of leaking water fittings in multi-dwelling complexes, and motivates the tenants to attend to them.
- The saving in water consumption achieved in multi-dwelling complexes with individual metering and billing is between 20 and 30 per cent of the former bulk-metered consumption.
- Tenants of individually metered flats prefer this system to bulk metering.
- The provision of individual meters would result in increased costs to the local authority which would generally not be offset by consequent savings in water purchased from the bulk supplier.
- The system in which individual meters are situated at the flats and remote counters are grouped together at a convenient place is preferable to a battery of conventional meters with separate pipes to each flat.
- The retrofitting of water meters to existing apartment buildings is generally impractical.

RECOMMENDATIONS

In view of the water saving potential inherent in the provision of individual meters in multiple-dwelling complexes, it is recommended that national regulations governing the supply of water to premises include the following:

- the water installation supplying dwelling units in multiple dwelling complexes shall be designed so that each unit's water consumption can be separately metered;
- where the local authority so requires, each unit shall be provided with a separate meter.

Research should be undertaken by meter manufacturers which will lead to the development of a locally manufactured remote read-out type of meter which is specially suitable for use in apartment buildings.

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