SUPPLY PRICING OF URBAN WATER IN SOUTH AFRICA

VOLUME 2

MAIN REPORT

by

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Report to the
WATER RESEARCH COMMISSION
on the project
"Pricing water as an economic resource:
implications for South Africa"

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Preface

This report forms part of the output of the Water Research Commission funded project titled "Pricing water as an economic resource: implications for South Africa" (Project K5/678). The scope and focus of the project was narrowed by the Commission on the recommendation of the steering committee to examine water pricing issues related primarily to urban water use, including the wholesale of water to (or by) local government. The report title has therefore been shortened to "Supply pricing of urban water in South Africa".

The principle objectives of the project are as follows: (1) to review water pricing theory, (2) to review the international practice of water pricing, (3) to review and assess pricing policy principles and goals for South Africa, (4) to assess available methodologies (and to develop new methodologies as necessary) to aid in the process of establishing water pricing policies and setting wholesale and retail water tariffs in South Africa, (5) to recommend policies for, and an approach to, urban water pricing in South Africa, and (6) to assess the implications of the policies and approach with reference to an urban case study in South Africa.

The primary outputs from the project comprise the following set of reports:

Main reports

Supply pricing of urban water in South Africa: Executive summary.

Supply pricing of urban water in South Africa: Main report.

Working Papers (prefix: "Supply pricing of urban water in South Africa:")

1. Theoretical approaches to urban water pricing - a review.
2. Urban water pricing in practice - a comparative review.
3. Principles and goals for urban water pricing in South Africa - a discussion document.
4. Modelling urban water demand to understand efficiency and equity effects - towards a new methodology.
5. Water pricing in Grahamstown - a case study.

The research was undertaken and all reports written by Rolfe Eberhard with the oversight of Mr Ian Palmer (both of Palmer Development Group) and Profs John Sender, Mushtaq Kahn and Ben Fine of the School of Oriental and African Studies, University of London.

The views and opinions expressed in this report and the working papers are made on the basis of the research undertaken by the researcher and do not necessarily reflect the views and opinions of the Water Research Commission, the members of the steering committee, the researcher's supervisors at SOAS and colleagues at PDG. The author retains responsibility for all errors and omissions.

Executive Summary

1. Research context

This project was undertaken during a particularly fluid research and policy environment within South Africa. Since the original conceptjon of the project in 1993 many changes have taken place within the water sector. At that point, this project was one of a few initiatives undertaken specifically on water pricing. Subsequently many more research, policy and legislative initiatives have been launched. Hence this project has been adapted along the way so as best to meet the changing water sector needs. During this process, the researcher was actively involved in and/or contributed to a number of important policy initiatives in the sector, in particular, the development of the first tier water pricing strategy, the water services act and the regulations related to third tier water pricing. Thus it is fair to say that the research outcomes reported here have already helped to shape the current water policy environment. However, in many instances, the research presented here has gone beyond existing policies and current practice. Hence a number of recommendations for further change to policies and practice are proposed.

2. Project Objectives

The project objectives were as follows:

1. Review current international trends in water pricing theory and practice, with specific reference to the treatment of water as an economic resource.

2. Assess and review pricing policy principles and goals for South Africa on the basis of the above review and the treatment of water as an economic resource.

3. Develop a pricing methodology to maximise the attainment of the pricing policy principles and goals (of efficiency, equity and sustainability as reflected in the 1997 White Paper on Water Policy and developed during the national water tariff review process) for application in municipal areas.

4. Collate information necessary for assessing the efficacy of the proposed pricing methodology through a case study approach.

5. Assess the efficacy of the proposed pricing policy and methodology, with specific reference to: (a) the impact on the short- and long-term demand for water in the municipal and industrial sectors; (b) the impact on the allocation of resources within the water sector (between water supply to municipal, industrial and other sectors) and between economic sectors; (c) the impact on economic development in South Africa; (d) the impact on the provision and affordability of residential water to poor communities, and (f) the impact on the environment.

6. Evaluate the applicability of the proposed pricing methodology within the context of increased private sector involvement in water supply.

3. Outcomes and achievement of objectives

3.1 Pricing policy goals and principles

The following principles are proposed as a means of promoting *equity*:

1. In the allocation of water between sectors, water use for basic human needs should enjoy priority.
2. In the allocation of financial resources, the provision of services to meet basic needs for water should enjoy priority. This implies the effective targeting of subsidies.
3. Water and other pricing policies at the very least should not jeopardise access to the basic needs amount of water, and preferably promote such access.
4. The impact of water price reform on inequality with respect to access to water resources in particular, and on income-inequality in general, should be recognised and taken into consideration when proposing water price reform.
5. Water pricing reform, at the very least, should not increase inequality in access or income, and preferably reduce inequality. This implies targeted subsidies for poor consumers.

The following principles are proposed in relation to the promotion of *ecological sustainability*:

1. Legislative intervention is necessary to secure ecological sustainability.
2. External environmental costs should be internalised into the water price.
3. Higher water prices will generally promote ecological sustainability but not necessarily guarantee it. Moreover, the equity implications of higher prices must be taken into account.

Three general principles related to *financial sustainability* are proposed:

1. Full cost recovery from users is not necessarily desirable from both an equity and efficiency point of view.
2. Nevertheless, it is generally desirable that consumers face a positive marginal price implying that at least a portion of revenue should be derived from a volume related charge if this both practicable and cost effective (see below).
3. Within a defined context of subsidies and inter-government transfers from the national tax base, local water services should be financially sustainable; that is, revenue from water tariffs and other local revenue sources should be sufficient to cover ongoing costs (both capital and operating).

The following general principles are proposed to promote *efficiency*:

1. Pricing policy should recognise both the economic and social nature of water and make use of all three definitions of efficiency (described above) as appropriate to the particular context.

2. Higher prices will generally promote the more efficient use of water, however, the equity impacts need to be assessed and taken into account.
3. Where practical and cost-effective, payment should be in proportion to the amount consumed.
4. Prices should promote the development of competitive businesses. Hence business tariffs should not be loaded with excessive taxes or cross-subsidy requirements.

The following principles of good practice are proposed:

1. Tariffs should be fair in that they treat all consumers in the same circumstances in a consistent manner.
2. Tariffs and subsidies should be clear and easily understood.
3. Tariff enforcement should be fair and consistent.
4. The benefits derived from implementing a tariff (or tariff reform) must exceed the cost of implementation, that is, they should be cost-effective.
5. Tariffs should seek to generate revenue that is reasonably stable and predictable.
6. Consumers should have easy access to relevant information.

3.2 Pricing policy recommendations

3.2.1 First tier water pricing

Although first tier pricing is not strictly within the scope of this project, some recommendations relating to first tier pricing were made. These are summarised here.

1. **First tier water subsidy**. The existing policy states that the water necessary for a basic domestic supply should be supplied free of charge. Although the sentiment of this policy is admirable, its efficacy in practice is doubtful. First, the cost of raw water relative to the infrastructure costs at the second and third tiers is reasonably small. Second, the cost of the free water must be borne by the other water uses in the same system, which simply means that the cost of the remaining water will be increased proportionately, resulting in effectively the same average cost for the total amount of water supplied. Third, such a subsidy is complex to administer. In the light of this, it is recommended that all first tier water be priced at cost (resource charge plus full financial cost of infrastructure plus catchment management charge). Further, it is recommended that the subsidy for basic water supply be effected directly at the third tier along the lines discussed for retail water pricing. One possible source of the funding for the retail subsidy could be a resource tax on all first tier water abstraction.

2. **Assurance of supply**. The financial cost of first tier water should be related to the assurance of supply required by the respective users.

3.2.2 Wholesale water pricing

The following policy recommendations pertaining to wholesale (second tier) water pricing are made:

1. **Ring-fencing**: The water wholesale function should be ring-fenced as a separate business unit and regarded primarily as a commercial operation whose aim is to deliver water at the required quality and reliability at the lowest possible cost.

2. **Cost-based pricing**. The wholesale price should be set as the sum of the price (or cost) of the raw water and the costs entailed in the wholesale function (typically treatment, conveyance and storage).

3. **Calculation of costs**. There are three generally accepted approaches of calculating or accounting for capital costs, namely, the *funding approach*, the *depreciation approach* and the *rate of return approach*. Fund accounting has been used for many years by water boards and other public sector utilities, and is therefore well understood in that sector. It is also reasonably objective and could therefore be monitored or regulated without too much difficulty. However, fund accounting is less well accepted in capital markets where depreciation accounting is the norm, preferably based on the current value of assets. The dependence of water boards on external loan finance – a situation that is likely to become more rather than less significant – suggests a move towards depreciation accounting. **Comment**: Some water boards are involved in exercises to investigate the implications of switching from fund to depreciation accounting and this is an appropriate first step. However, it is desirable that a uniform approach to cost accounting be adopted for the purpose of establishing wholesale water prices in South Africa.

4. **Cross-subsidisation**. As a general principle, there should not be cross-subsidisation between consumers supplied by a wholesale Water Services Provider (WSP) because this is typically not transparent and it is not subject to direct political review or control. However, there is a pragmatic argument for a uniform wholesale price where cost differentials between wholesale consumers are not large.

5. **Performance indicators**. It is difficult for an outside agency to accurately monitor wholesale costs because cost-structures will be specific to local circumstances. Nevertheless the development of performance indicators and best-practice benchmarks may provide useful references for comparison between different wholesale WSPs.

6. **Institutional support costs for the third tier**. The costs of supporting institutional development at the third tier should be accounted for separately. It is preferable that the revenue for these costs comes from the national budget (or a national levy on first tier water sales) as this is more equitable. (Areas in most need of institutional support may not have capable wholesale WSPs to assist.) Failing that, the revenue may be obtained through a uniform surcharge of bulk treated water sales. It is recommended that the equitable share subsidy not be used for this purpose.

3.2.3 Retail urban water pricing

The following policy recommendations pertaining to retail (third tier) water pricing are proposed:

1. **Governance**. Retail water tariff levels should continue to be determined or mediated at the local level by local governments through locally elected political representatives.

2. **Definition of a minimum basic water supply**. A minimum basic water supply should be regarded as access to 25 lcd in South Africa as a whole.

3. **Definition of a target basic water supply**. A target basic water supply in urban areas should be regarded as access to and consumption of 50 lcd. This implies a general preference for on-site supplies in urban areas because off-site access typically constrains consumption to less than 30 lcd.

4. **Capital cost subsidy for basic supply**. To the extent that it is financially feasible, the capital costs of the provision of infrastructure which makes 50 lcd available and accessible to households which otherwise would not be able to afford it and be willing to pay for it should be subsidised. (Current policy is for 25 lcd.)

5. **Cost of basic access (connecting)**. On purely equity grounds there should be a zero access price for a basic domestic water supply where affordability is constrained and where implementation of a non-zero access price limits access. However, requiring a partial contribution from households towards the cost of access may be important, especially in rural areas, to achieve development goals, to match a purely supply side approach with demand responsiveness and to improve the sustainability of systems.

6. **Basic consumption subsidy**. There are strong social and equity grounds for making available an affordable lifeline tariff which will encourage (or at least not discourage) the use of a certain minimum amount of water (50 lcd) necessary to maintain basic health standards. (The imposition of volume related pricing at a significant level amongst poor households for low levels of consumption may have the unintended effect of discouraging the adequate use of water and therefore is not recommended.) Such subsidies should also apply to communal standpipes and other restricted supplies.

7. **Volume related pricing for unrestricted on-site supplies**. Where domestic water use is unrestricted, it is important that consumers face a positive marginal price for additional water used in excess of that needed for basic domestic needs (50 lcd).

8. **Full cost recovery for non-domestic users**. Non-domestic users should direectly or indirectly pay at least the full costs of the water services provided (both capital and operating).

9. **Encouraging water-use efficiency and conservation: domestic users**. Domestic water usage in excess of 200 lcd in South Africa may be considered to be luxury use. Therefore, there should be strong incentives that encourage water conservation where consumption exceeds 200 lcd. These incentives should include higher tariffs, which could be related to the average incremental cost of new water resource development. Education and informative billing should complement higher tariffs. Seasonal tariffs may be warranted in certain areas.

10. **Encouraging water use efficiency and conservation: non-domestic users**. The establishment of best-practice water-use benchmarks by consumer type (for large consumers) and the implementation of disincentive or penalty tariffs for the wasteful use of water will encourage investments in water saving technologies and practices.

11. **WSP investments in conservation**. WSPs should apply cost-benefit analyses to investments in water savings in relation to supply augmentation. The scope of

WSP investments in water savings may include the full or partial subsidisation of water saving technologies including plumbing and appliances at the consumer level. Supply-side investments of this nature may be particularly important among poor and older households where credit markets are prone to failure.

12. **Revenue sufficiency**. Outside of known, well-defined, quantified and secure inter-governmental transfers, revenue from tariffs (including property taxes) should fully recover costs and ensure financial sustainability.

13. **New industrial demand**. Water using industries should face the correct economic incentives when making investments in new capacity. This means that the cost or price that new water using investments face should be related to the incremental cost of capacity expansion in that water supply system.

14. **Cross-subsidies**. Residential consumers should not cross-subsidise non-residential consumers. Cross-subsidies from non-residential to residential consumers should be limited to reasonable levels and should not jeopardise the international competitiveness of industries.

3.3 Proposed retail pricing methodology

A methodology for the implementation of the retail (third tier) water tariff policy recommendations is proposed in the main body of the report. The proposed methodology builds on what has come before, namely the existing set of management guidelines for setting urban water tariffs in South Africa and the Water Supply Services Model (WSSM).

3.4 Tariff design - some practical guidelines

A set of practical guidelines for tariff design is provided in the main body of the report. These guidelines provide a coarse-grained approach that is helpful to assess the broad feasibility of different subsidy and tariff structure options. Once a broad outline has been worked out following this approach, the estimates can be tested and refined using available or custom-developed financial and tariff models.

4. Implications for South Africa

The implications for South Africa of following the recommended pricing policies and proposed pricing methodology are outlined in this section. It should be pointed at the many of the pricing outcomes will largely be determined at the local level and will differ depending on local circumstances. The limitations of econometric analysis for predicting demand responses to changes in prices are pointed out in the report. For these two reasons, it is not possible to draw definitive quantitative conclusions as to the likely general impact of the proposed pricing reform. Nevertheless, it is possible to suggest in broad outline what some of the likely impacts might be.

4.1 Implications of first tier pricing reform

Although quantifying the impacts of first tier pricing reform was not within the scope of this project it is possible to make the following general comments.

The price of water to irrigators will increase over the next five or so years. Catchment management fees will be introduced. The absolute quantity of the ecological reserve is likely to increase in future, which will increase the financial cost of the available water and increase the scarcity value of water in the catchment. The introduction of an economic resource charge in the medium term will increase the price of first tier water in water scarce catchments. Making first tier water that is used for basic needs available free of charge is likely to have only a small impact on water prices because the basic needs use is estimated to be only about 2% of total water use in South Africa.

The overall impact of these reforms over time will be to move water use away from lower value use to higher value use. Therefore, it may be expected that, in contrast to conventional expectation, water use for irrigation as a proportion of total water use will decline with time. Increases in the first tier water prices will be passed down to the second and third tiers. However, current first tier prices are already based on full costs for urban supplies, hence the impact of first tier water price reform on urban water prices is likely to be small in the short term and only moderate in the medium term. This is because raw water costs are only a small fraction of total water costs at the retail level. However, in the longer term, water resource development costs are likely to rise steeply, which will impact significantly on third tier urban water prices.

4.2 Implications of second tier pricing reform

A "clean" second tier role for water wholesale has been recommended, which implies that the wholesale function is run as a commercial operation. Water wholesalers should raise private capital at the lowest possible cost, set tariffs to fully recover costs (but no more) and operate the wholesale function as a distinct (ring-fenced) business entity. It is also recommended that tariffs reflect differences in supply costs between wholesale customers where there are significant cost differentials.

It is more equitable if rural subsidies are made available from the national budget and it is therefore not appropriate that urban-rural cross-subsidies take place at a regional level. The principle of "common pool" wholesale water pricing appears to have been taken too far in South Africa: setting prices to reflect costs more closely at the wholesale level will result in much higher water prices for some consumers and a lowering of prices for the remaining customers in the common pool system. To the extent that Water Boards and other wholesale WSPs carry out institutional support functions to assist retail WSPs, these costs should be accounted for separately. Preferably, these costs should be funded from the national budget, alternatively they can be funded by adding a surcharge onto bulk treated water sales. Wholesale WSPs should not try to effect conservation pricing because this is taken care of at the first and third tiers. Implementation of capital subsidies at the second tier level are not targeted neither are they equitable and are therefore not recommended. The marginal cost of expanding the second tier network to meet increasing demand should be calculated using a nationally defined methodology and reported annually.

There is not likely to be any significant *overall* impact on water demand arising from second tier pricing reform because existing prices at this level are already cost based. Increased first tier water prices will be passed onto the third tier. In some instances there may be significant adjustments because of the implementation of cost-based differential wholesale pricing and the elimination of second tier cross-subsidies.

4.3 Implications of third tier pricing reform

The impact of pricing reform at the retail level will be dependent on local circumstances to a very large extent. Not only will the tariff design be influenced by local factors such as costs, demographics and the pattern of water demand, but also the starting point of price reform will be different in each case. Nevertheless, it is possible to illustrate the possible implication of retail price reform in broad terms and to describe the factors that will determine the feasibility of cross-subsidies.

4.3.1 Broad implications of domestic price reform

The primary goal of the pricing policies advocated here is to improve access to water services. The implementation of these policies should help to facilitate a significant improvement in access to water in South Africa. There should be a strong preference for on-site water supplies, particularly in the urban areas of South Africa. The pricing policies put forward support this preference. The provision of restricted on-site supplies offers an intermediate option between off-site supplies such as communal standpipes (where consumption of water is generally inadequate) and unrestricted on-site access (which may be prohibitively expensive).

The policies seek to ensure that households not only have access to adequate water services, but also can *afford* to consume a target of 50 lcd. Thus the pricing policies and methodologies recommended here have the twin goals of encouraging domestic water use where this is less than 50 lcd and discouraging water use where this is in excess of 200 lcd. The overall effect of this should be to reduce the existing disparities in domestic water use arising from apartheid policies; specific effects will be locally determined. Setting higher tariffs for luxury water use (water use in excess of 200 lcd) will have the impact of improving water-use efficiencies through investments in water saving devices and reducing wasteful water use. Thus water conservation will be promoted. Cost-based tariffs for non-residential consumers will help to ensure financial sustainability.

4.3.2 Financial sustainability and cross-subsidies

The key premise in the analysis presented here is that the WSP must be financially sustainable. The extent of subsidies that are sustainable and the leeway that Water Services Authorities (WSAs) or WSPs have to incorporate cross-subsidies into urban water tariff design will depend principally on the following factors: (1) the capital subsidies made available to the water sector from higher tiers of government; (2) the total equitable share subsidy made available to the WSA from higher tiers of government; (3) the share of this subsidy made available to the retail water sector by the WSA; (4) regional and local cost factors which determine the cost of supply; (5)

the total wealth of the supply area; (6) the proportion of water consumed by the non-residential compared to the residential sector; (7) the income distribution within the supply area; (8) the consumption distribution in the supply area and (9) the political feasibility of introducing cross-subsidies. Many of these factors are locally specific. Hence it is not possible to quantify the impacts of retail price reform at the national level.

4.3.3 Durban - setting an example

The strategic plan for water services supply, management and pricing adopted by Durban Metropolitan Council offers a good example. The plan ensures universal access to on-site water while maintaining financial sustainability, targeting subsidies to those most in need, ensuring affordability of services and encouraging conservation amongst large domestic consumers. Financial modelling of alternative scenarios played an indispensable part in the development of the strategic plan. Other WSAs in South Africa should use the approach adopted by Durban, which is described in the main report, as a model.

4.3.4 Grahamstown - dealing with difficult legacies

A detailed analysis of water pricing in Grahamstown was undertaken as part of this project. Specific conclusions arising from this study are presented in the main report and in Working Paper 5. Only the more general conclusions arising from the study are replicated here. The particularities of the historical institutional and political-economy context in Grahamstown highlight the need for a context-specific approach to pricing reform. It may not be feasible to implement progressive block pricing where institutional capacity is weak. Choosing the appropriate definition of the marginal cost may be complex and hence using marginal costs as a benchmark may be inappropriate in certain contexts. In cases where significant excess capacity exists and where there are simultaneous high fixed costs, it is not in the WSPs interests to promote water conservation. In certain contexts, higher prices for non-residential consumption arising from the need and desire to cross-subsidise residential consumption may jeopardise the already fragile economic and institutional base and is not advisable.

5. Recommendations related to methodology

The recommendations made with respect to the methodology of pricing and price reform are summarised here.

No mechanistic method: A generalised method which can be applied in order to determine the appropriate price structures and tariffs in any specific urban area does not exist and is not desirable.

Political-economy context: The development of an appropriate pricing policy must be informed by both the national *and locally specific* historical, socio-economic and political-economic contexts.

What is, is: Pricing reform must start with the existing situation. Existing conditions have arisen for particular reasons that need to be understood. It is not possible to impose a uniform blueprint.

Decision-making: The appropriate pricing policy for a particular context cannot be decided on by an "impartial expert". The very real political-economy trade-offs integral to price reform must be made with reference to local political decision making processes.

Process: The following pricing process is recommended: (1) develop an understanding of the political-economy context at the country and city level; (2) develop consensus on equity, sustainability and efficiency frameworks that address the political-economic realities; (3) develop consensus on an appropriate and practical *set* of indicators for equity, sustainability and resource efficiency; (4) develop explicit pricing objectives linked with measurable goals; (5) determine the price structure and set the price levels so as to achieve the defined objectives; (6) evaluate the impacts; and (7) refine the price structure and level. This approach emphasises the iterative nature of the pricing process whereby improvements are made so that the objectives are more fully achieved. The availability of practical measures whereby the extent of attainment of the specified objectives can be assessed greatly assists this incremental reform process.

Best practice principles: A set of best practice principles is proposed and their practical application discussed.

Data requirements: Specific data sets, which are necessary and/or desirable for use in the tariff reform process, are proposed (see main report). These data sets take the likely data limitations into account.

Practical performance indicators: A number of practical performance indicators are proposed. These indicators will allow the tariff reform process to be more transparent and enable progress to be more easily assessed.

Measurable goals: A set of measurable pricing and performance goals is proposed.

Estimation techniques: The use of sophisticated econometric estimation techniques is highly unlikely to yield meaningful results and is therefore not recommended for general application. On the other hand, descriptive techniques for analysing data are likely to be useful. Histograms and nonparametric density functions are likely to be useful tools. These do not impose theory on data form, allowing the "data to speak for themselves", and are particularly useful for examining issues related to distribution and inequality.

Financial modelling: Spreadsheet-based financial models are very useful for evaluating the impacts of alternative tariff structures and levels.

Tariff design: Practical guidelines for setting tariffs are given in the main report and have been summarised above. These are largely complementary to the existing *guidelines*. However some important amendments are proposed which are highlighted in the main report.

Subsidy design: An explicit process for quantifying, prioritising and applying subsidies is proposed.

6. Recommendations related to institutions

Governance: The governance structure for wholesale and retail water supply advocated in the Water Service Act of 1997 is endorsed in this report as an appropriate model for the South African context.

Ring-fencing the wholesale WSP function: The wholesale function undertaken by WSPs should be ring-fenced and a separate cost-centre established.

Separation of wholesale supply-systems: Separate cost centres should be established for different wholesale supply-systems.

Institutional support for third tier water management: It is recommended that consideration be given to the establishment of a small specialised "retail support agency" whose task would be to assist with institutional reform and provide specialist technical, economic and financial services to third tier WSPs. Such an agency could facilitate greatly improved water resources management amongst retail WSPs in all areas in South Africa through a strategic approach and is an improvement on the sole reliance on Water Boards to fulfil this function.

Amendment of the tariff guidelines for WSP managers: The existing *guidelines* should be amended to take into account the recommendations from this research project.

Learning by example: More emphasis should be placed on institutional learning through the communication of successes and failures in water management at the retail level. Successful examples of water pricing reform such as that achieved by Durban Water and Waste should be actively promoted.

Informative billing: Informative billing should be more actively promoted in addition to other important improvements to customer support, namely language capability, more accessible payment points and improved communication with consumers.

7. Recommendations for further research

Performance benchmarks for wholesale WSPs: Best practise performance indicators and standards are needed to enable the comparison of wholesale WSPs and to encourage greater efficiencies in wholesale WSPs.

Restricted on-site access: The options for (and technical, institutional, financial and social implications of) providing an intermediate water supply option between off-site access and unrestricted on-site access should be *more fully* explored. The innovations in this area undertaken by Durban Water and Waste, and their preliminary experiences of using this technology, suggest that such an intermediate option has significant potential to fill an existing gap in the demand for water services.

Grey water disposal. The potential for creative intermediate solutions needs to be explored.

Water-use efficiencies and technology: There is scope for dramatic improvements in technical water-use efficiencies in all water using sectors in South Africa which will have significant social benefits. Public investment of funds into research and development in this area is therefore warranted.

Industrial water use efficiencies: Little work has been undertaken on industrial water use efficiencies and research into locally appropriate best practice standards for specific water use, specific effluent production and recycle ratios is needed. Available evidence suggests there is significant scope for improvement.

System efficiency. Further investigation should be undertaken into the implications of water management reform on overall system efficiency.

Focus on major industrial water users: A few industrial sectors use a very large share of total manufacturing water use. A specific focus on water use efficiencies and pricing in these sectors is therefore warranted.

Industrial effluent pricing policy: Research into effluent pricing policy is needed. The strong relationship between water intake and effluent production in manufacturing industries suggests that one consideration should be adding at least a portion of the effluent charge directly onto the price of water. An effective effluent pricing policy has the potential to reduce effluent volumes (and hence the costs of treatment), increase water recycling and reduce water consumption.

Location of new water using industry: The location decisions for new water using industry should be based on the costs of securing addition water supplies in the area and not on the existing average historic costs of water supply. This is particularly important where the marginal costs of extending supply capacity are high relative to historic costs. Practical and cost-effective methods of implementing such a policy need to be investigated.

Pricing in times of drought and plenty. This project has not addressed the question of pricing in times of drought and plenty in any detail. However, this issue was prominent in the Los Angeles case study. It is recommended that the Los Angeles pricing methodology be investigated further to ascertain its applicability to the South African context.

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1. Introduction

1.1 Project background and context

This project, whose full title is "Pricing water as an economic resource: implications for South Africa", was first proposed in early 1993. At that time it was one of a few known initiatives specifically on water pricing in South Africa. Subsequent to this, a large number of initiatives on or related to water pricing in South Africa have been initiated. The most significant of these projects are briefly described below.

In 1993, the WRC funded a general research project on the use of economic instruments in the water sector. The project was undertaken by Economic Project Evaluation and titled "*The Application of economics to water management in South Africa*". The final report was completed in 1996 (EPE, 1996) and its main outputs were as follows: (1) a broad discussion of issues and the possible use of economic tools, (2) a basic description of some economic tools, namely, cost-benefit analysis, water markets, transferable pollution permits, abstraction charges, effluent standards, and (3) an "ideal" pricing model for short-run water allocation in the context of demand exceeding capacity, using a market simulation.[1]

In 1995, the Department of Water Affairs and Forestry (DWAF) commenced a review of national water tariff policy. Early work resulted in a cabinet decision in February 1996 on interim policy and tariffs for government water schemes for the 1996/97 financial year.[2] A draft policy document was completed in April 1998 and used for public consultations.[3] The policy document was then transformed into a strategy document titled "*A pricing strategy for water use charges in terms of the National Water Act, 1998*" (DWAF, 1998). The water pricing strategy is for first tier water only, that is, the use of water from the water resource (all ground and surface water "extracted" from the environment and bulk raw water schemes managed by DWAF).[4] Although the strategy does not deal directly with second and third tier water, that is, treated water supplied in bulk (often by water boards) and then distributed to individual consumers (usually by a municipality), it nevertheless impacts on second and third tier water pricing. The first tier pricing strategy therefore has important implications for this project.

In parallel with the above initiative, DWAF undertook a review of the national water law. This process culminated in a White Paper ("*White paper on a national water policy for South Africa*", DWAF, 1997a) and the promulgation of the *National Water*

[1] The "ideal" model was not completed. As far as is known, this model has not been developed further and has never been used.

[2] The author participated (during 1996) in the Steering Committee set-up to oversee the project and contributed to the formulation of the social equity, financial sustainability, ecological sustainability and efficiency frameworks that inform the strategy.

[3] However, the policy document was never finalised and made publicly available.

[4] The pricing strategy also extends to indirect uses of water arising from reduced run-off through activities such as plantation farming and forestry.

Act of 1998 (RSA, 1998).[5] These specify the state's approach to water rights and set broad national policies and principles related to water management and pricing.

In 1997, DWAF promulgated the *Water Services Act* (RSA, 1997) which focused on the rights, duties and regulation of "water services institutions", that is, public and private institutions engaged in the distribution of treated water for industrial, commercial, institutional and domestic use.[6] The Water Services Act seeks to provide for flexible regulation, enforceable development plans and consensual contracting.

The *National Water Supply Regulations* were initiated by a group of major municipalities in about 1993 with the purpose of developing a uniform set of national water supply regulations to replace the existing disparate local authority bye-laws. The regulations set out the duties of local authorities as water service providers, regulate all aspects of the relationship between the local authority and the water consumer, define a water tariff structure for domestic use and set out the reporting requirements for annual water audits (NWSR, 1996). At the time of writing, the draft regulations could be adopted voluntarily by local authorities; the intention is that adoption of a core set of the regulations will become compulsory (Macleod, pers comm., 1998).

The 1998 *White Paper on Local Government* (DCD, 1998a) includes a section on tariff principles for municipal services but no detailed tariff regulations, guidelines or recommendations. At the time of writing, the Department of Constitutional Development was involved in an initiative examining the issues of tariff and subsidy targeting The initial draft report recommended the development of more specific national guidelines (DCD, 1998b).

Concurrent Water Research Commission projects that are related to water pricing include: "Economic model for urban network leakage management" (BKS Incorporated, 1998 – 1999), "Estimation of the residential price elasticities of demand for water by means of a contingent valuation approach" (Economic Project Evaluation, 1997 – 1999), "Improved management of assets in the water supply industry with regard to possible privatisation" (University of the Witwatersrand, Department of Civil Engineering, 1998 – 1999), "Model for water demand management planning and monitoring" (BKS Incorporated, 1998 – 1999), "Philosophy and methodology for the implementation of 'the polluter pays' principle in the context of receiving water quality objectives" (Stewart Scott Incorporated, 1997), "Pricing of water resources in South Africa, with specific reference to riparian surface water" (University of Natal, Department of Agricultural Economics, 1997 – 1998), "Review of industrial effluent tariff structures in South Africa and guidelines on the formulation of an equitable effluent tariff structure" (Kerdachi, Private consultant, 1997 – 1998), and "Tool for evaluating the effect of alternative funding options (with different risk profiles) on water tariffs" (Peter Ramsden, 1998 – 1999), "An Economic Analysis of Surface Irrigation Water Rights Transfers in Selected Areas of South Africa" (Department of Agricultural Economics, University of Natal, 1997 – 1998), "The development of a methodology to determine the value of water in the Berg River basin" (Department of Agricultural Economics, University of the Orange Free State, 1998 – 2000), "Development of a framework for the introduction

[5]The White Paper is referred to as the 1997 White Paper hereafter.

[6] Water used for the purposes of agriculture was specifically excluded

of waste discharge charges systems in South African catchments" (Stewart Scott Inc. and Development Planning and Research, 1998 – 1999), "Incorporation of economic considerations into quantification, allocation and management of the environmental water reserve" (Institute for Natural Resources, University of Natal, 1998 – 1999), "Modelling the value of water as an economic resource in selected catchment areas of South Africa: Great Fish and Sundays River (Department of Agricultural Economics, University of Natal) Great Letaba River (Economic Project Evaluation) and Vaal River (Greengrowth Strategies) (1998 – 2001), "Econometric and institutional economic analysis of water use in the Crocodile River catchment, Mpumalanga Province, South Africa" (Cambridge Centre for the Study of Institutions, 1997 – 1998).[7]

1.2 Project objectives

In the light of the unfolding project context given above, the steering committee agreed in 1997 to the following modifications to the original project objectives: (additions to original project objectives are underlined, deletions are struck out)

1. Review current international trends in water pricing theory and practice, with specific reference to the treatment of water as an economic resource.

2. ~~Propose~~ Assess and review pricing policy principles and goals for South Africa on the basis of the above review and the treatment of water as an economic resource.

3. Develop a pricing methodology to maximise the attainment of the ~~proposed~~ pricing policy principles and goals (of efficiency, equity and sustainability as reflected in the 1997 White Paper on Water Policy and developed during the national water tariff review process) for application in municipal areas.

4. Collate information necessary for assessing the efficacy of the proposed pricing methodology through a case study approach.

5. Assess the efficacy of the proposed pricing policy and methodology, with specific reference to:
   - The impact on the short- and long-term demand for water in the municipal and industrial ~~and agricultural~~ sectors.
   - The impact on the allocation of resources within the water sector (between water supply to ~~agriculture,~~ municipal, industrial and other sectors) and between economic sectors.
   - The impact on economic development in South Africa.
   - The impact on the provision and affordability of residential water to poor ~~urban~~ communities.
   - The impact on the environment.

6. Evaluate the applicability of the proposed pricing methodology within the context of increased private sector involvement in water supply.

[7] Information obtained from the WRC "current projects" data based as presented on the WRC web page (www.wrc.org.za) on 10 February 1999 and personal communication with Dr Gerhard Backeberg.

1.3 Scope and focus

At the second project meeting,[8] the steering committee concluded that the originally proposed scope of the research was too broad and that there was potential overlap with the national water tariff review being undertaken by the Department of Water Affairs and Forestry. As a result, the steering committee decided that the scope of the research should be narrowed to *focus on supply side pricing at the second and third tiers (wholesale and retail), specifically urban water tariffs.*

1.4 Research and policy making

Undertaking research whose purpose is to inform policy making (particularly in the current South African context) is much like the action of a cat trying to catch its own tail: the target is always moving. The policy context at the commencement of this research project was very different to the current context (which itself is changing rapidly). It is perhaps more helpful to view policy development in the new democratic South Africa as a two stage process. In the first stage, new policies were urgently needed to make a break from the status quo (that is, policies derived under the ideology of discrimination). Because of the urgency to fill the policy vacuum, the process was, of necessity, a "quick and dirty" one. In the second stage, these new policies are refined in the light of experience and more detailed and comprehensive research. It is hoped that the research undertaken in this project will make a contribution to the second stage of the policy making process, that is, the refinement and re-assessment of the 'new' policies in the water sector.

1.5 Audience

The intended audience of this report is *water policy makers and analysts* both within and outside of government, *water managers* (and their staff and consultants) in both public and private water services providers (WSPs) (including water boards and municipalities). The report is particularly targeted at those concerned with both the technical *and* political aspects of the determination of water tariffs specific to a supply area. Hence *democratic representatives* at the national, regional and local levels may also be interested in this report to the extent that they called upon to decide on tariff policy and/or to approve tariffs.

1.6 Terminology

This report is written in a way that is intended to be accessible to a lay audience even though it necessarily discusses many economic and technical concepts. (In contrast, the working papers are written predominantly for an expert audience.) Underlined words are explained in the glossary provided in Appendix 2.

In this report the terms *price* and *pricing* generally refer to *supply side* or administrative pricing. (There is a view that the terms *price* and *pricing* refer only to a negotiated price in a market.) The term's *price* and *tariff* are used synonymously in this report (as they are indeed in much of the economics literature).

[8] Held in mid-1996.

1.7 Outline

This report is structured in the following way: The *context* within which this research on water pricing in South Africa has taken place is described (contribution to Objective 4). A review of the *theory* of water pricing is presented (objective 1). The *practice* of urban water pricing is reviewed. (Objective 1.) The *principles and goals* governing the establishment of water pricing policy in South Africa are assessed and review (objective 2.) *Measurement methods* to assist in the development of a pricing methodology are reviewed. These measurement methods relate primarily to the determination of the efficiency of water use, the measurement of inequalities related to access to water and water use, and modelling financial sustainability (contribution to Objective 3). On the basis of the above, specific recommendations for the reform of South African *urban water pricing policy* are presented (contribution to Objective 3). A practical *methodology* for pricing urban water in South Africa in support of the proposed policy is proposed, including a set of practical tariff design guidelines. (objective 3). The implications of this pricing policy and methodology for South Africa are then assessed (objectives 4, 5 and 6). Finally, a summary of the project's *recommendations* is presented.

2. The South African context

Water pricing is affected by (and in turn influences) a wide range of factors. These factors include water availability, water use, water infrastructure (availability and costs), national water policies, institutional arrangements in the water sector, macro-economic linkages, the social context and the national financial framework.

The primary purposes of this section are twofold. First, to highlight the key contextual factors that must be taken into account in the development of a South Africa water wholesale and retail pricing policy. Second, to show how each of these contextual factors shapes the investigation and development of a South African specific water pricing policy.

The outline of this section is as follows: water resources, water use, water infrastructure, water policy, water institutions, macro-economic linkages, social context and financial framework.

2.1 Water resources

Water resource characteristics and availability will exert a strong influence on the development of a water pricing policy in any particular context. Where renewable water resources are abundant (and where water quality is both good and not threatened) there is likely to be little need for a pricing policy. On the other hand, where water resources are limited and there are competing demands for the limited resource, water pricing is much more likely to play an important role in ensuring the sustainable management of the resource and in assisting to increase (or maximise) the benefits derived from water use.

2.1.1 Water resource characteristics

South Africa's water resources may be characterised as follows: (1) South Africa is a water scarce country;[9] (2) water resources are not spread evenly across the country;[10] (3) South Africa suffers from hydrological extremes;[11] (4) areas of mineral wealth and economic development are not coincident with run-off;[12] (5) groundwater is not abundant;[13] (6) in several river catchments the water requirements far exceed the natural availability of water,[14] (7) overall, the available water resources are insufficient to meet projected demands at current usage and price levels within the next 30 years

[9] Average annual rainfall is less than 500 mm per annum whereas the world average is approximately 860 mm per annum (DWAF, 1986). "Located largely in a semi-arid part of the world, South Africa's water resources are, in global terms, scarce and extremely limited in extent" (DWAF, 1997b: 7).

[10] Much of the country may be classified as semi-arid with only 9% of the erratic rainfall reaching the rivers. A major share of South Africa's run-off originates in the eastern portion of the country (DWAF, 1986). More than 60% of the river flow arises from 20% of the land area (DWAF, 1997b: 8).

[11] Both severe and prolonged droughts as well as floods occur periodically. "[The] variation in annual rainfall is especially pronounced in the more arid areas where unpredictable droughts of extended duration often compound the hardships of water scarcity" (DWAF, 1997b: 8).

[12] DWAF (1997b: 9).

[13] DWAF (1997b: 8).

[14] DWAF (1997b: 9).

or so;[15] and (7) water development costs have been rising in real terms in recent years.[16]

2.1.2 Water resource availability

The most recent and reliable data on water resource availability and use in South Africa is presented in DWAF (1997b). More comprehensive, but older estimates, are given in DWAF (1986).

Total surface water run-off is estimated to be 50 150 million m^3 per annum.[17] Of this 20 350 million m^3 (41%) was already utilised in 1996. A further 13 250 million m^3 (26%) could be available for future use. The remaining 33% is not usable from a practical and economic perspective (DWAF, 1997b: 51).

International experience indicates that countries with renewable freshwater resources below 1 000 m^3 per capita per year are "*likely to experience chronic water scarcity on a scale sufficient to impede development and harm human health*" (WRI, 1996). Assuming a total population figure of 41 million people in 1996 (CSS, 1998), the total per capita availability of annual renewable fresh water was 1 220 m^3. Current estimates of population growth imply that the country's per capita water resources will dip below the 1 000 m^3 benchmark within the next 10 years (PDG, 1997).[18]

The poverty of South Africa's annual renewable fresh water resources compared to some neighbouring countries, the United States and Israel is illustrated in Figure 1 (data from World Bank, 1995).

[15] "Now looming is the full utilisation of the overall conventional water resources of the country in about 30 years should the efficiencies of water utilisation by the different users not be dramatically improved and should the current growth trends in primary and urban (domestic and industrial) water requirements, mainly as a result of population growth, continue to apply" (DWAF, 1997b: 65).

[16] See Section 0.

[17] This data includes Lesotho and Swaziland. Davies and Day estimate a total (surface and ground) water resource availability in South Africa (only) of 61 000 million m^3 per annum (1998: 7).

[18] The PDG (1997) calculation is based in CDE (1995) population estimates and FAO (1996) water resource estimates. CDE (1995:10) projects South Africa's population at 45.4 million in 2000 and 54.1 million in 2011. FAO (1996) reports total renewable freshwater resources in South Africa as 50 000 million m^3 per annum.

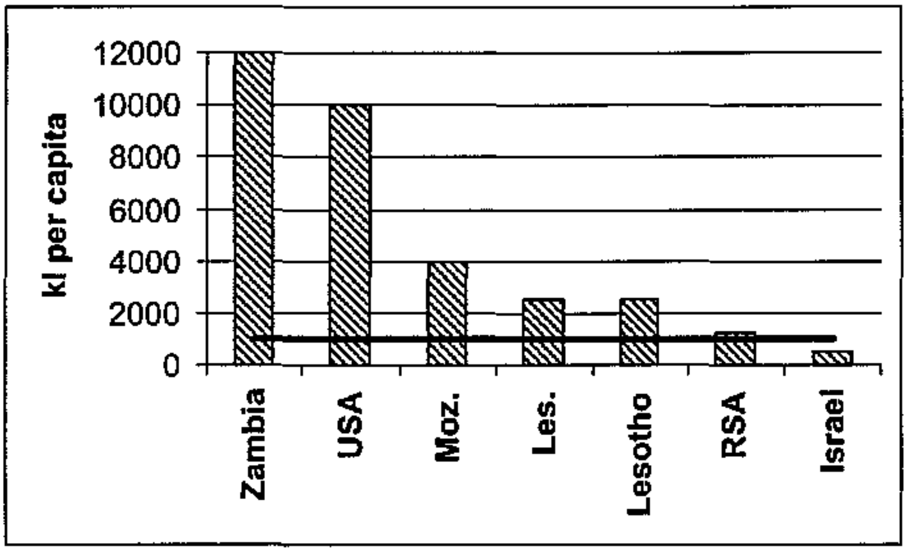


Figure 1: Annual renewable fresh water resources - country comparison

From the above data, it is clear that *the pressure on South Africa's limited water resources is both significant and increasing.*

2.1.3 The implications of resource scarcity for pricing policy

Water pricing can be used to assist in the allocation of water between different uses and users, affect water usage patterns, encourage the more *efficient*[19] use of water, discourage the wasteful use of water, and promote the sustainability of the water resource. Therefore, water pricing policy is likely to be a very important element of an overall strategy seeking to manage the water resource in an equitable, efficient and environmentally sustainable manner.

2.2 Water use

Any pricing policy must start with an understanding of the existing pattern of use and demand. Some key questions need to be answered: How is water allocated between users and is it fair? For what purposes is water being used and how efficient is the water use in achieving these purposes? What are the environmental impacts of existing water use and how are these being mitigated? What role can pricing play in influencing water use?

2.2.1 Inter-sectoral allocation of water use

Estimates of overall water use in South Africa are presented in DWAF (1986 and 1997b) and summarised in Table 1.

[19] The definition of the term "efficient" is discussed in detail in Section 3.3.

Table 1: Water use estimates for South Africa

	1980	1990	1996	2000	2010	2030
Urban and domestic	1 500	2 280	2 170	3 220	4 480	6 940
Mining and industrial	1 780	2 400	1 600	3 400	4 510	3 380
Irrigation and afforestation	10 100	11 410	12 340	12 860	13 940	15 870
Environmental	2 950	2 950	3 930	2 950	2 960	4 230
Total	**16 300**	**19 050**	**20 050**	**22 440**	**25 890**	**30 420**

Note: Estimates for the years 1980, 1990, 2000 and 2010 from DWAF(1986), and for the years 1996 and 2030 from DWAF (1997b). The 1996 and 2030 estimates include Lesotho and Swaziland.

A time-series for each of the two separate data sources (DWAF, 1986 and 1997b) is calculated from the implied annual compound growth rates and presented in Figure 2 and Figure 3, where agricultural water use represents irrigation and afforestation, urban includes domestic, and industrial includes mining and power. (The 86 and 97 in the legend to each figure refer to the data sources, namely, DWAF, 1986 and DWAF, 1997b.)

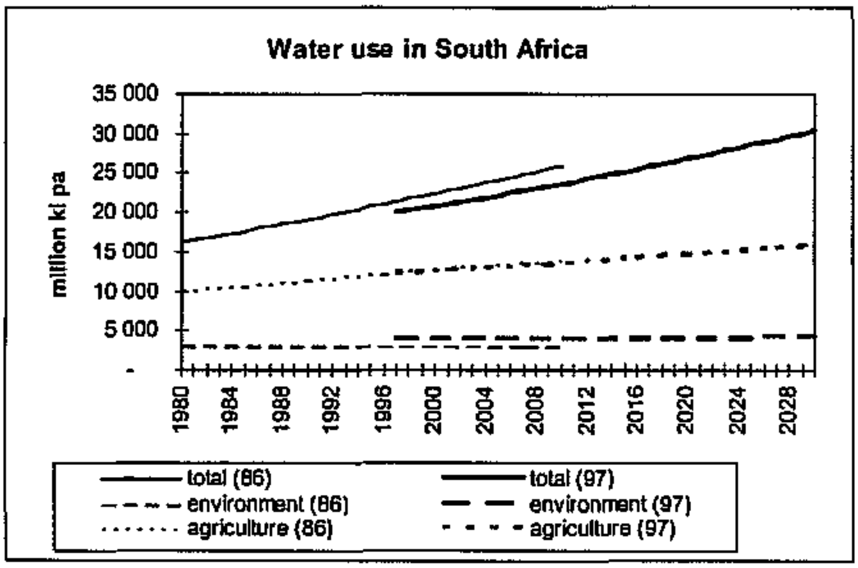


Figure 2: Water use in South Africa

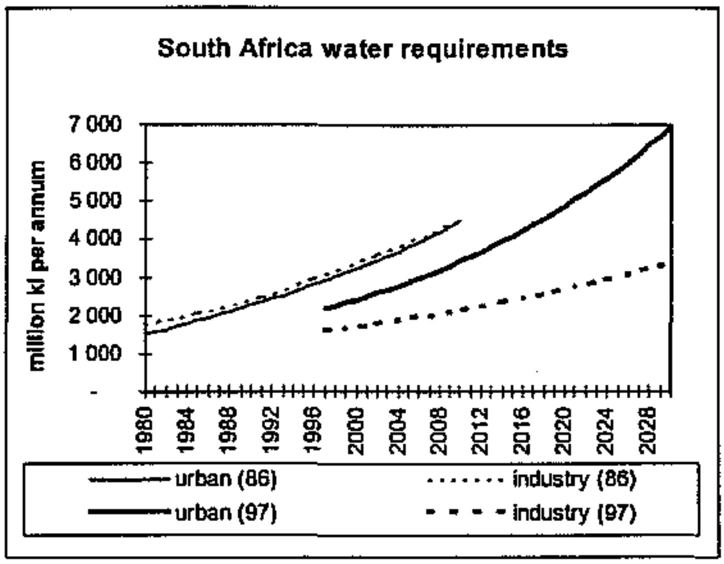


Figure 3: Urban and industrial water use in South Africa

The implied growth rates are shown in Table 2.

Table 2: Water use growth rates (% per annum)

	80-90	90-00	00-10	97-30
Urban and domestic	4.2	3.5	3.4	3.6
Mining and industrial	3.1	3.5	2.9	2.3
Irrigation and afforestation	1.3	1.2	0.8	0.8
Environmental	0.0	0.0	0.0	0.2
Total	1.6	1.7	1.4	1.3

Sources: DWAF (1986) for the years 1980 to 1990, 1990 to 2000 and 2000 to 2010, and DWAF (1997b) for the years 1997 to 2030.

The following points concerning the above data are of note:

Over-estimation of urban and industrial growth. It appears that urban and industrial growth (including domestic, mining and power) were significantly over-estimated in DWAF (1986). Nevertheless, high annual growth rates (3.6%) continue to be used for future forecasts.

Source of new growth. Most new demand for water is expected to originate from the municipal (urban and domestic) and industrial (including mining and power) sectors.

Under-estimation of environmental requirements. The amount of water needed by the environment appears to have been significantly underestimated in DWAF (1986). Environmental water resource requirements are still uncertain and may need to be revised in the future, leading to a potential further increase in environmental water use requirements.

Increase in agricultural water use. The recent estimates still postulate an increase in overall water use in agriculture and afforestation (DWAF, 1997b). In view of the increasing pressure on the national water resource, it is unlikely that agricultural water use will grow (at least not significantly) and it may even decrease.

Explanation of growth projections. The reasoning behind the water use projections is not well-documented. In general it appears that the potential impact of price changes and improvements in water use efficiency are *not* taken into account in the projections, that is, they represent a "business as usual" scenario.

2.2.2 Urban water use

2.2.2.1 Major urban areas

A reasonably comprehensive survey of municipal water use was undertaken in 1993 (PDG, 1994c). Some of the key results of this study are presented here largely for illustrative purposes. Total water use for each of the major urban areas in South Africa was estimated for 1991/2 and the year 2000. The estimates are presented in Table 3. Although the specific data are now out of date,[20] two points are note. First, there is considerable uncertainty inherent in the water use estimates which were sourced primarily from Water Boards and major municipalities. Second, water use in the Rand Water supply area dominates urban water use in South Africa.

Table 3: Urban water use projections

Major urban Area	Population in 1990[1]	Total use 1991/2	Predicted Growth	Total use 2000[2]
		Ml/day	% pa	Ml/day
Rand Water supply area	7 700 000	2 032	3.5 - 8.0[3]	2 800 - 4 000[4]
Durban / Pietermaritzburg	3 577 000	670	2.6 - 3.2[5]	840 - 890
Cape Town	2 560 000	710	3.4 - 4.4[6]	960 - 1050
Port Elizabeth	984 000	160	2.6 - 3.0[7]	200 - 210
East London / Mdantsane	451 000	78	2.6 - 3.0[8]	98 - 102
Bloemfontein	602 000	102	3.6 - 4.0[9]	145 - 180[10]
OFS Goldfields	467 000	79	3.0 - 3.5[11]	103 - 108
Total	16 341 000	3 830	3.3 - 6.1[12]	5 150 - 6 540

Notes: 1. Population figures for supply area based on Urban Foundation demographic model (UF, 1991) and water use figures from annual reports. 2. Annual growth applied to actual 1991/92 use, that is, over a 9 year span. 3. Based on least and most severe maximum 7 day demand scenario projections of the Rand Water Board, applied to average daily demand. 4. This data very approximate. Use excludes mining. 5. Based on Umgeni Water Plan 2025. These estimates are in the process of being revised. 6. Based on Spies and Barriage, 1991. 7. Port Elizabeth Municipality estimates. 8. Assumed to be the same as for Port Elizabeth. 9. From Bloemarea, 1992. They estimated 3.8% ± 5%. 10. The 3.8% growth was applied to actual 1991 usage (102 Ml/d) and Ninham Shand's estimated 1991 usage (126 Ml/d) respectively. 11. From Goldfields Water Board. Forecasts exclude mining use which is predicted to decline by -1.9% pa over the period 1993 to 2002. 12. Derived from above figures (weighted average growth). Source: PDG (1994c)

The breakdown in water use between domestic and other uses within urban areas and average per capita water use is shown for the major metropolitan areas in Table 4. The importance of domestic consumption with respect to total consumption is readily apparent.

[20] The population data is particularly suspect. The 1996 Census data was not available at the time of the preparation of this report.

Table 4: Urban water use (Major urban areas)

Metropolitan area	Domestic Consumption	Domestic consumption [9]	Total urban consumption [1]
	% of total urban	lcd	lcd
Gauteng	73 [2]	193	264
Durban / Pietermaritzburg	70 [3]	131	187
Cape Town	70 [4]	194	277
Port Elizabeth	60 [5]	98	163
East London / Mdantsane	60 [6]	100	166
Bloemfontein	68 [7]	115	169
OFS Goldfields	68 [8]	115	169
Total	71	166[10]	233

Notes: 1. Based on data from previous table. 2. RWB gives consumption breakdown as 1477 (73%) residential and 555 (27%) industrial. 3. No figures obtained. Assumed to be the same as for Cape Town. 4. Based on estimates and calculations set out in "Bulk water supply to the Cape Town metropolitan area - an overview", written as part of this project. 5. Source: Ninham Shand, Cape Town. Estimate for the PEM municipal area. This was assumed to be representative of whole metropolitan area. 6. No figures obtained. Assumed to be the same as for Port Elizabeth. 7. Based on estimates and calculations done in "Domestic water supply in Region C - an overview". 8. Assumed to be the same as for Bloemfontein. Note that total use figure excludes water supplied to the mines. 9. Consumption figures exclude losses. 10. Weighted average. Source: PDG (1994c).

2.2.2.2 Urban domestic use - an international comparison

It is instructive to compare per capita urban domestic water use in South Africa with that in other countries. An illustrative comparison is presented in Figure 4 (using data from Table 4 and Working Paper 2).

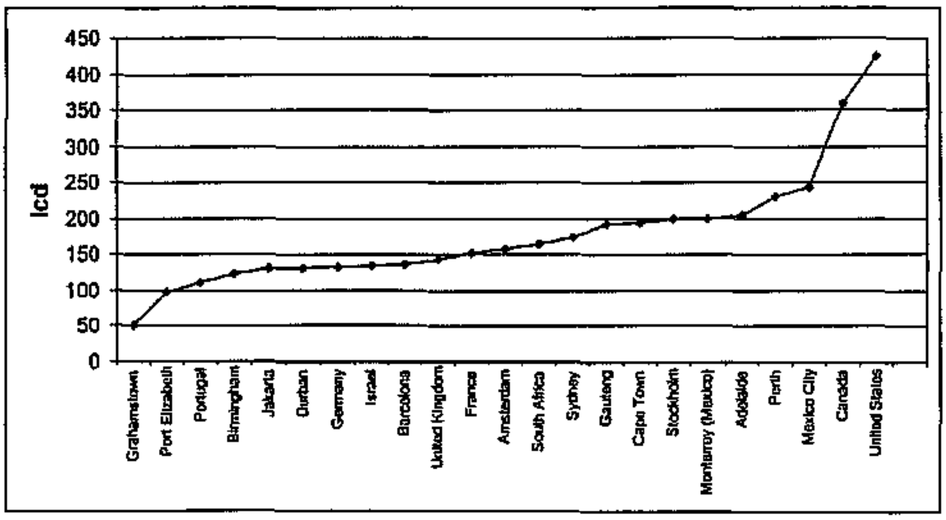


Figure 4: Urban domestic consumption – an international comparison

The typical range of per capita domestic use is from 120 to 200 lcd. It is noteworthy that domestic water use in wealthy developed countries is not necessarily high. This is probably due to a combination of the high urban residential densities and temperate climate experienced in typical European cities. The high per capita water consumption in Canada and the USA stands out as an exception; the high water use in Mexico City is surprising, but this is largely due to poor management and a high degree of water losses (see Working Paper 2). Interestingly, in some of South Africa's major urban areas, for example, in Cape Town and Gauteng, *average* per capita consumption does not compare unfavourably with domestic consumption in developed countries. However, in other urban areas in South Africa, for example, in Grahamstown, average domestic consumption is very low.

2.2.2.3 Domestic consumption distribution

Although *average* domestic water consumption is not unduly low in the major urban areas of South Africa, water consumption *within* the urban areas of South Africa is highly unevenly distributed. In particular, the distribution of water consumption between previously defined and designated "white" and "black" areas is highly skewed. For the purposes of illustration, two examples are given below. The first, shown in Figure 5, is taken from a survey of 98 local authorities (PDG, 1994c).[21] The very wide discrepancy in consumption between black and white households is clearly depicted.

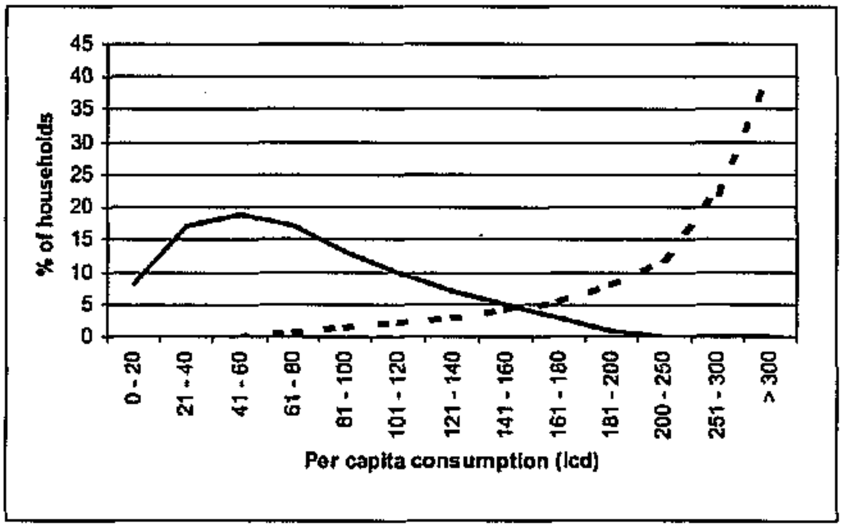


Figure 5: Consumption distribution for previous black and white local authorities

The second example, shown in Figure 6, comes from the Grahamstown case study (Working Paper 5). The pattern is similar, though the overall level of consumption in Grahamstown is lower than that for the major urban areas in South Africa (see Figure 4).

[21] The data has been smoothed.

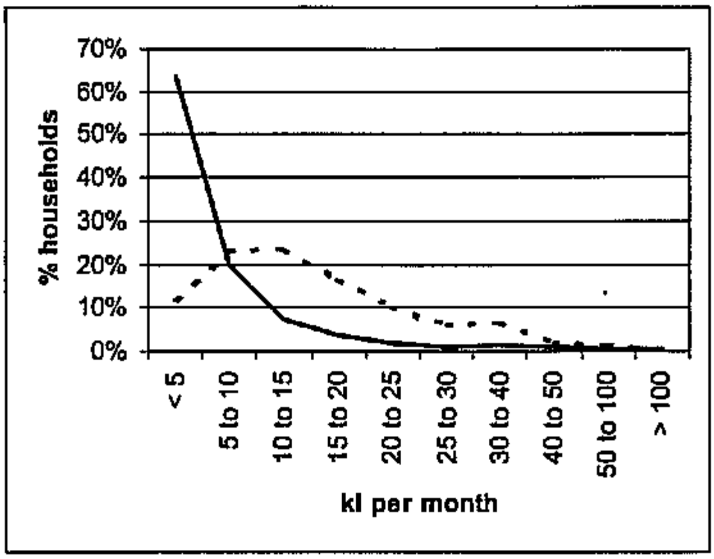


Figure 6: Consumption distribution in "black" and "white" Grahamstown

2.2.2.4 The composition of municipal consumption

For the purposes of illustration, the composition of water consumption in Cape Town in 1991 was as follows: household : 61%, industry: 15%, commerce: 7%, leaks: 7% and other: 10% (Davies and Day, 1998: 8). The exact composition may vary between years, though differences are unlikely to be significant. However, the composition of consumption will vary between municipalities depending on a range of factors (for example, climate, household incomes, the extent of infrastructure development, extent of commercial and industrial activity and tariffs).

Data on the distribution of water use within homes is not widely available. A study of (predominantly "white") homes in Cape Town undertaken in 1991 showed a distribution of consumption as follows: garden: 35%, toilet: 29%, bath: 20%, laundry: 20% and cooking 3%. It should be noted that this data is for a winter rainfall area and is therefore not representative of South Africa. In addition, the pattern of household water use varies widely between households, particularly between wealthy and poor households.

2.2.2.5 Unaccounted-for water

A survey of water use in urban areas in South Africa showed that there is considerable scope for improvement in water management which would lead to reduced water losses and unaccounted-for water (PDG, 1994c). The survey results are shown in Figure 7. Unaccounted-for water of more than 15% may be considered to be poor and less than 10% good. Hence the arrows in the figure indicate the potential scope for improvement unaccounted-for water.

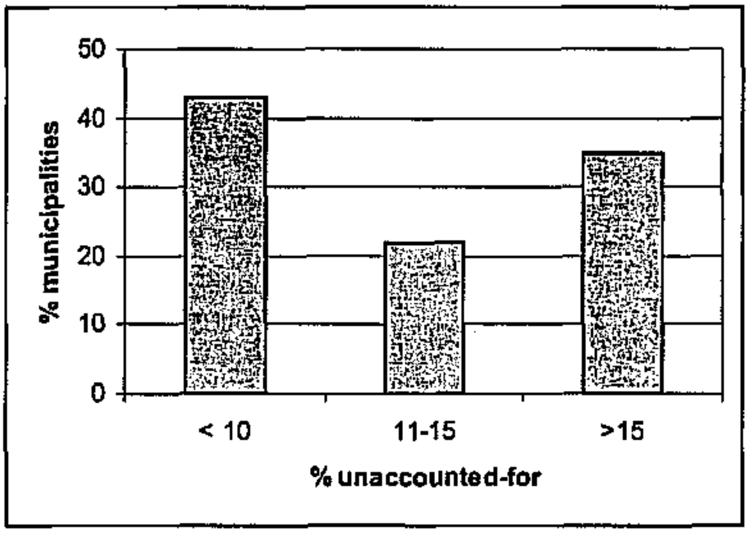


Figure 7: Unaccounted-for water in South African municipalities

2.2.3 Water use and contribution to GDP

One measure of the productivity of water is the sector contribution to GDP per unit of water consumed. Various estimates are summarised below.

Table 5: Relationship between water use and economic activity

	Water withdrawn	Value added [22]	Value added per kl	Demand per Rand value added
	million m³ pa	R million (1990)	R/kl	kl/R
Agriculture	9 580	13 055	1.4	0.73
Industry	1 448	106 514	73.6	0.01
Source: PDG (1997)				

As expected, non-agricultural productive uses of water add much more economic value compared to agricultural water use, both in gross terms and per unit of water consumed. The magnitude of this difference is striking: industry reaped more than 50 times the output than agriculture did for a given quantity of water. However, inter-sectoral linkages, in particular the dependence of the manufacturing sector on the agricultural sector, and the contribution of the agricultural sector to job creation, need to be taken into account. Foster (1995) provided the following breakdown of industrial water use:

[22] Output figures are from CSS (1994).

Table 6: Relationship between water use and economic activity

Sector	Water withdrawn [23]	Value added [24]	Value added per kl	Demand per Rand value added
	million m³ pa	R million (1990)	R/kl	l/R
Mining[25]	2 300	27 000	12	80
Manufacturing	273	76 000	278	4
Electricity	226	12 000	53	19
National	16 000	327 000	20	49

Source: Foster (1995) based on 1992/3 estimates.

Manufacturing shows a very high "value added" per unit of water consumed compared to mining and power generation.

Within the manufacturing sector, there are also large differences in GDP value added per kl of water consumed, ranging from just less than R10 per kl to more than R10 000 per kl. There is a strikingly direct and inverse relationship between GDP value added per kl of water consumed and total water consumed per manufacturing sub-sector, as depicted in Figure 8.

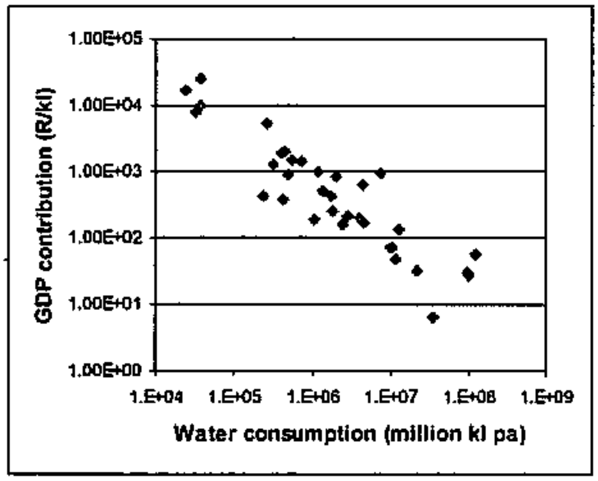


Figure 8: GDP contribution versus water consumption by manufacturing sub-sector

2.2.4 Water for power generation - the role of technology

Power generation is a significant water using sector in South Africa. The choice of technology in power generation (water versus dry cooling) plays an important role in water use. Eskom has managed to reduced water consumption per unit of electricity generated (by coal fired power stations) by more 41% in the 10 years from 1987 to 1996. The decline in both the total water use and specific water use is shown in

[23] There is a very large discrepancy between the DWAF (1986) estimates for industrial and mining water use and those provided by Forster (1995) given above. The reason for this is not clear.

[24] Output figures are from CSS (1994); population from World Bank (1994).

[25] Foster (1995) noted that the mining estimates were guesses (see below).

Figure 9.

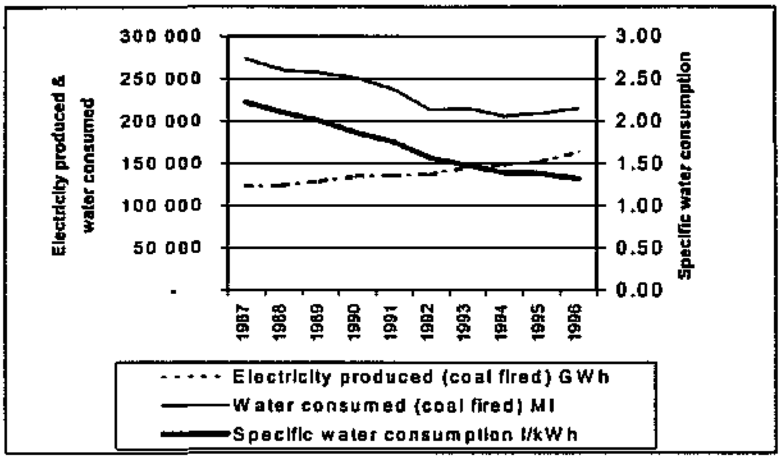


Figure 9: Water use for electricity generation

2.2.5 Manufacturing

Manufacturing as a whole contributes approximately 22% of the total GDP while consuming approximately 5 to 8% of the total annual renewable water resource. Foster (1995) analysed 34 "water using" sub-sectors which contributed 60% of manufacturing GDP. Some of the findings of the analysis are summarised in Figure 10. (The legend refers to large water using sub-sectors, that is, more than 50 million kl pa per sub-sector, moderate water using sub-sectors, that is, between 5 and 50 million kl pa per sub-sector, and small water using sub-sectors, that is, less that 5 million kl pa per sub-sector.) All 34 sectors used a total of 463 million kl per annum, however just three sub-sectors (petrol and oil refining, pulp and paper and basic chemicals) used 70% of the water (324 million kl pa) while contributing only 30% of the combined GDP of the 34 sectors. A further eight sub-sectors used 112 million kl pa. The remaining 23 sub-sectors used just 6% of the total water use amongst the 34 subs-sectors.

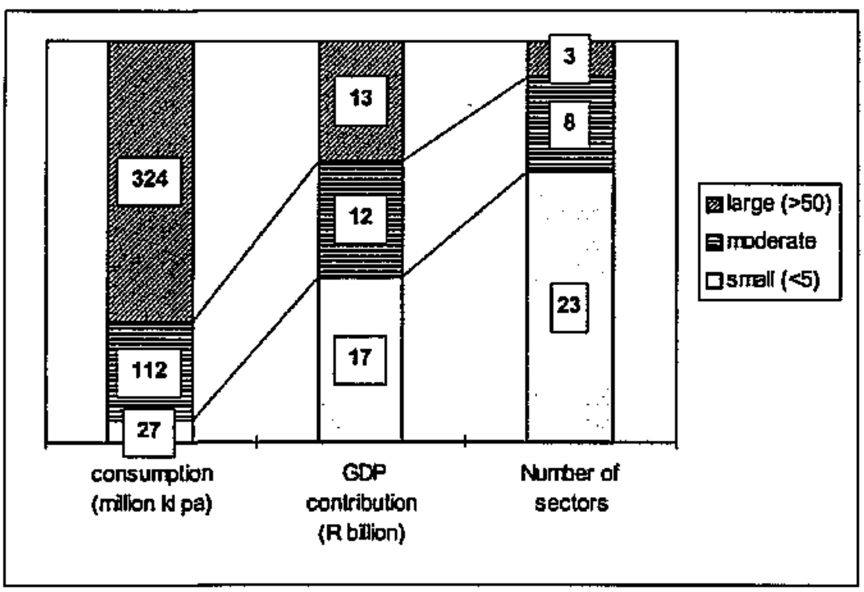


Figure 10: Water use in 34 manufacturing sub-sectors

The available data showed a very direct relationship between water consumption and effluent production.

2.2.6 The implications of existing water use patterns for pricing policy

The following key points arise from the above description of existing water use patterns in South Africa:

- **Inter-sector allocation.** Agriculture is a large user of water, yet the value added to the economy per unit of water consumed is significantly lower than industrial water use. There is considerable scope for the improvement of water-use efficiencies within agriculture. There is also scope for the reallocation of water from low value crops to high value crops. This will increase the overall benefit derived per unit of water consumed in the agricultural sector. The reallocation of water from the agricultural sector to the industrial sector could potentially increase the overall benefit derived for per unit of water consumed in South Africa. *However the forward and backward linkages between agriculture and industry need to be factored into the calculation of the net benefit of such a transfer.* The pricing of irrigation water (as well as other water used for agricultural and forestry purposes) is likely to encourage the more efficient use of water in each sector and facilitate the transfer of water from lower value to higher value uses within and between sectors.

- **Sources of new demand.** The growth in overall water use in South Africa is likely to arise predominantly from two sources: domestic and industrial/commercial demand. The causal factors underlying this growth are threefold: population growth, improvement in access to water supply infrastructure (making up the backlog in infrastructure that arose during apartheid), and economic growth. There are three implications for pricing policy. First, improving access to domestic water supply is a political priority (see below) and hence pricing should not discourage access to water and the consumption of a basic amount. Second, it is particularly important that the additional water demanded be used wisely, beneficially and efficiently. Hence, pricing in the domestic and industrial/commercial sectors (in particular) should promote these goals.

- **Uncertainty inherent in demand forecasts.** There is a high degree of uncertainty inherent in water demand forecasts. Water demand is a function of a large number of variables, some of which have large random elements (for example, rainfall). Although there is evidence that water demand does respond to changes in price, there is a high degree of uncertainty attached to any specific estimates of just how responsive demand is to price changes in a particular context (see Working Paper 4). This has implications for both water pricing and water demand forecasting methodologies. These are elaborated upon in Section 5.

- **Metropolitan areas dominate urban demand.** The major metropolitan urban areas dominate urban water use in South Africa. Therefore, from the point of view of overall water management, it is most important that water pricing and water management issues in the metropolitan areas receive priority attention.

- **Domestic use dominates urban consumption.** Domestic water use accounts for the largest share of urban water use in South Africa (typically between 40% and 70% of total urban water use in any city or town). A particular focus on domestic water pricing is therefore justified. This is not to say that pricing issues related to other municipal uses is not important. Commercial and industrial use can account for up to 40% of urban water use and institutional consumption can be significant. Hence the pricing of non-domestic water use is also important.

- **Establishing a norm for domestic consumption**. Comparative analysis of international experience suggests that an average domestic consumption of between 100 and 200 lcd is sufficient to maintain a high standard of living (see Working Paper 2). Such an *average* level of consumption is already attained in South Africa's major urban areas. However, domestic consumption in South Africa is highly skewed with a minority consuming much higher quantities of water (often in excess of 300 lcd) and a majority consuming less than 100 lcd (with many consuming less than 50 lcd). This suggests that it may be appropriate for pricing policy to seek to achieve the dual goals of encouraging consumption where this is less than 50 lcd and discouraging consumption where this is in excess of 200 lcd.

- **There is scope to reduce unaccounted-for water**. Although the standard of water management in South Africa's urban areas compares favourably with most developing countries (see Working Paper 2), there is definitely scope for improvement. Pricing policies should seek to help create the right institutional incentives to reduce unaccounted-for water and system leakage.

- **Investments and innovation to improve technical water-use efficiency**. The recent history of water consumption within the electricity industry in South Africa provides a dramatic example of the potential role of investments and innovation in water-wise technologies to improve technical efficiency and reduced water use. Higher water prices are likely to promote such investments and innovation. However, on their own they may be inadequate or insufficient. Scope for dramatic improvements in technical efficiency is not restricted to the energy sector, but also includes the manufacturing and domestic water use sectors. See, for example, Rocky Mountain Institute (1993, 1994ab).

- **Focus on petroleum, chemicals, and pulp and paper sectors**. These three sectors use a major share of total water use within the manufacturing sector. A specific focus on water pricing and incentives to promote technical efficiencies in these sectors appears to be justified.

- **Effluent policy**. The direct relationship between water consumption and effluent production highlights the complementarity of water and effluent pricing policies.

2.3 Water infrastructure

Domestic water use is strongly related to access to water services. In South Africa, access to domestic water services is highly unequal and is a significant factor constraining water demand. On the other hand, access to water by commercial and industrial enterprises is generally good. The costs of service provision depend on both the level of service provided and on water demand. However, water demand itself is also a function of the level of service provided and the price of water. The total investment requirement to make up the services backlog and to provide for new services is significant, though its absolute magnitude is uncertain, depending on many factors. The cost of new water resource development is increasing rapidly. These main points are expanded upon below and the implications for pricing policy elucidated.

2.3.1 Household access to water services

The Municipal Infrastructure Investment Framework (MIIF) summarises the situation with respect to municipal services in South Africa as follows: "(1) Under apartheid South Africa's cities, towns and rural areas were divided into vastly unequal confines - one well-endowed with municipal services, management capacity and the economic development necessary to pay for the services; and the other under-resourced, poorly located and suffering from deliberate restraints on economic development. (2) This inequality has, in many cases, led to basic needs not being met, created extensive hardships for those living in deprived areas, and often resulted in health problems. (3) The inefficiencies of the apartheid spatial form have also slowed economic development. At the level of the household, this is because being forced to live in poorly serviced areas has stifled productivity and reduced business opportunities. At a national level, the inefficiencies created by the apartheid spatial form have, inter alia, added to the cost of installing services, intensified the need for service subsidies and increased the cost of producing goods and services" (DCD, 1997).

The level of water service provided significantly influences water consumption. Service levels by settlement type were estimated for MIIF and are summarised below (DCD, 1997).

Settlement typology. MIIF used a settlement typology based principally on differences in institutional capacity and population density.[26] The typology distinguishes between urban core, urban fringe, dense settlements, villages, scattered settlements and farms.[27] The dividing line between urban and rural was assumed to be an institutional one in which urban areas are defined as within local council or metropolitan council boundaries.

MIIF estimated the distribution of population by settlement type as follows:[28]

[26] The typology was also based on "proximity to bulk infrastructure, cost of installing services, economic base, household income levels, what can and cannot be afforded; and what this means for service levels." (DCD, 1997: 2).

[27] The settlement types were defined in the MIIF document as follows: "(1) **urban core** refers to the formal city and town, including the former white local authorities and the old townships. A key characteristic of the core is the relatively high levels of economic activity. This, in turn, leads to higher land values and, typically, higher settlement densities, generally over 10 dwelling units per hectare; **urban fringe** is the term applied to various settlement conditions which exist within the boundaries of local councils but outside the urban core. This includes low-income settlements on the outer edge of towns and cities, which are incorporated into the new local councils (LCs), and tend to display middle order densities and large service backlogs. However, it also includes low-density high-income settlements. From a service point of view settlements in the urban fringe are more expensive to service, for an equivalent level of service, not only because they have lower densities, but also because they are further away from connector infrastructure. Examples include the settlements around the perimeter of King William's Town, Nelspruit, and Phalaborwa and the separate LCs of Winterveld and Botshabelo; (3) **dense settlements** refer to larger "rural" settlements (populations > 5 000) which may have formal layouts, as well as less formal, "traditional" settlements. They may be rather more "dense" than other rural settlements, but it is size which is their key characteristic. From a service cost point of view they would typically be more expensive to service than urban areas. Many of the settlements in Bushbuckridge are examples of dense settlements; (4) the term rural **villages** is used to represent smaller settlements (smaller than 5 000 but larger than 500 people). These are often unplanned traditional settlements, but resettlement areas are included. Densities are generally low, typically less than 5 dwelling units per hectare; (5) the dividing line between villages and **scattered settlements** is taken at a population of about 500. This has some logic with regard to services as there are indications that costs typically rise steeply where there are fewer than 100 units to be serviced. Scattered settlements include people living on communal land as well as farmers and farmworkers living on privately owned farms" (DCD, 1997: 3).

[28] The results of the 1996 Census were not available in time for incorporation into this report.

Table 7: Household distribution by settlement type

	Urban core	Urban fringe	Dense rural	Villages	Scattered settlements	Farms	Total
1995 (million)	4.32	0.80	1.06	1.94	0.17	0.61	8.90
1995 (%)	49	9	12	22	2	7	100
growth rate (% pa)	3.5	1.4	1.4	1.2	0.5	0.0	2.2
2005 (million)	6.10	0.92	1.08	2.18	0.18	0.61	11.07
2005 (%)	55	8	10	20	2	5	100

Source: DCD (1997)

Definition of service levels. MIIF used the following definitions of service level: (1) non-reticulated source: well, borehole, spring or river; (2) communal standpipe; (3) yard tank; (4) yard tap (metered) and (5) house connection (metered).[29]

The 1994 White Paper defined a basic water supply as the consumption of a minimum of 25 lcd, with access to the water supply within 200m of each household, a minimum flow at the source of 10 litres per minute, availability on a regular daily basis, 98% assurance of supply, effective operation and maintenance of the system, and safe to drink (DWAF, 1994: 15). However, in Working Paper 2 it was shown that it is highly desirable that households consume at least 50 lcd and therefore that national pricing policy should encourage the consumption of at least 50 lcd.[30] The definition of basic supply provided in the 1994 White Paper (that is, 25 lcd) should therefore be regarded as *a minimum*. To the extent that it is financial feasible, policy should aim to encourage water use of at least 50 lcd.

Service levels by settlement type. The MIIF estimated the distribution of service levels by service type as follows:[31]

[29] MIIF had the following to say about the definition of service levels: "(1) The term 'service level' relates to the way the service is experienced by its user: the more convenient to the user, the higher the level of service. For example, water provided in-house is more convenient than when provided by means of a yard tap, since the latter entails carrying water into the house for use. A yard tap is in turn more convenient to use than a communal standpipe. (2) Levels of service have an influence on the amounts of water consumed. Lower levels tend to constrain consumption: the need to carry water reduces the amount used. (3) The 'level' is different to the 'standard' of a service. The standard refers to the technical quality of the service concerned: the way that it is designed, built, operated and maintained" (DCD, 1997: 5).

[30] For example, it has been suggested and proposed that the *minimum* water requirement to sustain a healthy domestic environment is 50 lcd (World Bank, 1992; Gleick, 1997).

[31] MIIF notes that "there is a fair degree of uncertainty regarding current service levels in urban areas, and a great deal of uncertainty in rural areas where the lack of good information is of concern" (DCD, 1997: 7). A number of alternative estimates of service levels exist. For example, the Department of Water Affairs and Forestry estimate that between 12 and 14 million people lack adequate water supplies and over 20 million have inadequate sanitation services (DWAF, 1997a). An earlier survey of urban areas indicated that some 5 million people lack access to adequate water supplies which represents about 18% of the total urban population (PDG, 1994a). A discussion and comparison of the various estimates is given by Goldblatt (1997).

Table 8: Existing service levels by settlement type (1996, %)

	Urban core	Urban fringe	Dense rural	Villages	Scattered settlements	Farms
House connection	74	12	8	3	0	6
Yard connection	8	13	11	7	4	19
Communal standpipe	13	31	29	9	9	44
Inadequate	5	44	53	80	87	32

Source: DCD (1997). Note: Percentages refer to % of households.

The number of households without adequate services by settlement type is summarised in Table 9.

Table 9: Backlog in water services

Settlement type	Households without adequate water supplies	
	number	*% distribution*
Urban core	210 000	7
Urban fringe	350 000	12
Dense rural	560 000	19
Villages	1 550 000	51
Scattered settlements	150 000	5
Farms	200 000	7
Total	3 020 000	100 [1]

Note: 1: Numbers do not add to 100 due to rounding.

Thus only 19% of the households without adequate water supplies in South Africa reside in urban areas (the urban core and the urban fringe) whereas 81% reside in rural areas. More than 50% of the households without adequate water supplies in South Africa reside in rural villages.

2.3.2 Industrial and commercial access to water services

Access to water services by industrial and commercial enterprises in South Africa is generally good. In many cases water infrastructure was specifically developed where mines and the associated economic activities surrounding the mines were established, with residential access to water benefiting from this development. However, water infrastructure in the poorer areas in South Africa may be either undeveloped or poorly maintained with the result that commercial or industrial development may be impeded.

2.3.3 Costs of service provision

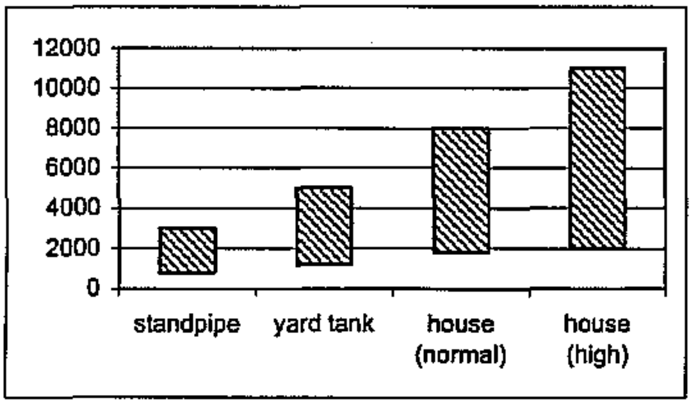
2.3.3.1 Unit costs

The capital costs related to investment in water services are dependent on a number of variables. These include service level, estimated future consumption, settlement characteristics,[32] property size, topography and geology, existing infrastructure, labour

[32]Settlement densities affect the units costs of internal services (distribution reticulation) and settlement size affects economies of scale (small settlements are more costly to service per household and may be further from additional reliable water supplies.

costs, material costs, distance to the water source, technical efficiency and economies of scale. Capital costs therefore vary significantly between service level (and between households for the same service level but different consumption) and from place to place.

For illustrative purposes, the likely range of capital costs for water services in the urban core areas are depicted in Figure 11.



Note: a range of costs is shown for each service type, ranging from low to high. Source: DCD (1997)

Figure 11: Variation of capital cost with service level (water supply - urban core example) (1996)

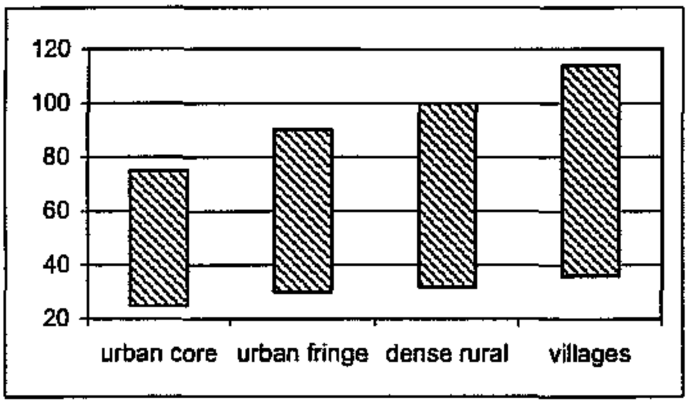
The influence of consumption (higher consumption is associated with higher levels of service) on bulk and connector costs is significant.[33]

Recurrent costs comprise operating and maintenance costs, bulk purchase costs and debt servicing. Both the bulk purchase cost and debt service cost are directly related to the capital costs. Operating and maintenance costs are affected by the level of service, the level of consumption, economies of scale, the age of the infrastructure and operating (technical) efficiency.

Recurrent costs vary widely. For illustrative purposes, the typical ranges of recurrent costs for water services in the urban core areas are depicted in Figure 12. Operating costs may vary from about R10 per household per month to more than R200 per household per month.

The impact of settlement characteristics on recurrent costs is shown in Figure 13. It should be noted that the costs for the non-urban core areas have a high degree of uncertainty. The purpose of presenting them is to show general levels and the trends associated with them (see DCD, 1997: 16).

[33] For a more detailed discussion of capital and operating costs, see DCD (1997) and PDG (1994ab).



Note: a range of costs is shown for each service type, ranging from low to high. Source: DCD (1997)

Figure 12: Variation or recurrent costs with service level (water supply - urban core example) (1996)

Estimates of total investment requirements

Order of magnitude estimates of the total investment over the next five years for providing water services were made in the National Infrastructure Investment Framework (NIIF) (RDP, 1995).[34] The NIIF five-year estimates were R35-50 billion for all water and sanitation services, and R23-33 billion for water services only.

2.3.4 Resource development costs – some trends

Future resource development costs are expected to be significantly higher than past investments in water supply capacity in many areas in South Africa. The most striking example is the high costs associated with the development of the Lesotho Highlands Water Project. The dramatic increase in marginal unit costs for the Vaal River system (raw water supplied into the Vaal River Dam) are shown in Figure 14 (World Bank, 1995). These cost increases are highly significant because of the dominance of Gauteng both in terms of economic activity and in terms of urban and industrial water use.

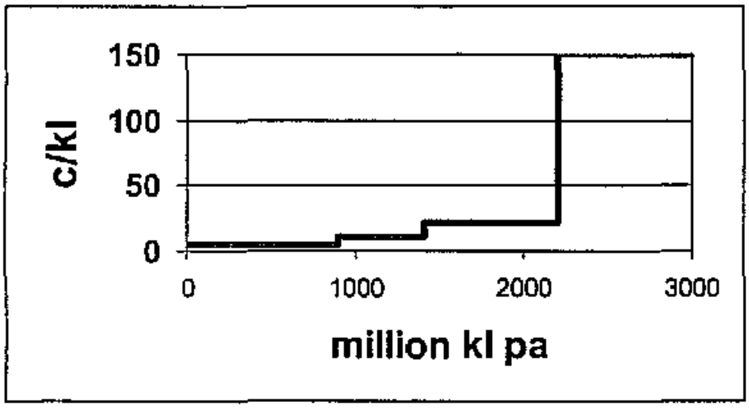


Figure 14: Vaal River system marginal costs

2.3.5 The implications of existing infrastructure and costs for water pricing

The discussion on water infrastructure presented above has the following implications for water pricing:

- **One third of households lack access to water services**, hence the principle equity contribution that can be made in the water sector is the improvement in access to water services. Pricing policies should therefore encourage greater access to adequate water supply services.
- **Most households without access to water services reside in rural areas.** Policies are needed to address the funding and sustainability of water supplies in rural areas in particular. Urban water pricing policies should not be made in isolation from these broader considerations.
- **Redressing inequalities arising from previous policies.** Because historic investments in infrastructure have favoured certain groups at the expense of others, "neutral" forward looking policies which ignore past investments will serve only to

[34] The capital costs quoted here include the cost of water resource development. They are fully inclusive costs in 1995 Rands.

entrench existing inequalities. Therefore, policies are needed which actively address the issue of inequality.

- **New growth concentrated in urban areas.** The population is expected to grow most rapidly in the urban areas, hence the demands for new infrastructure to meet this growth will be highest in these areas. It is particularly important, therefore, that the investments in infrastructure made in these areas are sustainable.

- **Costs directly proportional to service level and consumption.** Higher levels of service and consumption have important cost implications. The fact that it costs approximately three times as much to make available 150 lcd compared to 50 lcd needs to be reflected in the water pricing structure.

- **Economies of scale and density.** Unit infrastructure costs are higher in smaller lower density settlements compared to larger higher density settlements. Policies favouring the creation of larger and higher density settlements will assist in helping economies of density and scale to be realised.

- **Total investment requirements.** Pricing policy may have a profound impact on total investment requirements in a number of ways. First, pricing policy will affect the pattern of demand for connections, in particular the distribution of demand for different service levels. Second, pricing policy may also affect demand itself, hence impacting significantly on the timing of investments in new capacity. Third, pricing policy will affect the distribution of the cost and benefits in accordance with how it allocates revenue responsibility to meet the costs of the investments.

- **High marginal costs of resource development.** In many areas in South Africa, the costs of new water resource development are significantly higher than historic costs. In this context, two important questions related to pricing need to be addressed. First, how should the costs of capacity expansion be distributed or allocated? Second, should pricing be used to signal the high marginal costs of development, and if so, how?

2.4 Water policy

Water policy in South Africa is undergoing a process of rapid and significant evolution. This process commenced in 1993 and was coincident with the drafting of the new Interim Constitution for South Africa. The first policy statements to make a break with the past were contained in the Reconstruction and Development Programme (RDP) published as a key pillar of the ANC's election manifesto in 1993. The RDP become official government policy in May 1994. The first white paper on water policy was published in November 1994 ("Water Supply and Sanitation Policy: Water - an indivisible national asset.", RSA, 1994). This was followed by further policy documents and legislation which include: the "White Paper on a National Water Policy for South Africa" (DWAF, 1997a), the Water Services Act (RSA, 1997) and the National Water Act (RSA, 1998). This evolutionary process is still ongoing. At the time of writing, policies are being refined and regulations related to the actual and proposed legislation are being developed.

Key aspects of national water policy as it relates to water pricing are highlighted below. (The review of national water policy provided here is not comprehensive; the reader is referred to the source documents for further information).

2.4.1 Constitutional rights

The South African constitution is the highest law in the land and gives expression to the moral, social and political values of South Africans as expressed through their democratically elected representatives. The preamble to the constitution acknowledges past injustices and commits the people of South Africa to establishing "a society based on democratic values, social justice and fundamental human rights". The Bill of Rights contained in the constitution is the cornerstone of South Africa's new democracy. The following constitutional rights are of fundamental importance to the water sector in general and water pricing in particular: (1) the right to equality, (2) the right to dignity and life, (3) the right to an environment that is not harmful to health or well-being, (4) the protection of property rights from expropriation without compensation, and (5) the right of access to sufficient water and food and to primary health care services.

The last right is interpreted in the 1997 White Paper as follows: "Every child has a right to, amongst other things, basic nutrition and health services. Access to *sufficient affordable clean water for hygiene purposes* should be seen as part of the primary health care service" (DWAF, 1998).

It should be noted that this right is what is known as a "second generation right". This means that the government is required to prove that it is taking reasonable steps to meet this right and that citizens do not have an automatic and unequivocal right to immediate access to free water for domestic purposes. For example, the right of government to require reasonable payment for water has been tested and upheld in the courts (Macleod, pers. comm., 1998).

2.4.2 National water policy

2.4.2.1 Principles governing water law

The fundamental principles and objectives for the establishment of a new water law in South Africa are set out in the 1997 White Paper (DWAF, 1997a). Key principles which impact of water pricing include: (1) there shall be no ownership of water, (2) the water required to ensure that all people have access to sufficient water shall be reserved, (3) the quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved so that human use of water does not individually or cumulatively compromise the long term sustainability of aquatic and associated ecosystems, (4) the water for basic needs and the environment (as defined above) shall be identified as "the Reserve" and shall enjoy priority of use, (5) water resources shall be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water; conservation and other measures to manage demand shall be actively promoted as a preferred option to achieve these objectives, (6) the right of all citizens to have access to basic water services (the provision of potable water supply and the removal and disposal of human excreta and waste water) necessary to afford them a healthy environment on an equitable and economically and environmentally sustainable basis shall be supported, and (7) where water services are provided in a monopoly situation, the interests of the individual consumer and the wider public must be protected and the broad goals of public policy promoted (DWAF, 1997a).

2.4.2.2 A focus on basic needs and equity

The 1997 White Paper states that "the use of water to provide domestic services to meet *basic needs is a high political priority*". It further states that the "*the most important contribution to achieving equitable access* to water services is the provision of funds and the regulation and direction of institutions whose task it is to provide these services" (DWAF, 1997a: 8, own emphasis).

With respect to *pricing and equity*, the 1997 White Paper states: "It is important to note that the introduction of realistic pricing for water *does not further penalise disadvantaged communities* who were already penalised during the apartheid era. White communities were given a strong economic advantage under apartheid through access to cheap water, while economic development in black communities was restricted by a variety of economic factors, one of which was lack of access to affordable water. *In the interests of equity and social justice, this aspect will have to be considered in the question of water pricing. The price to be levied for water reserved to meet basic needs merits particular attention*" (DWAF, 1997a: 23, own emphasis).

2.4.2.3 Promoting optimal beneficial use

A key objective of the government in its management of water is "to achieve optimum, long term, environmentally sustainable social and economic benefits for society" from the use of water.[35] A key concept developed in the 1997 White Paper is <u>optimal beneficial use</u> that may be defined (briefly) as the best possible use in the public interest. The 1997 White Paper makes three points related to the promotion of optimal beneficial use: (1) there should be an appropriate balance between promotion and enforcement, (2) promotion through research, pilot projects, education and general communication activities will work best in a supportive framework which includes *regulatory incentives and penalties*, and (3) the provision of information on best practice and comparative performance with respect to water use will help to identify problem areas and encourage corrective action.

2.4.3 First tier water pricing policy

National policy with respect to first tier water (that is, raw water extracted from the fresh water resource) is set out in the 1997 White Paper and National Water Act of 1998.

The following four principles guide water pricing strategy for water use charges in terms of the National Water Act of 1998 (DWAF, 1998): social equity, ecological sustainability, financial sustainability and economic efficiency. The principle of social equity is deemed important because it seeks to address the imbalances of the past, both with respect to adequate access to water supply services and with respect to direct access to first tier water. Ecological sustainability is important because South Africa is committed to following a path of development that is environmentally sustainable. Financial sustainability is interpreted to mean that the full financial cost of supplying water should be recovered directly or indirectly from water users, including the cost of capital. Economic efficiency is interpreted to mean pricing water so as to reflect its scarcity value and the opportunity cost of alternative uses.

[35] Principle 7 of the "Fundamental Principles and objectives for a new water law for South Africa" (DWAF, 1997a: 34).

Economic incentives can be used to encourage water conservation and to shift water use from lower to higher value use. The national water pricing strategy asserts that each of these principles is of equal importance (DWAF, 1998).

The Cabinet decided in February 1996 that the price paid for water by *major users* should progressively be raised to meet the *full financial costs* of supply and to reflect its value to society. The key innovations here are the introduction of a resource charge which reflects the value of water itself (apart from any infrastructure related costs required to make the water available to the user) and a catchment management charge.

The Act provides for the establishment of a pricing strategy for achieving the goals of the national water pricing policy. This strategy is set out in the document titled "A pricing strategy for water use charges in terms of the National Water Act" (DWAF, 1998). The strategy provides for the setting of water use charges for three purposes: (1) funding water resource management, (2) funding water resource development and operation, and (3) achieving the equitable and efficient allocation of water.

It is intended that the *resource management charge* cover the following costs: planning and implementing catchment management strategies, monitoring and assessment of water resources availability, quality and use, water quantity management, management of water use permits, water resources protection, quality management and water pollution control and water conservation and demand management.

The *water resource development and operation charge* is intended to cover the full financial cost of investigating, planning, designing, and constructing a water scheme, including the finance charges related to the costs of raising and servicing loans, and the full operating costs (both direct and indirect). The capital cost will be determined by applying straight-line depreciation over the useful life of the asset. Both the value of the asset and the estimated remaining useful life will be periodically reassessed.[36]

It is further intended that an *economic charge* reflecting the scarcity value of water be introduced in water stressed areas. This charge would only apply to the 'economic uses' of water and therefore will not be applied to the basic needs and ecological reserve. Details on the calculation of this charge are not provided and it is stated that this charge will not be introduced immediately.

2.4.4 Second and third tier water pricing policy

The White Paper on Local Government (DCD, 1998a) sets out the following principles to guide tariff policy for municipal services (including water): (1) consumers should pay in proportion to the amount consumed (as far as is practically possible); (2) all households (with the exception of the indigent) should pay the full costs of the services consumed; (3) subsidies should be targeted to ensure access to a minimum level of basic services and to assist with ability to pay; (4) tariffs should be fair in that all people are treated equitably, (5) tariff policy should be transparent to all consumers, (6) tariff levels should be determined at the local level by municipalities, (7) tariffs should be consistently enforced, (8) tariffs should ensure that local economies are competitive and hence should not unduly burden local business

[36] The intention of the policy is to move towards Generally Accepted Accounting Practice (GAAP). More detail is provided in DWAF (1998).

through higher tariffs, as these costs affect the sustainability and competitiveness of such businesses and firms. Government and stakeholders have agreed to these principles.

The pricing policy for water services, that is, the purification and distribution of water by Water Boards, Local Authorities and other types of WSPs, is set out in the 1994 White Paper (DWAF, 1994), the Water Services Act (RSA, 1997) and the National Regulations Supply Regulations (1997).

The key policy has to do with self-financing and is stated in the 1994 White Paper:

> The basic policy of Government is that services should be self-financing at a local and regional level. The only exception to this is that, where poor communities are not able to afford basic services, Government may subsidise the cost of construction of basic minimum services but not operating and maintenance or replacement costs. (DWAF, 1994: 19)

This policy is confirmed and restated in the 1997 White Paper:

> To promote the efficient use of water, the policy will be to charge users the full financial cost of providing access to water, including infrastructure development and catchment management activities. This will be done on an equitable basis and according to the realistic reasonable programme which has already begun.
>
> To promote equitable access to water for basic needs, provision will also be made for some or all of these charges to be waived. (DWAF, 1997a: 4)

A framework for national tariff policy for water services is set out in the 1994 White Paper:

> The policy is that all consumers of potable water must contribute to the costs of their water supplies. In poor communities which are unable to afford to pay both the construction and operating costs of schemes provided by Government, a social tariff covering only operating expenses will be charged for the minimum level of service, which is a communal water source. For higher levels of service, the full cost of supply is charged. (DWAF, 1994: 23)
>
> Provided the costs are covered, the tariff may be charged as a fixed monthly levy, a charge per volume of water received or direct payment by the community towards the operation, fuelling and maintenance of their water supply. (DWAF, 1994: 23)
>
> The Department of Water Affairs and Forestry support[s] the adoption of life-line tariff systems to ensure that everyone has at least a basic level of service. ... [S]uch rates need to be set at the local or regional level with full participation of all interested parties. (DWAF, 1994: 24)
>
> In accordance with the principle that water has an economic value, the policy of sliding tariff scales is endorsed by the Department. The basic approach identifies three separate tariffs: (DWAF, 1994: 24)
>
>> *A life-line or social tariff* to cover basic human needs. The quantity shall not exceed 25 lcd. The tariff shall be set so as to cover only the operating and maintenance costs.
>>
>> *Normal tariff.* This is for normal use. The quantity shall not exceed 250 lcd and shall be provided at cost (operating, maintenance and capita) including the losses incurred though the life-line tariff.
>>
>> *Marginal tariff.* Water consumption exceeding 250 lcd will be charged for at the marginal cost defined as the present day cost of the latest or next augmentation scheme.

The 1994 White Paper notes that this tariff policy would need to be translated into "formats which simplify administration such as typical monthly consumption per household" (DWAF, 1994: 25). This is done in the National Water Supply Regulations (RSA, 1997) which is intended to provide a blue-print for local authorities to adopt as bye-laws for the management of water services within their local area. The tariff structure is defined in these regulations as follows:

> The tariff structure for potable water supplied to domestic consumers shall comprise at least three parts as follows:
>
> (a) a "life-line" tariff for a quantity of water of not less than 6 kl per consumer for a minimum level of service;
>
> (b) a tariff based on historic costs for any quantity of water consumed in excess of the quantity used in (a) up to a maximum of 30 kl per consumer per month;
>
> (c) tariffs based on the marginal cost of supplying water for any quantity of water consumed in excess of the quantity used in (b).
>
> The life-line tariff shall not exceed the tariff calculated by dividing the budgeted operating and maintenance costs for any financial year by the estimate of the quantity to be sold in that financial year for each local authority.
>
> Where the account period is greater or less than one month, the quantities to which block rates apply shall be adjusted proportionally. (RSA, 1997)

The regulations do not define marginal cost, nor do they provide any further information or guidelines in respect of either domestic or non-domestic tariffs. However, they do specify that local authorities should read water meters at an average frequency of once per month during each calendar year.

The more recent Water Services Act (Act 108 of 1997) provides for the Minister of Water Affairs and Forestry to prescribe national norms and standards in respect of tariffs for water services (see Working Paper 3). These norms and standards are in the process of being developed.

2.4.5 Implications for water pricing

The review of current water policy in South Africa presented above has the following implications for water pricing:

- **Methodology.** There is a complex interaction between existing policy and this project because the current water policy in South Africa provides both the context within which this pricing study is being undertaken as well as the material for a critique of existing policies.. Therefore, it is useful to draw a distinction between those policies which are taken as given in this project and those which are critiqued with the review to reform.
- **Constitutional rights.** In view of the fact that the Bill of Rights forms a cornerstone of South Africa's new democracy, *these rights are taken as given in this project*. The key implications of these rights (noted above) for water pricing are as follows: (1) water pricing should not, at the very least, jeopardise the right of people to an environment which is not harmful to health or well-being, and (2) pricing should promote access to, and the consumption of, an adequate amount of

clean potable water, and (3) these two considerations should enjoy priority over other policies.

- **Ownership.** The new national water law states that there shall be no private ownership of water rights but that the national government shall act as custodian of the national water resource. *The absence of private water rights is taken as a given in this project.*
- **Basic needs and ecological reserves.** *The setting aside and prioritisation of the basic needs and ecological reserves are taken as a given in this project.*
- **Equitable access.** *The principle of equitable access* of all user sectors to the water resource *is taken as given in this project.*
- **Promotion of conservation and other measures to manage demand.** This is proposed as the preferred option to achieve the objective of equitable access. The implications of this are investigated in this project.
- **The protection of consumers against monopoly interests.** *This principle is taken as a given in this project.*
- **Basic needs and equity a political priority.** The provision of infrastructure to meet basic needs and issues of equity are political priorities in South Africa which are reflected in the Constitution and the White Paper on water policy (RSA, 1994 and DWAF, 1997a). *This orientation is taken as a given in this project* and its implication for pricing are explored.
- **Optimal beneficial use.** The 1997 White Paper sets optimal beneficial use as a goal. However, this concept is not adequately defined nor made operational. The meaning and definition of this term, as well as the means of achieving it, are examined in this project.
- **First tier pricing policy.** The DWAF first tier pricing strategy aims to achieve four overall objectives as follows. First, *financial sustainability* of water resource planning, development, management and operation is ensured through full-cost recovery. Second, *ecological sustainability* is promoted through setting aside an ecological reserve and managing water quantity and quality through a combination of water use permits and economic incentives (pollution charges). Third, *equity* is promoted through making the first tier water for basic needs available free of charge.[37] Fourth, *efficient and equitable use* is promoted through the introduction of the economic charge reflecting the scarcity value of water in any particular catchment. *More detailed assessment and comment on these is presented in later sections in relation to the discussions on second and third tier pricing.*
- **Second and third tier pricing policies.** The primary purpose of this project is to assess the current South African second and third tier pricing policies, to make policy recommendations for pricing policy reform and to provide operation guidelines to assist water managers in setting price structures and levels. *Detailed discussion of the current second and third tier pricing policies are presented in later sections.*

[37] The cost associated with this is borne by all the economic users of the system (DWAF, 1998: 18).

2.5 Institutional framework

2.5.1 An overview

A brief description of the institutional framework in the water and wastewater sector in South Africa, as pertinent to the issue of water and wastewater pricing, is given below with reference to Figure 15 and Figure 16.[38]

DWAF is the national custodian of water. It directly determines three prices, the price of raw water extracted from the environment ($p_{environment}$)[39], the price of raw water from (government) raw water schemes (p_{raw})[40] and the price of water (effluent) returned to the natural environment ($p_{effluent}$). Research into, and an evaluation of, the method of determining and levying these three prices is not within the scope of this project. As custodian of the water resource, the government also has a mandate to develop norms and standards for the determination of other water tariffs (hence the dotted lines in Figure 15).

The prices that are the concern of this project are $p_{wholesale}$ and p_{retail}.

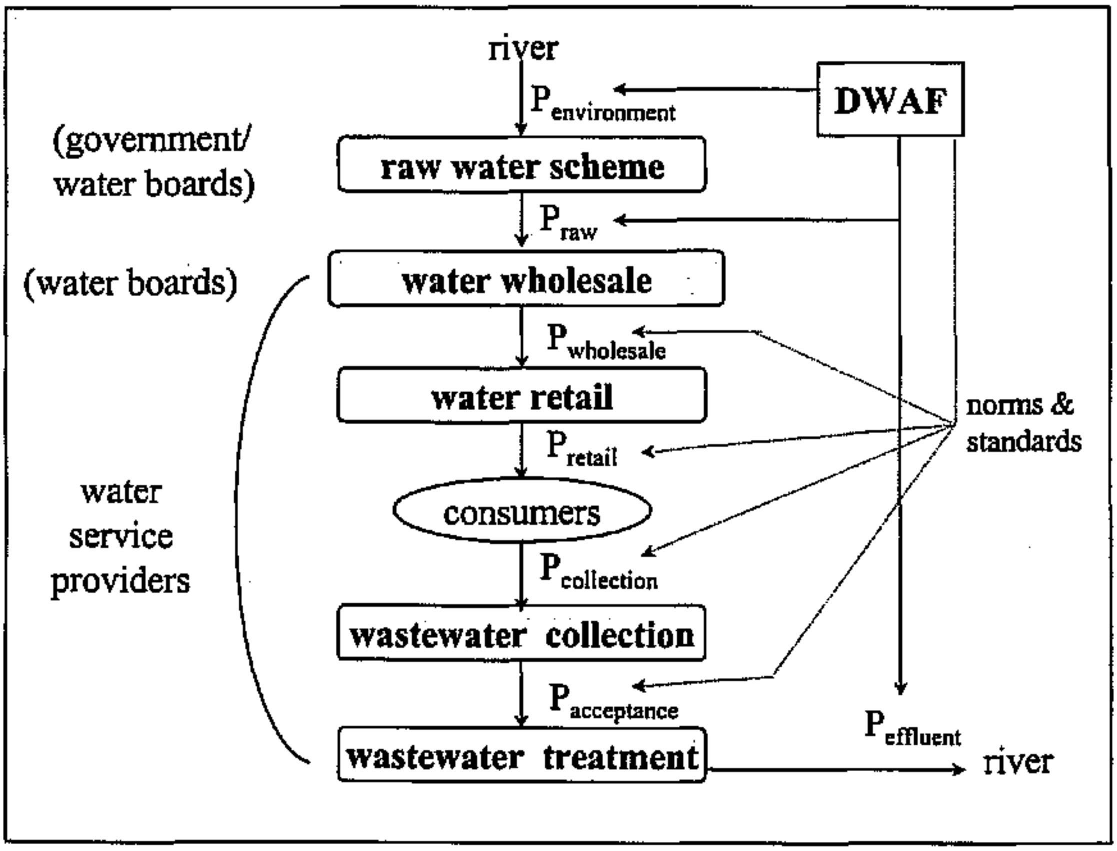


Figure 15: Water pricing in South Africa - a conceptual framework

[38] This discussion is based on the discussion provided in Working Paper 3.

[39] The cost of catchment management is assumed to be included in $p_{environment}$

[40] The government only directly determines the price of p_{raw} coming from government water schemes. Where Water Boards or other service providers own and manage water schemes, these WSPs will price p_{raw} in terms of guidelines provided by the government.

The exact institutional arrangements determining who sets the wholesale and retail prices may vary. Figure 16 shows the most common institutional arrangements.

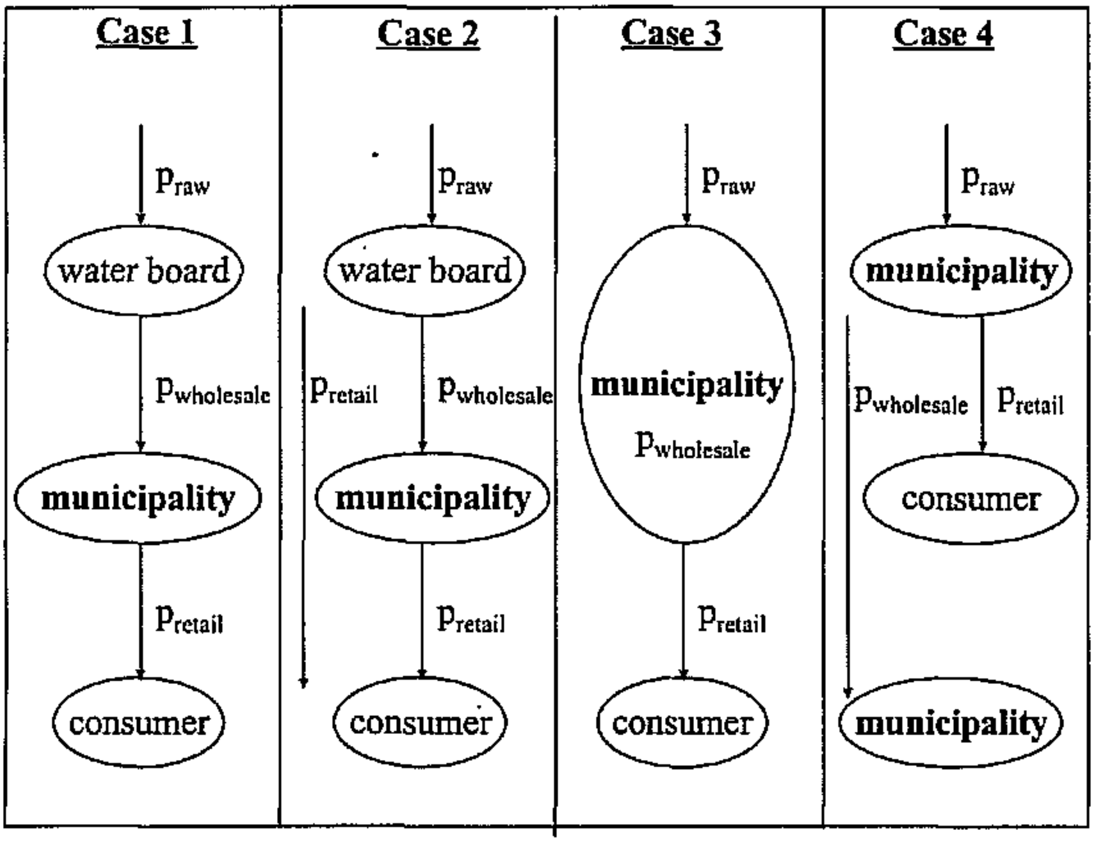


Figure 16: Principle institutional arrangements for water supply in South Africa

In *Case 1*, raw water is purchased (at p_{raw}) by a Water Board whose sole function is the treatment of the water and the distribution of this bulk treated water to municipalities in its service area. The municipalities purchase bulk treated water from the Water Board (at $p_{wholesale}$) and retail this water to end consumers (at p_{retail}). Many municipalities in South Africa purchase all of their water from a Water Board and retail water to consumers in their area.

In *Case 2*, the Water Board retails water directly to end consumers (at p_{retail}) in addition to its primary wholesale function. Rand Water and Umgeni Water are examples of this arrangement.[41]

In *Case 3*, there is no Water Board and the municipality arranges its own treatment and bulk distribution. In this case there is no explicit wholesale water price. Grahamstown is an example of this arrangement.

In *Case 4*, the municipality acts both as a wholesaler and retailer. Cape Town and Port Elizabeth municipalities are examples of this arrangement.

It should be noted that for any particular WSP, $p_{wholesale}$ and p_{retail} might not be uniform. In other words, a Water Board may charge different wholesale prices to

[41] Rand Water retail directly to mines as well as to other individual consumers. Umgeni Water retail directly to rural consumers as well as to other individual consumers.

different municipalities that it supplies and municipalities may charge different retail prices to different consumers in its area.

The above cases are also not exhaustive of actual and possible arrangements, although they are the principal ones. Other possible cases include: in Case 1, the municipal retail function could be undertaken by a private WSP; and in Case 3, the municipality could separate its wholesale and retail functions into separate business units and hence the wholesale price could be made explicit.

2.5.2 The implications of the institutional context for pricing policy

The primary implications of the institutional arrangements for water pricing are as follows:

- The national government has the ability to directly affect the second and third tier prices of water through the setting of the first tier water price ($p_{environment}$ and p_{raw}). The government's policy in relation to the setting of this latter price has been discussed above.
- As custodian of the national water resource, the national government can also exert an indirect influence over second and third water prices through the establishment of norms and standards. This is provided for in the National Water Act of 1998. It is not clear to what extent the law requires water service providers (municipalities) to follow these norms and standards.
- In the case of second tier prices, the government has the power to review, and if necessary veto, prices set by water boards. Where municipalities wholesale water to other municipalities, the price is usually negotiated between the contracting parties. Typically, receiving municipalities have severely constrained alternatives and hence their bargaining position is weak.
- In all cases, water services authorities (municipalities / local government) have the final responsibility in setting third tier water prices. This responsibility is defined in the Water Services Act of 1997. The right of municipalities to set tariffs locally is also established in the White Paper on Local Government (DCD, 1998a). Where municipalities are also the water service providers, their ability to influence the third tier water pricing structure and level will be much greater than where this function is undertaken by other WSPs such as Water Boards, other municipalities or private companies. In the latter case, the discretion that private companies have to set third tier water prices will depend on the exact nature of the contract between the water services authority (WSA) and the company. Typically the method of determining the price, if not the exact price itself, will be set out in the contract.

2.6 Macro-economic linkages

There is general consensus that South Africa should embark on a large-scale social and economic infrastructure investment programme seeking to redress the imbalances and deprivations of apartheid and, at the same time, restructure the economy so as to achieve rapid and sustained economic growth.[42] These two objectives are intimately

[42] Social and economic infrastructure is broadly defined here as investments which are a source of external economies and which generally need to be provided in large units, ahead of demand (after Muller, 1993). The backlog in infrastructure investment in South Africa is estimated to be R170 billion (DOF, 1996: 15).

linked. Economic growth depends on social and political stability, which in turn depends on the capacity of the new government to deliver the prospect and reality of a better future to the majority of the population. Sustained economic growth will also not be achieved without drastic improvement in human resource skills and productivity. Investment in water and sanitation services forms a major component of an overall reconstruction and development programme. Understanding the linkages between investment in water and sanitation and economic development, the economic impact of investment in water and sanitation *vis-à-vis* investment in other sectors, and the impact of water pricing reform on economic and social development is thus critical if the overall social and economic infrastructure investment programme is to be designed and implemented in such a way that its contribution towards rapid and sustained economic growth is optimised.[43]

2.6.1 South African macro-economic policy

South Africa's economic policy is informed by a macro-economic strategy which is set out in the document titled "Growth, employment and redistribution (GEAR)" a macro-economic strategy" (DOF, 1996). The strategy aims to facilitate the rebuilding and restructuring the economy such that the economy would contribute to the realisation of the following long-term vision: a competitive fast-growing economy which created sufficient jobs for all work-seekers; the redistribution of income and opportunities in favour of the poor; a society in which sound health, education, and other services are available to all; and an environment in which homes are secure and places or work are productive.

The core elements of the strategy which are particularly (or potentially) related to the provision of services include: (1) a renewed focus on budget reform to strengthen the redistributive thrust of expenditure, (2) a more rapid fiscal deficit reduction programme to contain debt service obligations, counter inflation and free resources for investment; (3) the accelerated restructuring of state assets to optimise investment resources, and (4) an expansion of the infrastructure investment programme to address service deficiencies and backlogs, (5) a monetary and exchange rate policy which aims for low (but positive) real interest rates, low inflation and a stable currency. It should be noted that these might conflict with water policy goals.

With respect to revenue, the strategy asserts that "international experience confirms that it is on the expenditure side that the state budget is most effectively able to contribute to redistribution", but that "it is nonetheless important that the incidence of taxation should remain progressive, while at the same time impacting across a broad base so as to avoid excessive rates" (DOF, 1996: 9).

The strategy asserts that "the provision of basic household infrastructure, in particular, is a relatively low cost and effective form of public intervention in favour of the poor and consistent with the reduction of income inequalities" (DOF, 1996: 15). The strategy notes that "improved water and sanitation is typically the first priority of rural communities", and that commitments have been made to "some 500 projects costing R1.5 billion" (DOF, 1996: 15). The strategy further notes that the rural water supply programme will ultimately result in the supply of potable water to the 12 million

[43] This introduction is taken from PDG (1994d) written by the same author.

people currently without adequate access, and that this will make a major contribution to poverty relief (1996: 15).[44]

The strategy envisages investment in finance being financed from four sources: government transfers, loan finance from multinational and local development institutions, commercial loans and private equity (through public-private partnerships). The appropriate mix of finance for any particular project will depend on the distribution and allocation of benefits, costs and risks, and on the potential for cost recovery.

2.6.2 Investment linkages

In analysing the effects of infrastructure investment on economic growth, it is useful to distinguish between three types of effects, namely direct, indirect and productivity improving effects. The MIIF describes these as follows: "The *direct* effects are the immediate employment and income generating effects of providing the infrastructure, which are by far the greatest during the construction phase but continue afterwards to some degree due to the need for operating and on-going maintenance activities. The *indirect* effects arise due to the conventional multiplier effect of increased economic activity, whereby more employment, higher levels of income and more demand within the construction sector leads to more demand for other goods and services thus stimulating economic growth. This effect will be strongest during the construction phase and will diminish as construction activity winds down. The magnitude of the effect will however be reduced to the extent that the additional demand is satisfied by imports, and that public sector investment crowds-out private investment. The *productivity improving* effects are potentially the longest lasting, and are the most relevant to sustainable growth. Suitable infrastructure opens up economic opportunities and lowers production costs, thereby rendering activities economically viable that were previously not so." (DCD, 1997: 10). Investment in infrastructure also has a distributive effect in that choices in the location of infrastructure investment can increase or reduce disparities in welfare and income distribution profiles between regions. There is empirical evidence that, under the right conditions, increased investment in public infrastructure has a positive effect on economic growth.[45]

The economic linkages related more specifically to investment in water services are highlighted below.

Health. Health benefits are most obviously associated with improved water and sanitation, although they are associated with other services too. The MIIF notes that "inadequate access to a sufficient supply of water of good quality and poor sanitation creates increased risk of disease, with diarrhoea being the most prevalent. Considering the relative costs and benefits of improved water supply and sanitation, the most important step is that which provides a properly functioning, properly managed

[44] Unfortunately, the length of the project planning and initiation phases where underestimated, resulting in large roll-overs of the annual budget allocated to water projects. Just as the momentum on project construction was increasing, the roll-overs were substantially cut resulting in significant problems (Palmer, pers comm., 1998).

[45] For example, recent evidence from the United States economy suggests that increased public investment in core infrastructure (water, sewerage, electricity, highways, mass transit, airports and gas) stimulates private sector output by as much as four to seven times more than the investment (WASH, 1992, p7).

service at a basic level" (DCD, 1997: 8). There is a general consensus on this point of view.[46]

Environment. Investments in water resource development and water supply infrastructure typically have negative impacts on the environment. These include reduction or alteration of river flows (resulting in a degradation of the aquatic ecosystem, deterioration of water quality (as a result of reduced assimilation capacity and increased water use) and the loss of species.[47] On the other hand, investments in water treatment infrastructure or water saving technology can improve the environment (or ameliorate the damage caused by water use).

Economic. WASH (1992) summarised the overall economic benefits associated with investment in water and sanitation services in the following figure.

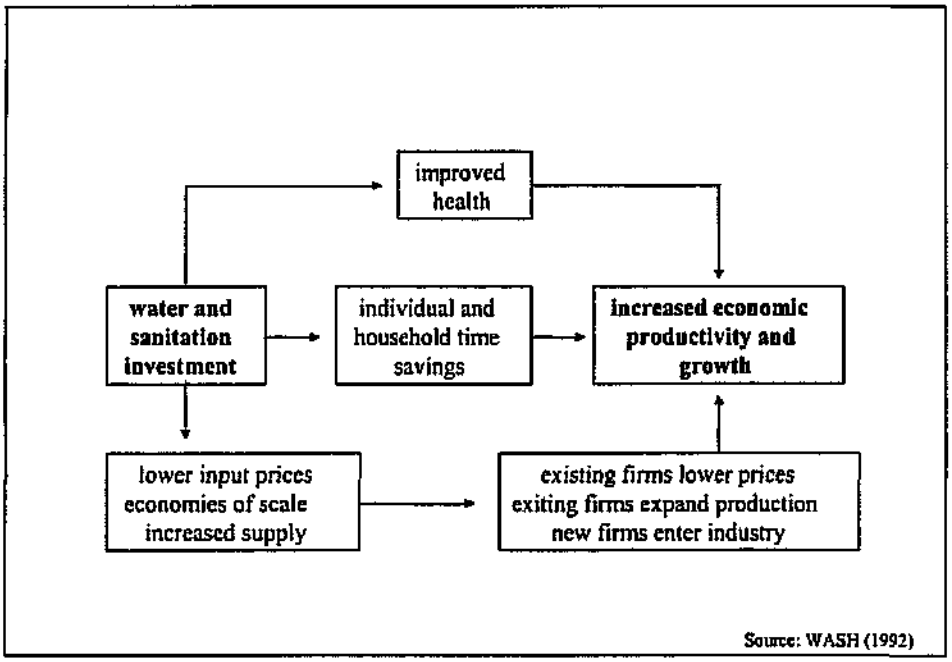


Figure 17: Economic benefits from water and sanitation

Investment in water supply may promote economic growth in several ways (WASH, 1992). It may increase the water supply for the commercial and industrial sector, through system expansion or rehabilitation. Increased availability of water may encourage the formation of new industrial and commercial enterprises by removing a major constraint on production. Investment in water may stimulate complementary investments by the commercial and industrial sector.

[46] For example, the World Bank recognises that "the potential health benefits from improved water and sanitation services are huge", and that in order to secure these benefits, water supply must be both uncontaminated and water use greater rather than less (World Bank, 1992: 101). The World Bank notes that a supply of 50 lcd is much more likely to secure health benefits than 15 to 30 lcd and that this higher consumption is only likely if water is supplied directly to the house or yard. Collection of water from communal street taps typically results in low water usage, that is, 15 to 30 lcd (World Bank, 1992). Thus, in contexts where these minimum conditions are not universally met, the World Bank contends that extending adequate access to safe water supplies is the most important contribution to equity that a government can make and should therefore be prioritised. For a discussion of the relationship between water supply, sanitation and health in the South African context, see Palmer Development Group (1993, 1994g).

[47] A discussion of these impacts is provided in Working Paper 2.

There are a number of linkages between water supply and sanitation investments that need to be explicitly recognised. Health improvements are only possible if improved water supply is accompanied by complementary investments in sanitation. Increased water supply could necessitate additional investment in the disposal and treatment of wastewater. The nature of the water supply and sanitation investments has an impact on the return flows into the water cycle. This last point is particular important in the South African context.

It should be borne in mind that investment in water and sanitation can also impact negatively on economic growth. Investments in water supply and sanitation may be sub-optimal, and therefore economically inefficient and wasteful of resources, for a number of reasons. These include: premature investments in water supply, regarded as necessary as the result of inefficient and/or wasteful use of water; investments in water supply and sanitation which are not least-cost solutions; and investments in sanitation which give no additional health or economic benefit, compared to the existing situation. Inadequate and/or inefficient water supply may limit economic growth within a country or region in a number of ways. For example, enterprises may become uneconomic as a result of water that is of poor quality, unreliable or too costly. The expansion of enterprises or establishment of new enterprises may also be hindered because of the lack of availability of adequate water.

Although it is possible to identify the benefits associated with investments in water and sanitation services, it is impossible to quantify them with any degree of accuracy primarily for the following two reasons. First, it is hard to attribute reasons for ill health (or death) and to know how to allocate the associated costs to the different causal factors. For example, if a child has diarrhoea, was this cause by contaminated water, food or another reason? Did the contamination arise because of the lack of infrastructure or the lack of health education, or the failure to apply received knowledge? These are not easy questions to answer with any degree of certainty. Second, the estimation of the costs associated with ill health in general, and with premature death in particular, are often subjective and controversial. It may also not be possible to quantify certain benefits.[48] Because of these difficulties, very few estimates exist, and those that do are not reliable.

2.6.3 The implications of macro-economic linkages for pricing policy

The primary implications of the macro-economic linkages outlined above for water pricing are as follows:

- **Investment in infrastructure.** Large-scale investment in social and economic infrastructure (including basic water services) is necessary for political and social stability. Basic services should be universally accessible. Pricing policies must seek to ensure that such investments are both feasible and sustainable.

- **Competitive economy.** The long-term vision is for an internationally competitive economy which implies low production costs. *Unnecessarily high water prices may jeopardise this and hence the impact of water pricing on international competitiveness needs to be taken into account.*

- **Redistribution in favour of the poor.** A core component of the macro-economic policy is the redistribution of both income and opportunities in favour of the poor.

[48] For a discussion measurement issues, see World Bank (1993).

Water pricing reform should therefore aim to have a progressive (or at the very least neutral) impact on income distribution. However, a substantial contribution will be made by direct government transfers: "the provision of basic household infrastructure, in particular, is a relatively low cost and effective form of public intervention in favour of the poor and consistent with the reduction of income inequalities" (DOF, 1996: 15).

- **Fiscal constraints and sources of finance.** Where feasible and desirable, greater reliance will be placed on cost-recovery (through user contributions) and private finance (for capital investment). Appropriate pricing policies have an important role to play in ensuring the financial sustainability of the sector, in harnessing user-contributions (hence releasing government resources for other priority uses), and in attracting private finance or capital into the sector (hence reducing government borrowing requirements).
- **Positive health benefits.** The positive health externalities associated with investment in water services suggest a rational for government subsidisation of basic water services. However, these benefits are both difficult to quantify and unlikely to be achieved without complementary investments in sanitation services and in preventative health services. The income distribution rationale for the subsidisation of basic services is stronger than the health rationale.
- **Negative environmental externalities.** The external environmental (and other) costs need to be internalised into the price of water.
- **Wasteful investments.** Investments that are premature, overdue, or not least-cost waste valuable and scarce capital sources that may have had better alternative uses. The appropriate pricing of water can have an important role is ensuring that the timing and choice of investments is optimised.
- **Complementarity.** Water investments must be viewed holistically and co-ordinated with investments in wastewater, sanitation services and other associated infrastructure. Similarly, the pricing of water must be addressed in conjunction with the pricing and regulation of wastewater flows.

2.7 The social context

The level and distribution of household income, and the degree of inequality are of considerable importance in the consideration of the pricing of domestic water consumption because they will have an important influence on the pattern of water demand and the affordability of water services. Each is discussed below.

2.7.1 Income levels and distribution

The following data is sourced from Deaton (1997).[49] Average household expenditure in South Africa was estimated to be R1 090 per month in 1993. However, household incomes were very unevenly distributed between race groups. For example, average household expenditure per month amongst white households was R4 615. When

[49] Processed income distribution data was not available from the 1996 Census at the time of writing. Deaton's analysis uses the data from the 1993 SALDRU / World Bank national South Africa "living levels" household survey (Deaton, 1997).

converted to an individual per capita expenditure (PCE) equivalent, the mean individual PCE is almost seven times larger for white people than it is for black people in South Africa.

Income distribution is also very unevenly distributed between households both across and within race groups, although it is more uneven between black households than between white households. In 1993, the poorest 20% of South Africans spent only 3% of all PCE, whereas the poorest 20% of black people spent only 5% of all PCE spent by black people. The poorest 20% of white people spent 7.5% of all PCE spent by white people; the poorest 50% of South Africans spent only 13% of all PCE (1997: 160).

The cumulative distribution of income (PCE expressed as Rands per month per person) for the white and black population in South Africa is shown in Figure 18 (source: Deaton, 1997: 166). The gap between black and white South Africans is stark.

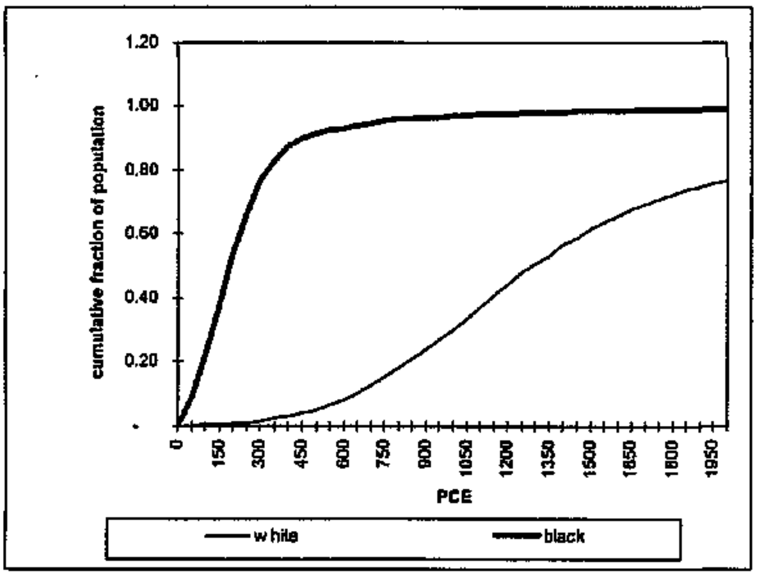


Figure 18: Cumulative distribution of PCE in South Africa

2.7.2 Affordability of services

Both service costs and income levels will vary by locality. Nevertheless it is possible to provide an indication of likely levels of affordability for water services in South Africa as a whole.

Cost assumptions. The following assumptions were made: Fixed operating and maintenance costs of R5 for communal standpipes and R10 for yard tanks and house connections; a variable operating cost of 100 c/kl (no capital contribution included in this); consumption of 5, 10, 20 and 40 kl per household per month for communal standpipes, yard tanks and house connections with normal use and high use respectively; full costs (inclusive of all capital costs) of R30, R60, R90 and R150 respectively for the four levels of service as indicated. For the purposes of this analysis, the costs are assumed to be purely a function of service level, each of which has an assumed fixed consumption. In reality, costs will vary within each service level depending on consumption as well as other locally or regionally determined cost factors. It should be borne in mind that, in specific circumstances, actual costs may be significantly higher than those used here.

Income data. Income data has been taken from Deaton (1997).

The 5% rule. The 5% rule is used here to indicate levels of affordability. This rule of thumb is commonly used (see, for example, Bahl and Linn, 1990) and has some empirical support in the South African context (Goldblatt, 1997). Macleod suggests that 5% may be too high for just water services and proposes a "2% rule of thumb" (Macleod, 1997).

Affordability constraints for water services as a function of household income are shown in Figure 19 and Figure 20. The first figure assumes that the full cost of the water service is paid, the second that only the operating and maintenance cost is paid. In the figures, "house1" refers to normal in-house use (20 kl/month) and "house2" to "high" in-house use (40 kl/month).

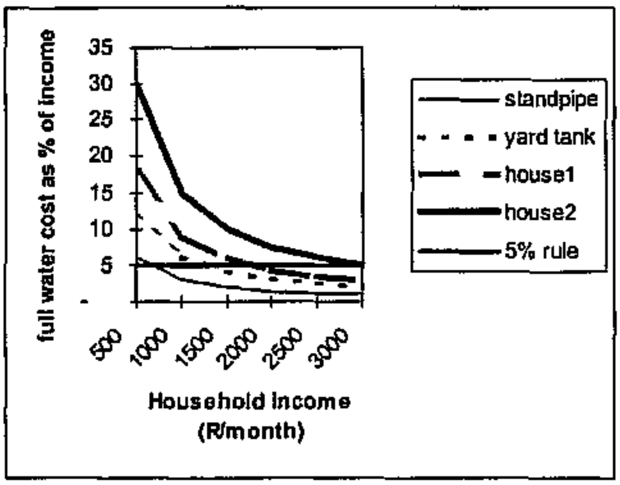


Figure 19: Income versus affordability of water services (full cost)

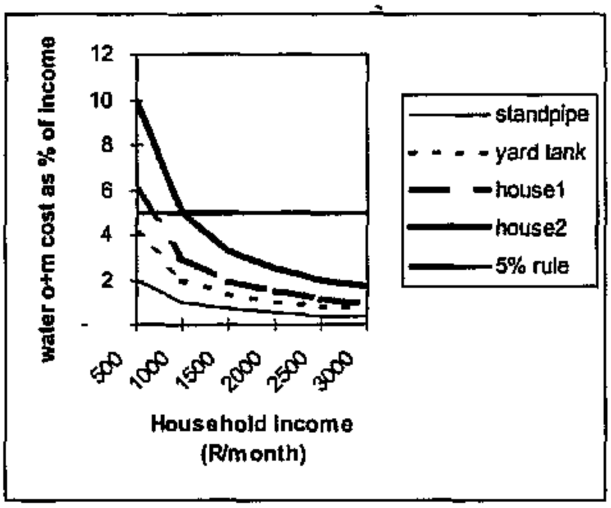


Figure 20: Income versus affordability of water services (O+M only)

Figure 19 shows that payment of the full cost for "high" in-house use (40 kl per month) is only affordable for households earning more than R3 000 per month, and that the full cost of "normal" in-house use (20 kl per month) is only affordable for households earning more than R1 500 per month.

Figure 20 shows that if households are only required to pay the operating and maintenance costs (with no capital or debt service contribution), then "high" in-house use is affordable for households earning more than R1 000 per month and "normal" in-house use is affordable for households earning more R600 per month.

In Figure 21 and Figure 22, the above information is combined with black household income distribution data to show the overall levels of affordability of water services amongst black households in South Africa.

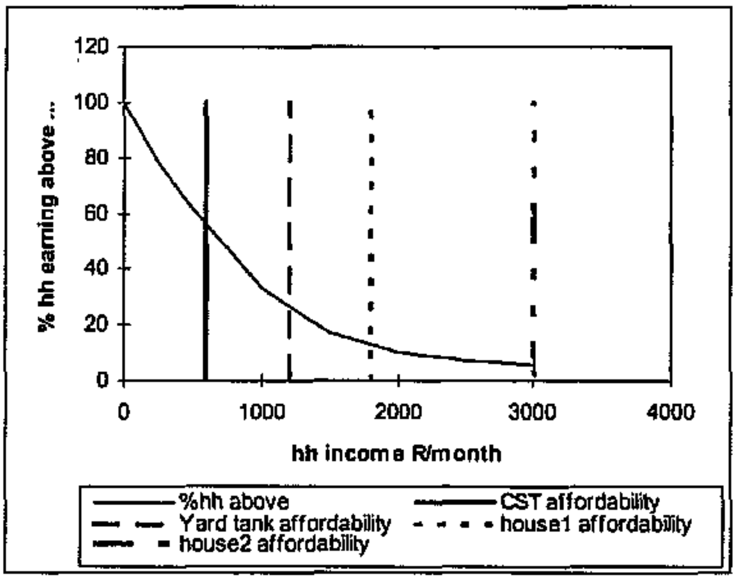


Figure 21: Household income distribution and full cost affordability of water services

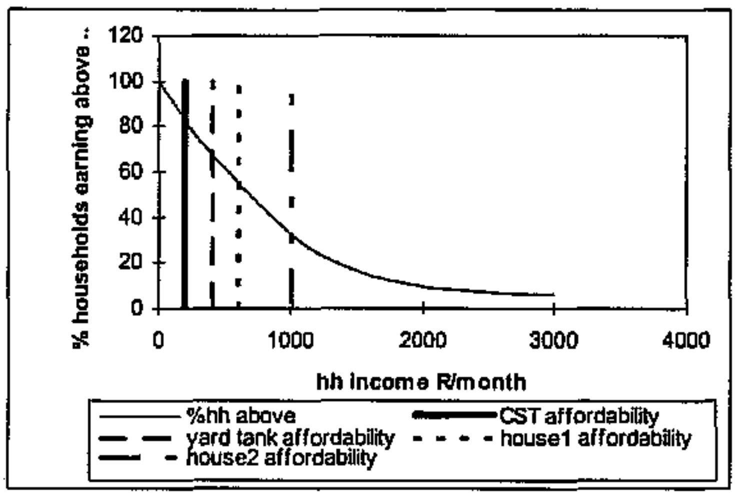


Figure 22: Household income distribution and affordability of o+m costs of water services

Less than 5% of black households in South Africa can afford the full cost of a high-use in-house water connection, and only some 15% of black households can afford the full cost of a moderate (or normal) use in-house water connection. However, some 40% of black households can afford the (full) operating and maintenance costs of a high-use in-house connection and about 60% can afford the (full) operating and maintenance cost of a normal use in-house connection. More than 80% of households can afford the operating and maintenance costs for a communal standpipe water supply, and about 70% of households can afford the operating and maintenance costs of a yard tank supply.

This kind of analysis could be repeated for all urban households in South Africa and on a city by city basis given the availability of suitable household income data.

2.7.3 The impact of water prices on income inequality

In the context of a high degree of income inequality, water pricing which is directly related to the cost of service provision is likely to have a regressive impact on income distribution. The likely impact of cost based water pricing on income inequality in South Africa is illustrated in Figure 23. The following assumptions were made in order to derive the data presented in the figure: in-house water supply, a fixed cost of R10 per month, a variable cost of 300 c/kl, a base consumption of 66 lcd for a family of five with a household income of R500, a constant family size across the income range, an income elasticity of demand of 0.5 for the income range R500 to R5000 per month, 0.4 for the range R5000 to R10 000 per month and 0.3 for the range R10 000 to R15 000 per month.

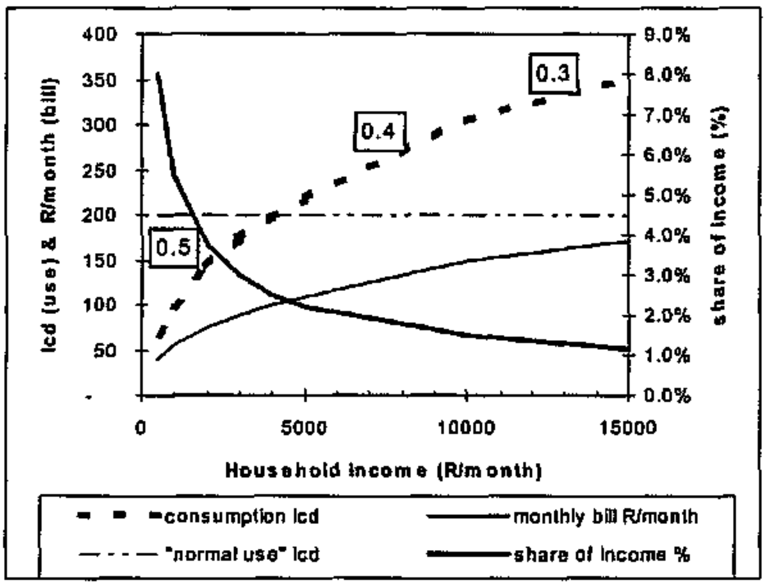


Figure 23: The impact of cost related water pricing on inequality

The figure shows water use (in lcd) as a function of household income (lcd on left-hand y-axis). From the water use, the monthly bill is derived (shown as R/month and also plotted against household income, also using the left-hand y-axis). The monthly bill as a *percentage* of household income ("share on income") is then calculated (and plotted against household income using the % y-axis on the right).

The figure shows that, using these assumptions, a poor household with an income of R500 per month and consuming just 66 lcd would have to spend 8% of its income to cover the cost of service provision whereas a household with an income of R15 000 per month would have to pay only 1% of its income to cover the cost of the water service even though its per capita consumption is more than five times that of the poor household. It is therefore clear that the overall effect of cost-based water pricing on income distribution will be regressive.

Comment: Empirical evidence suggests that actual income elasticities are likely to lower than those assumed here (see Working Paper 4). If this is the case, then the effects of cost based pricing on income inequality will be greater than that described.

2.7.4 The implications of the social context for pricing policy

The primary implications of the national social context outlined above for water pricing are as follows:

- **Income distribution** in South Africa is highly skewed. Pricing policy that exacerbates this inequality is undesirable.
- **Cost-based pricing** typically will exacerbate income inequality because the income elasticity of water demand is low (much less than 1). The indiscriminate application of cost-based pricing therefore is not recommended.
- **Marginal cost pricing** of the form "price equals long-run marginal cost" in contexts where the long-run marginal cost is higher than the average historical cost will have an even more regressive impact on income distribution compared to cost-based pricing. Hence a general application of marginal cost pricing is not recommended. (Marginal cost pricing is discussed in more detail in Section 3. (Theory).

2.8 Financial framework

Both the national and local government financial frameworks are of critical importance to water tariff policy because they determine the financial constraints within which water tariffs must operate. Each are briefly reviewed below.

2.8.1 Financial transfers from central government

A general financial framework for the provision of subsidies to assist in improving access to, and affordability of, basic water services has been established. The subsidies take the following forms: (1) capital subsidies to assist with the development of bulk infrastructure, (2) capital subsidies to assist with household access to water and sanitation services, (3) operating subsidies arising from the "equitable share" policy, and (4) making available the first tranche of "first tier" water (equivalent to the portion required to meet basic human needs) available free of charge to "second" and "third tier" water suppliers.[50] The details of these subsidy mechanisms are described in DCD (1998b), DOF (1998), DBSA (1998) and DWAF (1998).

It is difficult to quantify these flows with any degree of certainty. This is because many of the grants are made available for a composite set of services and it is not

[50] The "first second tier" refers to national or government water schemes, the "second tier" refers to regional schemes managed by water boards or local authorities, and the "third second tier" refers to the distribution of water to end-users. See DWAF (1998) for full definitions.

possible to determine what portion of these grants have been allocated specifically to water supply. For example, the housing grant may be used to provide access to water services through contributing to the cost of the local distribution network, and the equitable share subsidy may be used with a large degree of discretion (see DCD, 1998b).

Notwithstanding this uncertainty, it is possible to draw the following more general conclusions with a fairly high degree of confidence: (1) the capital costs of ensuring universal access to *basic* water supplies could be fully covered by the capital subsidies, and (2) the operating costs of supplying a "basic needs amount" of water to poor households could be fully covered by the operating subsidy.[51] However, the extent to which this will be realised in practice is uncertain. In this context, it should be noted that, at the time of writing this report, there is a current initiative to rationalise some of these subsidies (See DBSA, 1998).

2.8.2 Local government financial framework

Tariffs are an important source of local government revenue in South Africa, accounting for 44% of income, compared to 34.5% from intergovernmental grants, 15.5% from property taxes and 6% from other sources (DOF, 1998). Of the local authority's total tariff income, electricity accounts (on average) for about 65% and water for about 20%. However, large differences exist between municipalities.

2.8.3 The implications of the financial framework for pricing policy

The primary implications of the national economic framework outlined above for water pricing are as follows:

- **Nature and level of national subsidies.** It is reasonable to assume that both the nature and level of general (not water-specific) national subsidies related to infrastructure and services should be taken as a given because it is unlikely that this project will be able to alter these in any significant way.
- **Direct urban water related subsidies.** There are *no* subsidies (capital or operating) which are specifically dedicated to the urban water sector. The general national policy is that urban water supply should be largely self-financing, with assistance for poor households provided through more general subsidy mechanisms (the low-income housing grant, the bulk infrastructure grant linked to the housing grant, and the equitable share policy).
- **Price and financial sustainability.** The sustainability of services requires that total revenues (from all sources) match total costs over the long run. At the local authority level, service tariffs are typically used as a financial balancing tool to ensure that revenues match costs. Given the dependence of local authorities on tariff income for a large share of their income, this function is critically important.
- **Trade-offs.** However, there is some leeway within this role because it is possible for water revenue to be used to subsidise other services or, in turn, water services can be subsidised by other revenue sources (such as property taxes). These

[51] The amount to be made available through the "equitable share" policy for the subsidisation of operating costs for basic services has been estimated to be R86 per household per month. The total amount is estimated to be approximately R1 billion per annum. This amount is for all services and not just water supply. See DOF (1998) for details. The amount has been described as insubstantial (Macleod, pers comm., 1998).

financial trade-offs, together with their economic and social implications, lie at the heart of water tariff policy.

2.9 Concluding remarks

The following major themes arise from the above discussion of the South African context. First, improving the efficiency of water use is important in the light of the increasing water scarcity faced by South Africa and the unsustainability of a purely supply oriented approach to water provision and use. Second, sustainable water provision requires that the ecological resource base (the environment) is adequately protected. Third, equity concerns are or particular concern within the South African context because of past policies which deliberately denied people equal economic opportunities. For political (as well as other reasons to be discussed in later sections) it is not desirable that pricing policy focus exclusively on the efficiency of water use; pricing policies should also take equity impacts into account. Fourth, the key to a successful water pricing policy in South Africa is achieving the appropriate balance between these three objectives: efficiency, sustainability and equity. A key objective of this project is to assist policy makers and practitioners in determining and effecting this balance.

3. Water pricing theory - a review

A critical review of the theory of water pricing was undertaken as part of this project and is presented in Working Paper 1 ("Theoretical approaches to urban water pricing: a review"). The key points arising from this review are presented here.

It is necessary to point out that pricing may be approached through the "lens" of different theoretical schools of thought. Three important approaches are neo-classical economics, institutional economics and political economy. The approach adopted here is one that is critical of neo-classical economics and leans more towards the institutional and political economy approaches. The reasons for this orientation are discussed in detail in Working Paper 1. However, it is recognised that there are contending view points that are not represented in this brief summary.

3.1 The marginal cost pricing rule

The "golden rule" of neo-classical pricing theory is marginal cost pricing, that is, setting the price of a good equal to the marginal cost of supply. A key claim of neo-classical economics is that if all prices in an economy are set equal to marginal costs, and there are no externalities or other market distortions, then there will be a Pareto-efficient allocation of resources. A Pareto-efficient allocation of resources is said to exist when it is not possible to increase overall welfare without causing some individuals in society to become poorer. *Hence, the claim is that marginal cost pricing maximises (or at least increases) the overall welfare of society.*[52]

This logic has an intuitive appeal. For example, a producer (or supplier) is unlikely to want to produce (or sell) her last unit at a (marginal) price which is below the (marginal) cost of replacing that unit because the business would otherwise be unsustainable. Where there is perfect capital divisibility (no "lump sum" investments are required), perfect resource mobility (no sunk costs) and perfect information, it can be shown that competitive pressures will tend to create pressures for prices to reflect marginal costs.[53]

However, the welfare maximisation claim linked to marginal cost pricing cannot be sustained for a number of reasons which are briefly summarised below with reference to the water sector.[54]

First, capital indivisibility is the rule rather than the exception. Capital indivisibility is particularly significant in the water sector.[55] There is ambiguity in the definition of

[52] For example, Bahl and Linn state: "The basic rule of efficient pricing states that the price of a public service should be set equal to the marginal cost of producing the service. The justification for this rule is that wealth is maximised when the benefit of an additional unit of the service to the consumer - which is reflected by his willingness to pay the price - is equal to the cost of providing this additional unit, that is, its marginal cost" (1992: 241).

[53] In this case, if a producer sets a price higher than marginal cost, she will be undercut by other producers who offer a better price. Similarly, if the producer sets a price lower than marginal cost, she will go out of business. For a formal discussion, see Mas-Colell *et al* (1995). The basis of the welfare maximisation claim is the first fundamental theorem of welfare economics.

[54] More detailed discussion of each of these points is provided in Working Paper 1.

marginal cost where there is capital indivisibility because short-run marginal costs may be very different to long-run marginal costs. The choice of definition of marginal cost is subjective and depends on the relative importance attached to short-run versus long-run resource allocation issues. Two schools of thought exist, one advocating short-run marginal cost pricing (and alternative methods of raising revenue for the fixed costs and revenue short-falls) and the other long-run marginal cost pricing. There is no consensus in the literature as to which approach is correct (or "more correct").[56] Neither approach can be shown to result in the Pareto-efficient (or Pareto-superior) allocation of resources.[57] Furthermore, there is no one theoretically correct definition of long-run marginal cost.[58] In addition to this, the determination of long-run marginal costs are also contingent on the valuation of capital and the determination of the discount rate, both subject to theoretical conundrums. Differences in theoretical approach, particularly in the case of the discount rate, will have large impacts on the measurement of long-run marginal costs.

Second, sunk investments resulting in resource immobility are common. Irreversible sunk costs are very significant in the water sector.[59] These sunk investments are typically financed through borrowing and hence there is a need for an ongoing income stream to meet the finance costs. There may therefore be a divergence between the price needed to meet financial requirements (to repay the loan and meet operating expenses) and that needed to ensure (either short- or long-run) allocative efficiency. Alternatively, if the sunk investment has been paid for though a tax, then economic distortions arise as a result of the tax.[60]

Third, information is usually incomplete and/or costly to obtain. For example, in the water sector, it is typical that only a very small percentage of consumers are able to recall, with any reasonable degree of accuracy, last month's water bill, water used or

[55] The water sector is highly capital intensive. For example, in the United States, the asset requirement per $1 of revenue is about $10 to $12, which is three to four times the capital intensity of the telephone and electricity industries (Hanemann, 1997: 152). In order to achieve economies of scale, investments are typically related to periodic but large increments in supply capacity.

[56] The electricity industry in France is a primary example of the short-run marginal cost pricing model (following in the tradition of the French regulatory school). Investment costs and operating losses of the government owned electricity utility (Electricité de France) arising from pricing at short-run marginal cost are funded through lump-sum subsidies from the state (Dasgupta, 1993). In contrast to this view, many urban water price policy advocates endorse a long-run marginal cost pricing approach (see Working Paper 1). It is also an approach favoured by some (but not all) neo-classical public utility theorists, for example, Kahn. It is worth quoting Kahn's conclusions in full: "The practical achievable benchmark for efficient pricing is more likely to be a type of average long-run incremental cost computed for a large expected incremental block of sales, instead of short-run marginal cost estimated for a single additional sale. This long-run incremental cost would be based on (1) the average incremental variable costs of those added sales and (2) estimated additional capital costs per unit for the additional capacity that will have to be constructed if sales at that price are expected to continue over time or to grow. Both of these components would be estimated as averages over the same period of years into the future" (Kahn, 1988: 85). For a more formal definition of average incremental cost, see the Glossary and Working Paper 1.

[57] See Working Paper 1.

[58] For example, Mann *et al* (1980) present four different definitions of marginal cost, each differing in how they treat capital expenditures. Beecher *et al* (1991) add a fifth definition. These definitions are presented in Working Paper 1. See also Saunders *et al* (1976, 1977).

[59] Dams, for example, have very little value in alternative uses.

[60] Relative prices are changed by the imposition of a tax.

the price of water. This knowledge presupposes monthly metering and billing which also has a cost implication and is far from universally practised.

Fourth, perfect competition is seldom, if ever, realised. The absence of competition means that producers are able to set their own prices. Private monopolies may wish to realise monopoly profits by restricting output and raising prices. The regulation of private monopolies (for example, requiring monopolies to set prices equal to marginal costs) is subject to inefficiencies and public monopolies may prioritise other objectives above allocative efficiency. (Pricing issues related to ownership and governance are discussed in a later section.)

Fifth, the presence of externalities will mean that Pareto-efficiency is not realised. Externalities are important in the water sector. For example, the provision of basic water services has positive public health benefits, and water use may have negative external costs associated with the deterioration of water quality and damage to the environment. These benefits and costs are typically not included in the price of water.

Sixth, the Pareto-efficiency claim is theoretically untenable where market distortions exist because of the problem of the second-best.[61] It can also be shown that, in general, equilibrium analysis will not lead to the determination of prices that lead the economy even towards Pareto-efficiency.

Seventh, there is not just one marginal cost associated with the provision of water, but an array of marginal costs: marginal peak hour, day, month and year capacity and operating costs, marginal connection costs and marginal availability costs. The calculation of these costs is complex, costly and uncertain. In many cases subjective judgement is involved.[62] Marginal costs also differ between consumers, but there is no consensus on how marginal costs should be allocated between, for example, new and existing consumers.[63]

Eighth, at a practical level, the determination of long-run marginal costs is particularly prone to measurement problems arising from future uncertainty (demand, supply and costs) and subjectivity in the choice of the time frame of analysis and discount rate. Short-run marginal cost pricing does not escape these problems because the investment decision is likewise subject to these uncertainties and subjective choices.

Ninth, demand may not be responsive (or only mildly responsive) to price, in which case pricing will not influence (or only slightly influence) the efficiency of resource

[61] A detailed discussion of this point is presented in Working Paper 1.

[62] For example, it is necessary to distinguish between average capacity costs and peak capacity costs, yet peak capacity costs are joint costs which include some average capacity costs; hence the allocation or attribution of costs must in some sense be arbitrary.

[63] Existing consumers whose demand is not growing over time arguably do not contribute to marginal capacity expansion costs, although opinions differ on this. Hanemann (1997) argues that all consumers contribute to peak demand and hence all consumers are essentially responsible for the marginal capacity expansion costs to the extent that these are related to peak hour, day, month or seasonal demand. On the other hand, Hanke and Wenders (1982) argue that the marginal costs of old and new consumers are different. In the latter case it should be noted that the impact of pricing schemes which differentiate in this way between old and new consumers may be quite regressive. For example, it is typically more costly to serve low-income neighbourhoods in developing countries because these are often situated on remote or marginal land with difficult topography or other cost-escalating factors.

allocation. Available evidence suggests that water demand is generally price inelastic, that is, demand is mildly responsive to changes in price.[64]

Kahn, an advocate of marginal cost pricing, concludes as follows:

> The task of translating [the principles of marginal cost pricing] into actual price schedules is so extraordinarily difficult that it is entirely possible to accept their validity while at the same time concluding that the task of following them is an impossible one. Few would go so far as to abandon the effort entirely. But all would point out, and correctly so, that even the most sophisticated and conscientious effort to apply these principles inevitably involves large doses of subjective judgement and, at the very best, can achieve the *roughest possible approximation* of the desired results. The uncertainty of the resulting estimates and the impossibility of devising and enforcing rate structures that fully embody them counsel a rounding of the edges, a tempering of the principles themselves. Such a tempering is not objectionable even on purely economic grounds: the economic costs of ascertaining and enforcing economically efficient rates can well outweigh the efficiency advantages that such rates suppose to achieve. (Kahn, 1988: I:182, own emphasis)

The above quote provides a frank but rare admission (among neo-classical economists) of the limitations of the marginal cost pricing rule. *In the light of the above discussion, it would indeed be foolhardy to hold onto an unambiguous Pareto-efficiency claim for marginal cost pricing in the urban water sector.* It is therefore not surprising that the review of pricing practice failed to find an example of marginal cost pricing in the form advocated by economic theorists (see Section 4.).

3.2 The Kaldor-Hicks compensation principle

Neo-classical economic policy making relies heavily on the Kaldor-Hicks compensation principle. This principle states that if an economic policy has the consequence of making one set of people better off and another worse off, a potential Pareto-improvement can be said to have occurred if the gainers could compensate the losers and still benefit from the change. The emphasis of most neo-classical analyses in support of policies is on "potential Pareto-efficiency improvement"; the question of the distribution of losses and gains inherent in almost any economic intervention is typically left to a political process (that is, it is ignored in the analysis). Most neo-classical economists consciously chooses this route in an attempt to avoid the inevitable subjectivity of welfare economics and in this way sets itself up as an "objective" science. However, this objectivity is misleading for a number of reasons. First, almost all economic policies have very real consequences for income distribution. In fact, the outcome of marginal cost pricing policies may be highly inequitable. Second, the process of establishing policies which seek to maximise potential Pareto-efficiency improvements is hardly objective, requiring numerous subjective judgements (see above). Third, the many accommodations required to account for imperfect or incomplete markets, externalities, imperfect or asymmetrical information, capital indivisibility, and transaction costs render the potential Pareto-efficiency claims implausible in many circumstances.

One of the most important failings of neo-classical economics is that it does not treat income distribution logically and coherently. Neo-classical economics asserts that

[64] This point is taken up in more detail in a later section.

Pareto-efficiency is independent of income distribution, that is, any distribution of income can be Pareto-efficient.[65] However, this is inconsistent within the theory's own logical framework. Clearly, the prevailing structure of market demands is dependent on the income distribution. Therefore, the whole pricing process implicitly assumes a postulated initial income distribution, which contradicts the second fundamental theorem of welfare economics. The theory of welfare economics thus ends in a logical quagmire and the assertion that perfect competition maximises welfare and is in the best interests of all is untenable. In reality, the existence of imperfect markets, market power, income inequality, imperfect information, transaction costs and uncertainty necessarily introduce the notions of subjectivity and power. Welfare economics is unable to adequately take these phenomena into account.

In conclusion, *it is irresponsible to ignore the distribution and equity impacts of pricing policies and pricing reform.*

3.3 The definition of efficiency

3.3.1 Allocative efficiency

In neo-classical economics, efficiency is defined exclusively in terms of a Pareto-allocation of resources within an equilibrium environment. In other words, neo-classical economics is concerned with the Pareto (or 'optimal') allocation of resources at a given moment in time for a given income distribution in accordance with willingness-to-pay on the part of the consumer (for the marginal unit of consumption) and willingness-to-produce (for the marginal unit of production) at the market equilibrating price. This price must be adjusted where there are market distortions, hence some form of public regulation is almost always required.

This definition of efficiency hinges on two important assumptions. First, it presupposes that the value attached to the use of a resource by a consumer or producer can be derived directly from a monetary measure of willingness-to-pay. Second, it assumes that appropriate adjustments can (and are) made for market distortions and externalities.

The first proposition is particularly problematic in a context where income distribution is highly skewed, which is typically the case, especially in developing countries. The second assumption is contentious. The original optimality claims of neo-classical economics have been successively watered down to take into account a whole range of market distortions. In this context, Samuels (1995) asserts that neo-classical economics has a tendency to reach Panglossian conclusions of the nature "whatever is, is optimal", and that this has the result of lending selective credence to *laissez-faire* policies.

This definition of efficiency is also static, that is, it is concerned with the allocation of resources at a particular point of time. The neo-classical emphasis on static equilibrium analysis largely forecloses the analysis of the operation of real world dynamic processes (Samuels, 1995). This is also a distinct limitation.

[65] This is the second fundamental theorem of welfare economics. For example, Sen has shown that people can starve notwithstanding the fact that the economy is in a Pareto-efficient state (Sen, 1977).

In the light of the above, an exclusive focus on static-allocative-efficiency is clearly problematic. Two other definitions of efficiency present themselves as alternatives: technical efficiency and optimal beneficial use. These are discussed below.

3.3.2 Technical efficiency

Technical or x-efficiency may defined as the achievement of a specific objective with the use of the minimum possible resources. This definition is most easily understood in the context of the physical production of a good. A production process is x-efficient if a given output is achieved with minimum resources, that is, if it is not possible to use less resources to achieve the same output or to achieve more output with the same set of input resources. For example, there would be an unambiguous improvement in x-efficiency if the same output was achieved with the use of less water and no additional resources were required to achieve this. Typically, however, an improvement in x-efficiency requires a substitution of resources. For example, in order to use less water per unit of product produced, it may be necessary to invest in water saving technology. The decision as to whether or not to go ahead with such a resource substitution (in this case, capital investment for water saving) is usually taken on the basis of an explicit or implicit cost-benefit analysis. This requires the costs and benefits of the alternatives to be valued. In this sense, x-efficiency is not very different from allocative efficiency because both require the valuation of resources. However, the objectives linked to the use of each definition are different. Pareto-allocative-efficiency focuses on the optimal static allocation of resources across the whole economy, whereas x-efficiency focuses on the least-cost solution to a particular production function or objective. Although this may appear to a play on semantics, the distinction is important. *An exclusive appeal to allocative-efficiency "requires" (the elusive) marginal cost pricing and is reliant on flawed general optimality claims. Whereas, an appeal to x-efficiency is much more about seeking least cost solutions to specific problems and is free from the more general value judgements implicit in the "everybody will be better off" claim of marginal cost pricing.*

A technical definition of efficiency lends itself to practical operation much more easily that the neo-classical definition of allocative-efficiency. The latter presupposes marginal cost pricing whereas the former does not. The technical definition lends itself to "best practice" bench marking of particular types of water usage. For example, in the iron and steel industry, it is possible to define a best practice bench mark in terms of the amount of water consumed per ton of steel produced. The level of technical efficiency in water use then can be measured easily in relation to this reference. Such an approach is applicable to most manufacturing sectors as well as to many other uses of water. See, for example, Rocky Mountain Institute (1993, 1994ab).

Another definition of technical efficiency may be useful in certain circumstances. A World Bank paper on technical efficiency in water use defines efficiency as the ratio of consumptive use to gross use (Xie *et al*, 1993).[66]

[66] Gross use = total water supplied plus water reused. The paper estimates US industry to have an water use efficiency of only 16% compared to 29% for industrial consumption in Beijing, the latter being accomplished through a combination of pricing incentives and regulation. The comparison of technical efficiency for household water use between developed countries (10 - 20%) and undeveloped countries (35 - 85%) is also instructive showing that much of the additional water demand arising from increased living standards is "wasted" (non-consumptive) use of water which technically could be recycled. This report does not raise the issue of water pricing at all and the relationship between pricing and technical efficiency is not developed in

3.3.3 Optimal beneficial use

The 1997 white paper uses a third definition of efficiency, namely optimal beneficial use. Water use may be described as being of *beneficial use* if it is used for an economically or socially useful purpose. *Optimal beneficial use* achieves the desirable combination of social, economic and environmental objectives, in other words, it is beneficial use in the public interest. The definition of efficiency in terms of optimal beneficial use thus recognises the *social* value of water and the fact that it is inappropriate to value water solely in terms of value placed on the resource by the "highest bidder". Social choice is implicit within this definition of efficiency.

3.3.4 Water pricing and efficiency

In one obvious sense, higher water prices that are directly linked to consumption will tend to promote greater water use efficiency (broadly defined) because the opportunity cost of using water becomes greater. Hence, pricing is an obvious tool to promote greater water use efficiency. However, for the reasons already outlined, there is not necessarily one "efficient" water price. Further, the effectiveness of pricing as a tool to promote efficiency will depend on the price elasticity of demand for water. This is discussed further in Section 5..

On the basis of the above discussion, it may be concluded that an exclusive focus on Pareto-allocative efficiency is inappropriate. Other definitions of efficiency, namely technical efficiency and optimal beneficial use provide a richer "tool set" with which to evaluate the efficiency impacts of pricing policy. Further, establishing the efficiency effects of pricing requires that the demand response to price changes is known. As shown in Section 5., this is by no means a straight forward task .

3.4 Institutional form and pricing

3.4.1 Urban water monopolies

The prevailing monopoly structure of urban water supply can be explained most convincingly by appeal to the decreasing cost structure of the industry (that is, economies of scale arising from technological factors) rather than to other factors (such as the economising of transaction costs). The governance structure of a water monopoly (the extent of public or private ownership of assets and the extent and nature of regulation) will impact on the likely monopoly outcomes. For example, the primary motivating forces of a private monopoly are likely to be profit and market power. On the other hand, public monopolies are likely to be motivated by different factors, for example, political survival or prosperity. In this context, the analysis of the efficiency and efficacy of regulation is just as important as the analysis of the market failure.

other World Bank reports and in its advocacy of pricing policy. An almost exclusive focus on (comprehensive and non-selective) static allocative efficiencies would appear to be inappropriate in the light of the significant gains in technical efficiency that could be realised in a more targeted approach and given that marginal cost pricing across the board is unlikely to be realised in practice (see Section 4). The household technical efficiencies quoted here also raise obvious equity issues: why should a poor household with a technical efficiency of 80% be required to pay the same marginal cost price as a wealthy household with a technical efficiency of 10%?

3.4.2 The need for public regulation

The arguments for the public regulation of urban water monopolies are persuasive given the high *social value* placed on the provision of an adequate and safe water supply and the socially undesirable outcomes potentially arising in the context of an unregulated monopoly. Regulation is necessary or desirable in three respects. First, there is a need to safe guard public health by ensuring that adequate standards are maintained in terms of the quality, quantity and reliability of water delivered. Second, there is a need for economic and financial regulation to prevent monopoly pricing and the realisation of monopoly or excessive profits. Third, it is desirable that the regulation of urban water monopolies promotes equity through encouraging universal access to water services and discouraging unfair or discriminatory policies and practices.

3.4.3 Franchise bidding

It has been argued that monopoly pricing outcomes can be avoided by using *ex ante* bidding to award the monopoly franchise to the firm that offers to supply the product on the best terms.[67] However, in the presence of uncertainty, it is not possible to write complete contracts because all eventualities cannot be foreseen, and open contracts pave the way for opportunism. Williamson (1985) argues convincingly that uncertainty and opportunism are not trivial problems in the context of franchise bidding, especially in the context where there is a high degree of asset specificity and where assets have a long economic life. Both of these pertain in the urban water sector. Williamson concludes that "franchise bidding for public utility services under uncertainty encounters many of the same problems that the critics of regulation associate with regulation" (1985: 333). Further, franchise bidding does not obviate the need for regulation.

From an economic theory point of view, there appears to be little or no *efficiency* advantage of privatisation through franchise bidding compared to a regulated private or state-owned monopoly. Economic theory, *per se*, therefore cannot offer guidance as to the most appropriate form of governance for a natural monopoly and the assessment of the efficiency of the different models must therefore be left to an appeal to other considerations or as a matter for empirical investigation.

It is also important to note that the choice of institutional and ownership form is unlikely to be made solely on the basis of efficiency considerations. This is for two reasons: (1) both the theory and evidence are inconclusive, and (2) the political and ideological context is likely to significantly influence the choice of ownership.

3.5 Implications for pricing policy

The review of theory, presented above in a highly summarised form, has the following implications for pricing policy and pricing methodology:

- **Marginal cost pricing.** The welfare maximisation claim of marginal cost pricing is theoretically weak. In the presence of capital indivisibility there is ambiguity in the definition of marginal cost. Market distortions place significant restrictions of the optimality claims of marginal cost pricing. Hence, *an exclusive focus on marginal*

[67] For a full discussion of this topic, see Working Paper 1.

cost pricing is inappropriate. Kahn concludes that the application of marginal cost pricing principles is "extraordinarily difficult [,] ... [the] task of following them is impossible [,] ... large doses of subjective judgement [are required] ... [and that] uncertainty ... counsel[s] a rounding of the edges" (1988: I:182).

- **The Kaldor-Hicks compensation principle.** Even if the welfare maximisation claim of the marginal cost pricing rule is accepted, the application of this rule may impact negatively on inequality and hence may be undesirable. Neo-classical economic relies on the Kaldor-Hicks compensation principle to negate this objection. This claim is not valid because it is impossible to achieved non-distortionary, costless lump sum transfers. Further, the structure of demand is directly influenced by the prevailing income distribution. *Hence, a consistent and comprehensive analysis of pricing policy should include an examination of the likely impacts of price changes on income distribution and address issues related to inequality.*

- **The definition of efficiency.** An exclusive focus on allocative efficiency is inappropriate. Technical efficiency is a more direct measure of the efficiency of resource use and can be useful in assessing the efficiency impacts of pricing reform. Optimal beneficial use emphasises the social value of water and the need for social choice in the way in which water is allocated and used. *Pricing policy should recognise both the economic and social nature of water and make use of all three definitions of efficiency as appropriate to the particular context.*

- **The influence of market structure.** Institutions impact on the structure of markets and hence on market outcomes. Therefore an analysis which ignores the institutional structures underlying and impacting on markets is incomplete.

- **Pricing is a function of institutional and ownership form.** Pricing rules will typically be a function of the institutional and ownership form. In particular it is likely that there will be a difference in the pricing rules adopted by state-owned, privately-owned-unregulated, privately-owned-regulated and privately-owned-franchised water utilities. The former are more likely to pursue an array of objectives in their pricing strategies (hence pricing rules are likely to be heterodox). Pricing rules for regulated private water utilities will depend on the nature of the regulation (such as cost-plus or maximum return on investment). In general, average cost pricing rules are simpler to regulate although marginal cost pricing rules are also possible.

4. Comparative review of water pricing practice

A primary purpose of undertaking a review of pricing practice is to highlight the differences between pricing theory and practice, and to reflect on the reasons for this.

The review, which is fully reported on in Working Paper 2 ("Urban water pricing in practice: a comparative review") covers three areas. First, *cross-country policy recommendations* for water tariffs emanating from prominent multinational agencies are examined because these recommendations are seen by many to be the views of "experts" on how theory *should* be applied in practice by Water Services Provider (WSP) managers. A review of the environmental economics literature as it pertains to water pricing is also presented.[68] Second, a *survey of water pricing* in a wide range of countries and cities is reported on in order to illustrate the diversity of tariffs applied in practice. Third, *case studies* of water pricing in the cities of Gaborone, Hanoi, Jakarta, Mexico City, Monterrey, Los Angeles and Tucson are presented. These case studies were undertaken in order to gain a deeper understanding of water pricing *processes and practices* and to attempt to comprehend these against the background of the theory. Emerging themes, and the implications of these for pricing theory and policy are discussed in the final section of the Working Paper.

Key points arising from the review are presented below.

4.1 World Bank policy advocacy

The World Bank has a much more direct influence on country water pricing policies (compared to the OECD and UN) because of its role as a financier of development projects, hence it is the only multinational agency discussed here.

A careful reading of the World Bank policies shows that these policies could be used to advance a nuanced approach to the complex problems facing urban water managers in establishing water tariff policy and setting tariffs.[69] The policies do recognise the "political realities" and inequalities inherent in the real world of water supply and that the role of subsidies will continue to be important. Nevertheless the themes that tend to dominate the policy advocacy arena are marginal cost pricing,[70] eradication of subsidies, managerial autonomy from political influence and privatisation. The potential disadvantages of privatisation, including the longer-term impact on inequality through the concentration of resources, are either not mentioned at all or are under-emphasised. Numerous examples of positive outcomes from privatisation are cited whereas privatisation failures are rarely mentioned, or if they are, are blamed on the public sector (inadequate regulation and enforcement is often cited). The almost universal non-application of marginal cost pricing in the water sector does not appear

[68] The review focused on the following writings of Pearce: Pearce and Turner (1989), Pearce *et al* (1990a). Pearce *et al* (1990b) Pearce (1989) and Pearce and Warford (1993).

[69] World Bank policies relating to water pricing are discussed in Working Paper 2. The main references used were: World Bank (1992, 1993a, 1993b, 1994, 1997).

[70] Marginal cost pricing typically is defined by the World Bank as average incremental cost pricing, where the average incremental costs is calculated by dividing the discounted value of future supply costs by the (similarly discounted) amount of additional water to be produced. A more precise definition and method of calculating AIC is provided in Working Paper 1.

to deter the World Bank's advocacy of this pricing practice. The potential lack of congruence between the advocacy of marginal cost pricing for public enterprises and franchise bidding for long term lease contracts (the adjudication of which often hinge on the water tariff as one of the key determinants, with the lowest price bid being deemed the most efficient) is not discussed at all.

4.2 Pricing and sustainable development

4.2.1 An overview

Pearce and Warford summarise a key environmental economics' argument for using pricing incentives to promote environmental sustainability as follows: (1993: 32)

> Prices are powerful incentives. If prices are set too low, excessive use is made of the resource. The extreme example is zero-priced resources. ... To secure an efficient use of resources, outputs should be priced at their marginal social cost, which comprises the marginal costs of production and the external costs of the resource degradation caused by producing the good.

The marginal cost of production referred to is the long-run marginal cost although the definition and calculation of this are assumed to be unproblematic and are not discussed at all. (This argument is, of course, the standard neo-classical one.) The environmentalists, however, stress market failures and, in particular, those which cause private costs to diverge from social costs (arising from externalities) and where markets fail to exist. The latter is usually ascribed to failure to adequately define property rights. These failures can be fixed, in their view, primarily through two routes: full privatisation (in which private property rights over the resource are established, or public regulation. They recognise that the former may not be feasible in all circumstances though they have no problems with that option in principle. For the latter they recommend using market-based incentives.

However, whilst recognising that market failure provides a rationale for government intervention in markets, they strongly caution that public intervention in resource pricing frequently results in prices being set below even the private cost of production or supply (even in developed countries) with consequent "excessive or wasteful" use of resources and "considerable environmental degradation" (Pearce and Warford, 1993: 32, 174).[71] Pearce and Warford qualify the advocacy of efficient pricing by international agencies as follows: "Although international agencies advise the developing world that interventions distort market signals and contribute to environmental degradation, they should also recognise that rich countries engage in similar policies" (1993: 174).

Comment: Many resource economists operating within the neo-classical economics framework believe that sustainability can be achieved through the appropriate valuation of the environment and that this can be largely achieved using market-based or market friendly techniques. Their advocacy of marginal cost pricing is compatible with neo-classical marginal cost pricing. However they do give some emphasis to market failures and recommend ways to value resources (and damages) in the absence of markets. The need for political intervention to implement these recommendations is

[71] For example, they note that electricity prices in the United States are, on average, set at a level 23% below the long-run marginal cost price and that the adoption of marginal cost pricing could save $60 billion worth of energy (Pearce, 1993: 181).

implicit in their discussion. However, important equity issues and the political-economy implications of public intervention (or non-intervention in the case of private markets) are not explored. Postel (1997) questions the efficacy of a purely economic approach suggesting that in the absence of an appropriate "water ethic" it is inevitable that water resources will be degraded, but the political-economy underlying both the absence and formation of such an ethic remains unexplored by her. Opposition to large dams has grown and become an important political-economic factor for new dam developments. The newly established World Commission on Large Dams is likely to play a role in developing guidelines for the future development of large dams. This could influence large new water development projects with implications for resource availability and hence water pricing

4.2.2 Implications for water pricing

The overview of, and comment on, pricing and sustainable development presented above in a highly summarised form has the following implications for water pricing:

- **Water should have a value in and of itself.** Pearce repeatedly argues that under-priced resources will be overused resulting in environmental damage. The implication is that water itself (the drop of water in the stream or in the ground) should have a non-zero positive value. The actual value attributed to water will depend on both the *definition of sustainability* and the method of estimation.
- **Definition of sustainability**. A *strong definition* of sustainable development implies that the physical stock of water resources available (measured in both quantity and quality) should be maintained for future generations. A *weak definition* of sustainable development implies that the sum of the value of the stock of the water resources and the value of the capital stock (money wealth) should be maintained over time.

In the case of **groundwater**, the *strong definition* would imply that the rate of extraction should not exceed the rate of replenishment. A *weak definition* would imply that the groundwater resource could be over-exploited or degraded provided that the wealth created by this action more than compensates the actual cost of either replenishing/rehabilitating the aquifer or securing an alternative renewable supply. In the case of **surface water**, a *strict application of the strong definition* is probably untenable because it would mean that no consumptive use of the water could take place.[72] A *non-strict application of the strong definition* could assert that the extraction of water from a river of stream is permissible *as long as* no (minimal) harm is done to the natural environment.[73] In practice it is probably easier to regulate this directly rather than using price as an indirect mechanism.[74] The *weak definition* would mean that the value added from using the water resource must be able to more than compensate for the damage.

[72] The stock of renewable resource would be diminished in that location by the amount extracted from the river less that returned in a pure state.

[73] Minimum stream flow requirements which are being legislated in some countries (for example, the United States and South Africa) would fit into this category of sustainable development.

[74] In this case, that portion of the water resource required to maintain the proper functioning of the environment is not subject to pricing or competing uses at all and is, in the true sense of the word, "priceless".

From an environmental point of view it is obvious that the weak definition is not very satisfactory as there is no guarantee that the value added will indeed be used to maintain the stock of natural assets.[75]

- **Method of estimation**. Pearce implies that the privatisation of property rights would result in the proper valuation of the resource and hence in sustainability. Even if this were possible (and desirable) in the case of water, this contention remains dubious.[76] Valuing water by means of a market is applied in practice in only a limited number of circumstances and other means of valuing water are therefore necessary. Methods which emphasis the utilitarian use of water in the environment are discussed in Gibbons (1986). However, existing methods for valuing the water resource itself remain problematic. Pearce *et al* (1990a) assert that these measurement difficulties should not cause valuation to be abandoned and that it is better (from an environmental and sustainability point of view) to err on the side of higher rather than lower values. This is in accordance with the general sustainability preference for proactive rather than reactive policies. The most pragmatic approach to setting a value for water is probably that advocated by Rogers (1995, pers. comm.) and called "third best pricing" which simply means raising the price of water and monitoring the impact. This "method" emphases the feedback loop in the pricing process, that is, *it is not so much the absolute level of the price that matters but the impact that price has on a desired set of objectives.*

- **Pricing and future investments - cost benefit analysis**. The role of cost-benefit analysis in the case of water supply projects has always been somewhat problematic because of the difficulty of how to measure the benefits, in other words, the value of the project output (water).[77] In practice, the cost of the project has been reduced to an average price per unit of water and it has been presumed that as long as there are consumers who are willing to purchase the water at that price, then the benefits at least exceed the costs.[78] The inclusion of a water resource cost (the cost of the water itself) and greater attention to the costs of environmental impacts is likely to increase the costs of water supply projects and hence the "price" of water (as calculated in the cost benefit analysis). This "price" could be viewed as a version of the long-run marginal cost (as it is the cost of the next project). At a minimum, a sustainable development approach to pricing calls for a resource cost and the inclusion of all environmental costs in the costs of a water supply project. The added implication is that water from that project is in fact charged at a price which would recover all of these costs.

- **Pricing and choice of discount rate**. The choice of discount rate will impact directly on the price of water if the above pricing schema is used. (It influences the price of water from that project because the price is derived from the cost part of the cost-benefit analysis.). Pearce *et al* (1990a) argue that the discount rate should

[75] In the case of groundwater, a resource tax could be used to ensure the sustainability of the aquifer (though direct regulation is an equally valid option and may be more sensitive to equity issues). In the case of surface water, a "priceless" reserve for environmental functioning appears to be the best method. It should be noted, however, that the establishment of such a reserve does in fact have price implications for the remaining resource (which becomes more scarce and more valuable as a result).

[76] See Working Paper 2.

[77] For a discussion and critique of cost-benefit analysis for (rural) water supply projects, see Schur (1993).

[78] This is the approach adopted by the World Bank.

be set equal to the market rate for capital and that risk and intergenerational equity issues should be addressed separately. The primary risk related to surface water supply projects is that of drought. Pearce *et al* argue that future flows should be converted to their certainty equivalents.[79] Provided that minimum flow requirements are set and adhered to and all environmental damage costs are included (preferably through the inclusion of ameliorative projects), then intergenerational considerations would have been taken care-of. The *only, though key,* uncertainty remaining is a view as to how market rates for capital are likely to change in the future.[80]

Pearce *et al* further asset that the arguments for using a (lower) *social* discount rate rather than the private discount rate (for capital) are not persuasive. They base this assertion primarily on the fact that there is no objective basis for determining the social discount rate. However, this is a spurious or inconsistent argument because they do not use the same logic for rejecting the valuation of the environment which similarly has no objective basis of measurement (see above). One argument for a lower social discount rate is premised on the fact the marginal opportunity cost of capital (expended on any one project) for society as a whole is lower than for a private agent. While this is difficult to establish empirically, there is reason to believe that this is indeed true and that *using a lower discount rate for public projects than that used for private projects is justified.* However, determining the size of the adjustment will require a subjective judgement.[81]

- **Marginal cost pricing.** The sustainable development agenda of environmental or resource economists generally supports the basic contention of neo-classical economics that resources should be priced at their marginal cost. The argument for this is based on the simple premise that if a resource is priced at below its marginal (social) cost, it will convey the incorrect impression that water is an abundant resource and "too much" of the resource will be used, resulting in environmental damage. This is not so much an allocative efficiency argument as a resource damage argument.

- **Conservation and consumer discount rates.** The significant divergence of consumer discount rates from market discount rates has important implications for investments in resource conservation. Advocates of neo-classical economics tend to favour private investment in conservation in response to price signals. That is, if the price of water is set at its marginal cost, then consumers will make appropriate and efficient decisions about their own investments in water saving technologies and appliances, and thus conservation can be "left to the market". However, there

[79] The income flow is related to water availability which can be converted to certainty equivalents (the firm yield). Using the cash flows thus derived will result in a higher unit price because the firm yield will be lower than the average yield. Incidentally, this is the argument for differential pricing according to the assurance of supply. Water cooled thermal power stations, for example, need a very high assurance of supply. Irrigated lands, however, may accept a much lower assurance of supply in return for a discounted price. The Californian Metropolitan Water District has two price schedules - interruptible and non-interruptible. This is obviously an important issue in South Africa.

[80] If perfect capital markets are assumed, then there would be no problem. However, this is not the case.

[81] The *inherent subjectivity within the choice of discount rate* sits uncomfortably with neo-classical economists who prefer to hide this away or ignore it. The implication of the subjectivity is that economic analysis cannot be divorced from political-economy (a conclusion neo-classical economics seeks to avoid). (See also the discussion on discount rates given in Working Paper 1.)

is strong evidence that the market fails to allocate resources efficiently, especially for poorer households and elderly people (Pearce *at al*, 1990a). *This supports the argument for WSP investment in private (household level) water saving technologies*. Such a view is cogently put forward by Woodwell (1992) who argues that WSPs should include in their cost benefit analyses an analysis of investments in water conservation as an alternative "project" to water supply enhancements.

- **Equity**. In the literature reviewed, the implications of sustainable resource pricing for equity are scarcely mentioned.

4.3 Tariff survey

The following key points arise from the tariff survey:

Metering. Metering of both industrial water and domestic water is extensive in both developed and developing countries although exceptions do exist. The benefits of metering are significant, especially in the context where water is scarce and new resources expensive to develop: it enables improved water management and the reduction of waste (through the capability of water audits), and it enables water to be priced in accordance with the amount of water consumed (with attendant fairness and waste reducing incentive advantages). The case studies show that significant improvements in water management and improved services (including greater access) are often, if not always, associated with the introduction of a metering programme.

Types of tariff. A wide variety of tariff structures are in use around the world. Two part tariffs with fixed and variable components are common. In dryer climates where water is scarce, as well as in developing countries, rising block tariffs are prevalent. The absence of water tariffs, or tariffs that are not related to the volume of water consumed are very much the exception. As will be shown in the city case studies which follow, the driving forces behind changes in tariff structure include the need to improve cost recovery, the desire to improve fairness (shift costs to large consumers), address equity though implementation of life-line tariffs and to dampen demand (through raising the marginal price of water, usually by means of an inclining block structure). The prerequisite for many of these changes is universal metering or, at least, a significant expansion in the extent of metering.

Marginal cost pricing. No instances of "pure" long-run marginal cost pricing, in which all water to all consumers is priced at the long-run marginal cost (or <u>average incremental cost</u>) were found in the survey.[82] This is an important finding because it remains the basic tenet of efficient pricing among water economists operating within the neo-classical framework, and the basis of policy advocacy by the World Bank. Selective long-run marginal cost pricing is applied in some contexts, particularly where pressures on water resources are acute. Selective marginal cost pricing usually targets specific consumer categories, seasonal demand and/or certain consumption bands. For example, in the case of domestic consumers, consumption above a certain

[82] A form of short-run marginal cost pricing is sometimes practised. In these cases, the water price is set equal to the operating cost of the supply. (Average operating costs are likely to approximate the short-run marginal cost where there is excess capacity). However, in this form of marginal cost pricing, the price signal is completely divorced from the investment decision. The theoretical arguments for and against short-run marginal cost pricing are presented in Working Paper 1. Although there is no consensus in the general theoretical literature, public utility theorists involved in the water sector overwhelmingly favour long-run marginal cost pricing.

threshold may be priced at the long-run marginal cost (by using a rising block tariff with two or more consumption blocks). However, it is rare for the marginal rates, even in these instances, to be set equal to the full *social* long-run marginal costs of supply.

Privatisation and pricing. The principle impact on pricing from the privatisation of infrastructure in most cases is an overall increase in tariffs over a period of time and an improvement in cost recovery. Privatisation does not necessarily rule out government price subsidies. However, these are usually given for a limited transition period only. A more direct means of subsidising the poor in the case of privatised concession contracts is the provision of targeted infrastructure subsidies, for example, a subsidy per new low-income household connected to the piped network. Where public WSPs are particularly inefficient, privatisation can result in improvements in service provision without price increases. Where this is the case, a key improvement is usually seen in revenue collection. This is because privatised utilities typically are able to enforce stricter debt collection policies (for example, through disconnections) compared to public WSPs. Specific impacts of privatisation are examined in more detail in the case studies.

4.4 Lessons from the city case studies

The primary purpose of undertaking the city case studies was to gain a deeper understanding of water pricing *processes and practices* and to attempt to understand these against the background of the theory reviewed in Working Paper 1. In undertaking the case studies, answers were sought to the following questions: (1) *Who decides* on the water pricing system? How has the pricing system been established? What are the influences (theoretical and other) on the water pricing policy? How have these changed over time and why? (2) What are the explicit and implicit *objectives* of water pricing? How have these changed over time and why? (3) What is the *structure* of the pricing system, how has this changed over time and why? (4) How *effective* has the pricing system been in terms of the set objectives? What impact does water pricing have on the efficiency of water use, income inequality and resource sustainability? How "fair" is the pricing system?

The following criteria were used for the selection of the case-studies: (1) representation of cities in both developed and developing countries, (2) representation of cities with both scarce and abundant water resources, (3) representation of both public and private management / ownership of water supply, (4) water management and pricing experiences that exhibit one or more of the following characteristics: high marginal costs of source development relative to average costs, significant service inequalities, significant changes in pricing structure and prices levels over time, conservation programmes, privatisation, and public management, and (5) availability of reliable current (and where relevant) historical information.

Seven cities were chosen. These are shown in Table 10 with reference to two of the selection criteria:[83]

[83] The researcher wished to include Santiago (Chile) and/or Buenos Aires (Argentina) as case studies, however, suitable published material could not be located.

Table 10: Selected cities by country type and water resource availability

	water resources	
	scarce	plentiful
Developing countries	Gaborone, Botswana Monterrey, Mexico Mexico City, Mexico	Jakarta, Indonesia Hanoi, Vietnam
Developed countries	Los Angeles, USA Tucson, USA	*

* It was felt that it was not necessary to include a city in a developed country with plentiful water resources.

Key points arising from the case studies are highlighted below.

4.4.1 Who decides?

Four basic models of decision making were present in the case study sample: (1) decentralised (city level) political control, (2) devolved management responsibility to a public utility (with central political control), (3) centralised (country level) political control, and (4) privatised utilities (with central or devolved political control). Each is discussed in turn. In addition to these different institutional models of decision making, the issue of responsibility for new development costs arose as an important issue. This is discussed in the last sub-section.

4.4.1.1 Decentralised political control

Water pricing decisions are largely decentralised to the local (city) level in the United States. This is also a common practice in many developed and some developing countries. In Tucson and Los Angeles, policies and final decisions on tariffs are made by locally elected politicians. Some outside constraints are imposed by the state or federal government. For example, cities in California are required to prepare five-yearly urban water management plans, cities in Arizona are required to demonstrate sustainable water resource planning and use, and all cities in the United States must comply with various federal water quality and environmental provisions.

The power of citizens to influence water pricing has been demonstrated in both Los Angeles and Tucson. Important elements of radical tariff reform were rejected by a minority but powerful constituency in each city forcing revision. The influence of business interests on the non-domestic tariff structure is readily apparent and the municipal WSPs have been reluctant to impose higher water prices for fear of jeopardising jobs. Hence business tariffs have been consistently lower than domestic tariffs in these two cities historically although the gap has narrowed significantly. Low-income residents are catered for through the provision of a free allocation of water (8 kl/month) in Tucson (though a fixed monthly connection fee of $5 is payable) and a direct credit ($5 - which is equivalent to 8 kl/month) in Los Angeles. Median usage in Los Angeles is 40 kl/month and, considering the overall level of wealth, the allocation is not generous but can nevertheless enable a household to get by without compromising health. An innovation in Los Angeles is the extension of the water credit to households living in apartments (who typically do not have individual meters and who were previously excluded from the benefit) by adding it as a credit on the electricity bill. The price of water for "reasonable use" (variously defined by each city)[84] has been kept at or below the historic cost figures. Thus it is fair to say that the tariff reforms have not disadvantaged low income families and have, overall, shifted costs to larger consumers of water despite the resistance on the part of larger consumers.

The experiences of Tucson and Los Angeles show that within a context of decentralised local level water management in which pricing decisions are made by locally elected political representatives, with increasing pressure being placed on the water resource, and in the context of a developed economy with universal access to in-house metered water, *it is politically feasible to implement a full cost recovery (revenue neutral) progressive rising block pricing with high marginal tariffs which have the dual benefit of increasing incentives to use water wisely and catering for affordability constraints (through life-line tariffs or direct credits).* However, a key question remains: can such an approach work in a developing country context and, if so, under what conditions?

4.4.1.2 The water utility model

The political-economy of decision making in the Botswana type water utility model is slightly different to that presented above. In this case, the water utility was established with the clear political twin mandate of universal access and financial autonomy (with the exception of government payment for provision of standpipe water to initially unserved areas). Beyond the broad mandate (derived politically through the democratically elected parliament), policy making is essentially depoliticised. The water utility has managerial autonomy, being accountable to the defined mandate and not directly to political representatives. This has enabled the WUC to operate on a commercial basis and to implement tariffs which achieve three objectives: (1) full recovery of costs, (2) affordability for basic requirements (life-line tariffs) and (3) reduced wastage through providing incentives to use less water (high marginal tariffs). The implementation of the last objective has not been popular, particularly amongst businesses (the tariff structure is applied equally to domestic and non-domestic uses). However there is little doubt that the well-run, efficient and financially viable WSP has benefited most consumers (basic use is subsidised, reasonable use is reasonably priced, services are reliable and service coverage is very high). These objectives are rarely accomplished in the water sector in developing countries.

The removal of the tariff setting process from the political arena has the advantage of giving management a free hand to set tariffs to achieve the objectives of the mandate despite potentially negative responses on the part of a minority but potentially politically powerful consumer constituency. Middle-class "subsidy capture" is not an uncommon phenomenon in developing countries and is well documented.[85] Botswana's WUC stands out as a rare example of an efficient and effective public water utility in the developing world.

[84] In Los Angeles, the definition is particularly complex and arguably weighted in favour of owners of larger properties (ergo wealthier households).

[85] The World Bank asserts that "price subsidies to infrastructure almost always benefit the nonpoor disproportionately. In developing countries, the poor rely on private vendors or public standpipes rather than private connections for water supply and they are infrequently served by sewerage systems" (World Bank, 1994: 81). Data published by the World Bank indicates that the ratios of public subsidies to richest versus poorest quintile for selected countries are: Hungary: 1.2, Costa Rica: 1.3, Uruguay: 1.3, Argentina: 1.4, Chile: 1.5 and Dominican Republic: 2.8 (World Bank, 1989).

4.4.1.3 Fiscal centralism

The implicit objective of central funding for, and subsidisation of, urban water services in Hanoi and Jakarta was equity. However, in both cases, the net result was highly inequitable. The failure to make sufficient resources available meant that a minority benefited from the subsidies. Lack of managerial accountability (severely undermined by lack of resources) led to inefficiency and wastage of resources. The central control and allocation of resources in (at least) Jakarta was ripe for patronage. Greater reliance on local resources increases managerial accountability. There was an absence of a clear mandate and insufficient resources were secured for the adequate provision and operation of services. In this context, local consumers (or would be consumers) are particularly disempowered.[86]

4.4.1.4 Privatisation

It is hard to determine the exact causes of privatisation with any confidence. It is highly probable that both national and international political and macro-economic factors played an important part in the privatisation of water services in Mexico City and Jakarta. Nevertheless, it is fair to say that poor management and the need for large ongoing subsidies also added significant pressures and may have contributed to privatisation. In neither city was the privatisation decisions made by local citizens in a referendum or issue orientated election of local political representatives.[87]

It is pertinent to pose the following question: What impact will privatisation (through long term concessions in both cities) have on decision making and the distribution of cost and benefits related to water supply? The answer to this question depends on both the nature of the contract entered into (and its exact provisions) *as well as the distribution of power over time* between the private company and the regulating agency (national government in both cases). It is unfortunately too soon to answer the latter part of this question.[88]

It may be asserted (with a fair degree of confidence) that *if the contract is well structured and provided the external environment is conducive*, privatisation should bring significant benefits in the short term, especially where the existing infrastructure is poorly managed.[89] The primary benefits are likely to include an injection of management expertise and capital.[90] Another benefit may be an increase in technical efficiency (through, rehabilitation, improved maintenance and better management).[91] If investment in new service provision to the previously unserved is structured into the

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[86] Whilst Monterrey was eventually on the receiving end of central government beneficence, a more critical analysis of the historic political-economy dynamics leads to the conclusion that capriciousness played a significant role. Fiscal centralism of the type experienced in Mexico in the 1980s and early 1990s does not lend itself to the equitable allocation of development resources.

[87] The privatisation decision was made by a democratic national government in Mexico and a non-democratic national government in Indonesia. The broad economic policies of the Mexican government, which included privatisation, are (arguably) endorsed by the majority of the electorate, that is, those who elected the government into power.

[88] The privatisation of water supply in Mexico City commenced in 1995, and in Jakarta in 1998.

[89] Specific information on the privatisation contracts was not available. Of course, privatisation contracts may be poorly structured with much less desirable results. See, for example, Cramer (1998).

[90] These would typically have been lacking or severely constrained in the publicly managed WSP.

[91] Though is no theoretical expectation that a change in *ownership per se* should lead to increased efficiency (see Working Paper 1). Neither does the empirical evidence support this (see Working Paper 2).

contract, then there may be significant equity benefits too.[92] The costs of these improvements must be paid for. The exact distribution of the costs will vary depending on the contract. However, it is almost certain that there will be a shift in costs over time away from tax payers to users. Ongoing government subsidies may or may not be provided, though a reduction in the level of subsidies over time typically is structured into the contract.[93] Debt collection is also likely to improve.[94] In essence, though the benefits to users may be significant (improved access, reliability and quality), it is likely that these benefits will be paid for more directly by users.[95] Another group also benefits from privatisation, namely the owners of equity in the private company who receive a return on their investment through increased share values and dividend payments.

The risk of negative impacts of privatisation in the short term arise from the potential for poorly structured contracts, poor regulation, poor monitoring and enforcement, and under-valuation of assets at the time of the sale.[96] Provided these dangers are averted, the short-term benefits from privatisation are likely to be positive for the reasons given above.

The distribution of costs and benefits in the long term are much less certain. This is because there is considerable potential for the power relationship between the private company and the regulator to move in favour of the private company, which, in turn, may also lead to a shift in the distribution of the benefits towards the company.[97] (This is known as regulatory capture.)[98] The ultimate consequences of this are likely to be a concentration of power and benefits and an increase in inequality.[99] The early experiences of privatisation in Los Angeles and Monterrey confirm this.[100] How the longer term works out depends very much on the regulatory framework that is adopted and the power relationships between the contracting parties (determining the likelihood of effective enforcement).

4.4.1.5 Responsibility for the costs of capacity expansion

Both Tucson and Los Angeles made efforts to shift the cost of capacity expansion onto new developments which were the proximate cause of new (incremental) water demand. These pressures were resisted by developers and in the case of Tucson and the Metropolitan Water District of Southern California, the policies have been rescinded. The apparent "consensus" around the principle that those responsible for

[92] It has been argued previously that where service provision is not universal, the extension of services to the unserved is one of the most important equity contributions that can be made. Much is made of these benefits in the publicity surrounding the Buenos Aires privatisation contract, for example.

[93] See Working Paper 2.

[94] For reasons previously discussed in Section 4.3.

[95] Hence, the net benefits to user may or may not be positive depending on the past financial and tariff arrangements. I am not arguing, incidentally, that a more direct relationship between benefits and costs is a bad thing.

[96] See, for example, Cramer (1998). Even within a developed country such dangers exist. For example, experience shows that the assets for the water industry in the UK were undervalued at the time of sale.

[97] And its shareholders.

[98] The reasons for this have been discussed in Section 3.4.3.

[99] See, for example, Cramer (1998).

[100] See Working Paper 2 for a discussion of the Los Angeles and Monterrey experiences.

the increase in consumption should bear the cost of system expansion collapsed when the impact of the implementation of the consensus was felt. The debate around the responsibility for system expansion costs raises important equity issues. These issues are all the more acute in the context of a developing country where the wealthy typically already have a water supply and a relatively stable demand and where the bulk of system expansion often is needed to cater for lower-income households. In this context, a policy of shifting costs onto new development may be seen as being highly inequitable and regressive.

4.4.2 Pricing objectives and their attainment

Perhaps the most striking feature of the case studies is the complete absence of agreed measurable parameters by which the attainment of pricing objectives can be assessed. In the absence of measurable parameters, assessment of the attainment of pricing objectives is necessarily imprecise and subjective. Nevertheless, such a broad assessment may still be useful. A summary of the pricing objectives (and an assessment of their attainment) is presented in the table below for each of the cities studied.

Table 11: Pricing objectives and their attainment in case studies

	Gaborone	Hanoi	Jakarta	Mexico City	Monterrey	Tucson	Los Angeles
Recover O+M	+++	+	+	+	+	+++	+++
Recover CAP	+++			x		+++	+++
Affordability	++					+++	+++
Reduce waste	++					++	++
Equity		x	x	+	++	+++	++
Fairness						++	++
Sustainability			x				++
Efficiency	++		x			++	++
Conservation	++					++	++
Incremental change						+++	++
Transparency							++

Notes: O+M = operating and maintenance cost, CAP = capital costs. The +++ system is a subjective evaluation by the author of the extent to which the stated objectives have been realised: x = failure + = poor attainment ++ = reasonable attainment and +++ = good attainment.

The presentation of the table risks reductive reasoning. (The reader is referred to the discussion of the objectives and their attainment for each city, which is presented in Working Paper 2). Nevertheless, what is immediately apparent is the coincidence between the failure to recover operating and maintenance costs and the general lack of attainment of other pricing objectives, in particular equity. Hanoi and Jakarta both "fail" the primary "equity test", namely, a significant proportion of households in the city being doubly disadvantaged as a result of the pricing policies: they have no formal (public) water service *and* they receive no subsidy (and hence invariably have to pay more to secure their own water), whereas those with a formal supply not only have access to a better and cheaper water supply, but they also receive a subsidy (often in proportion to how much water they use). The case of Monterrey is unique because of the unprecedented investment in the "Water for all" project. Whilst this certainly significantly improved equity in access to water services in Monterrey, when this approach is examined at the country level, the overall contribution to equity is questionable because the level of investment in this one city almost certainly is not replicable country-wide (or, at the very least, the political-economy conditions for this to occur are unlikely to be realised).

On the other hand, realisation of full cost recovery coincides with good attainment of other pricing objectives including equity, fairness and increased efficiency. It is notable that full cost recovery does not need to jeopardise affordability. Gaborone, Tucson and Los Angeles all include features in their tariffs which promote the affordability of "reasonable use" and subsidise low-income households through direct credits or life-line tariffs (provision of a free or subsidised water allowance up to a specified consumption).

Efficiency and reduced wastage of water is promoted in Gaborone, Tucson and Los Angeles by the implementation of high marginal tariffs (seasonally differentiated in the case of Los Angeles) for the top consumption band within a rising block structure for residential consumers (and industrial consumers in the case of Gaborone, although this is under revision). This structure shifts the burden of costs onto larger consumers and provides greater incentives for larger consumers to reduce consumption. However, both Tucson and Los Angeles have refrained from implementing marginal tariffs for industrial consumers in this way, preferring to place a surcharge on the differential use between summer and winter. The perverse incentive of increasing winter usage so as to lower summer charges is negated by the imposition of (substantial) sewer charges which are based on winter consumption.

4.4.3 Pricing structure and levels

Flat rate tariffs are implemented in Hanoi and Monterrey. However, revenues are insufficient to meet full costs in the case of Monterrey (where capital investment is subsidised by the federal government), and operating costs in the case of Hanoi (the deficit is made up by central government subsidies, though even these are insufficient to provide for adequate operation and maintenance).

Rising block tariffs are implemented in Jakarta, Mexico City, Gaborone, Tucson and Los Angeles. However, in Jakarta and Mexico City, revenues were not adequate to meet operating costs. Sufficient revenues to meet full costs (operating and capital) were raised in Gaborone, Tucson and Los Angeles. A form of marginal cost pricing is implemented in Gaborone, Tucson and Los Angeles as discussed above under "pricing objectives".

An analysis of how tariff structures have changed over time in Tucson and Los Angeles is instructive as both are "rich" cities situated in (now) water resource poor areas. Both cities originally implemented standard two-part tariffs (fixed monthly fee and constant volumetric tariffs). Both subsequently changed their tariff structures to decreasing block tariffs favouring large water consumers. (Tucson changed its tariff to this form in 1964, Los Angeles much earlier). Plentiful water resources were available to both cities at this time (a large groundwater aquifer in the case of Tucson and the supplementary water from the Colorado River Aqueduct in the case of Los Angeles). The primary influence on this change was the desire to attract and keep large water users (industries) and to promote economic growth. Los Angeles changed its tariff to a standard two-part tariff in 1977 in response to a significant drought, however, prices for industrial water were still lower than domestic water. Tucson changed from a declining to inclining (mild two-) block structure in 1974 and to a much steeper block tariff in 1976 (the "water furore").[101] This "radical change" arose primarily from a financial crisis stemming from poor planning and fast urban growth rather than a shortage of water per se. Since then this tariff structure has essentially been retained and become even steeper over time, though commercial and industrial prices continued to be lower than domestic prices (with a surcharge on peak seasonal consumption rather than absolute consumption). Water tariffs in Los Angeles were fundamentally restructured in 1993 with the implementation of a rising two-block tariff, with the second tier explicitly set at the average incremental cost of supply. (Industrial and commercial water prices were conceptualised in a similar fashion to those of Tucson, that is, a surcharge on peak summer consumption related to average winter consumption.) The "radical" change in pricing structure in Los Angeles was precipitated by the 1987-1992 drought, with water restrictions being implemented in the latter part of the drought. In both cities, even though tariffs were structured so as to mute the impact on low-income and water-wise domestic consumers, the impact on large domestic consumers caused such extensive political reactions that tariff structures were revised in both cities to accommodate the disaffected constituencies, even though these were in the distinct minority and were wealthy.

4.4.4 Pricing impacts

4.4.4.1 Efficiency of water use

Neo-classical economics measures resource efficiency in terms of the departure of prices from marginal costs: the greater the difference between marginal price and marginal cost, the less efficient water use. This is not a very satisfactory measure for a number of reasons: (1) The calculation of marginal cost is subjective and inexact. (2) Even if water is priced at its marginal cost, allocation efficiency is not guaranteed on theoretical grounds because of the problems associated with market failure and second-best pricing. (3) Even if the theoretical premise of second-best pricing is accepted (that is, its theoretical flaws are glossed over), for practical reasons, resource efficiency may not be obtained by marginal cost pricing in the context of significant income inequality. It is sufficient to consider a simple example. A very wealthy household is likely to use water wastefully even when water is priced at its marginal cost. This is because the cost of the water supply will be a very small percentage of the wealthy person's income and the price elasticity of demand will be essentially zero. On the other hand, a very poor household may purchase much less water than is efficient from both the household's and society's point of view because the cost of water priced at its marginal cost represents a significant proportion of the household budget and the price elasticity of demand may be highly elastic.[102] *A system which*

[101] See Working Paper 2 for a detailed discussion of this episode.

[102] If water demand is elastic for a low-income household, this may mean that the household is willing to sacrifice water use for the sake of other more necessary goods such as rent and food. It does not indicate that the household is using an adequate quantity of water to maintain a healthy environment. Even if the water demand of a low-income household is inelastic, this may mean that the household has reached the absolutely minimum necessary quantity of water to live and that the household is forced to sacrifice other essential items such as

allows wasteful use of a resource in the context of severe water under-use which threatens health and productivity can only be described as efficient by stretching the meaning of that word.

However, while higher marginal water prices increase the incentive to use water more wisely and to reduce wastage, it is clearly problematic to use this as the sole measure of water use efficiency for the reasons outlined above. There is a sound rationale, therefore, for using a *wider set* of measures to establish water use efficiency. It is apparent from the literature review and the case studies that no such alternative set of measures exist.

4.4.4.2 Income inequality

Neo-classical economists, by appealing to the first and second fundamental theorems of Welfare economics and the Kaldor-Hicks compensation principle, argue that pricing should not be used for the purpose of influencing income distribution. The weaknesses of this argument have been highlighted above.[103] In particular, any pricing policy affects income distribution (whether this is intended or not). The multiple objectives commonly associated with water pricing (see above) mean that the water pricing process must be subject to *political mediation*. There is, therefore, no cogent reason why pricing policy cannot be used in a more explicit way to affect income distribution. The case studies show that all of the pricing structures had (often unintended) impacts on income equality and equity. However, clear equity goals and measures were generally left unstated and were often ambiguous. The development of a transparent equity framework would serve to enhance the pricing policy process. This point is taken up below.

4.4.4.3 Resource sustainability

The review of the environmental policy literature has demonstrated that pricing, on its own, is unlikely to lead to resource sustainability, although it can certainly contribute to it. In the case of Tucson and Los Angeles, the primary impetus in the move towards protecting the environment has come through the respective state legislatures which have introduced certain controls on water resource extraction to balance aquifer extraction and recharge (in the case of Tucson) and maintain river flows and lake levels (in the case of Los Angeles). Economic instruments have generally been considered a supplementary tool. Implications for theory and policy are discussed below.

4.5 Implications for pricing policy and methodology

4.5.1 The policy making process and multinational agencies

Neo-classical economic thinking has come to dominate the policy advocacy of important multinational agencies such as the OECD and the World Bank. Its influence within the United Nations is more muted but still apparent. Of the three agencies reviewed, the World Bank has the most significant influence on water pricing policy in developing countries because of its role as financier. The influence of neo-classical

food. See, for example, the excellent study of water demand amongst poor households in Khartoum (Cairncross and Kinnear, 1992). A review of price elasticity of demand studies is given in Working Paper 4.

[103] A more detailed refutation of this argument is presented in Working Paper 1.

economics is also most evident in the World Bank. The essence of the World Bank policy prescriptions are marginal cost pricing, eradication of subsidies, managerial autonomy from political influence and privatisation. Although a closer reading of World Bank policy advocacy admits to a more nuanced contextualised approach to policy making, as already indicated, World Bank practice is not always in accordance with this. For example, the World Bank is generally averse to inclining block tariffs in its direct policy advocacy (contending that all water should be priced at its marginal cost) even though it does admit to the important role that such a tariff structure can play.[104] Policies which seek to increase efficiency invariably have equity implications (see above). It is therefore irresponsible to advocate efficiency enhancing policies without adequate analysis of the equity implications, a practice the World Bank has followed.[105]

In the light of the above, *the policy advocacy of multinational agencies should, at the very least, be critically tested within the receiving context.* For it is only proper contextual analysis within the political-economy reality that will enable appropriate and feasible policies to be developed in any particular context.

4.5.2 Sustainability, pricing and political-economy

A strong definition of sustainability requires that the stock of water (quantity and quality) be maintained over time. As water resources have become more scarce (greater competing use) the issue of sustainability has become more important.

Some environmentalists operating within the neo-classical framework believe that sustainability can be assured through the privatisation of water rights and/or appropriate resource and marginal cost pricing. However, the privatisation of water rights has inherently high transaction costs and problematic equity implications. Some countries have chosen to go this route, although often only to a very limited extent.[106] Many environmental economists remain pessimistic about water markets (Pearce *et al*, 1990a). The appropriate valuation of the water resource itself (using applied economic tools) and marginal cost pricing are seen as alternative "objective" ways of ensuring sustainability. However, there are at least two major objections to this: (1) the process of valuation is inherently subjective, and (2) pricing, on its own, will not necessarily ensure sustainability.[107]

These objections bring pricing and sustainability into the realm of political-economy. First, legislative intervention (arising out of a political process) appears to be

[104] "For water, increasing block tariffs can be used - charging a particularly low 'lifeline' tariff rate for the first part of consumption (for example, 25 to 50 litres per person per day) and higher rates for additional 'blocks' of water. This block tariff links price to volume, and it is more efficient at reaching the poor than a general subsidy because it limits subsidised consumption. Increasing-block tariffs also encourage water conservation and efficient use by increasing charges at higher use. These tariffs are most effective when access is universal. When the poor lack access, as is frequently the case, they do not receive the life-line rate and typically end up paying much higher prices for infrastructure services or their substitutes" (World Bank, 1994: 81).

[105] For example, in World Bank policy advocacy related to water pricing in South Africa, the Bank was very explicit that its brief was to improve efficiency and that the equity implications were something for South Africans to look after (Roome, pers comm., 1994).

[106] A limited water market in water rights has developed in the United States, Mexico and Chile amongst other countries. For a critical discussions of these markets see, for example, Bauer (1997).

[107] It is important to note here that markets too, without appropriate regulation, will not necessarily ensure resource sustainability, in fact, markets left on their own are most *unlikely* to ensure sustainability (in the strong sense).

necessary to ensure the sustainability of the water resource. Second, the valuation of the water resource raises important questions related to who is doing the valuation and whose interests the valuation serves.

4.5.3 Disjunctures between pricing theory and practice

4.5.3.1 The myth of marginal cost pricing

No instances of marginal cost pricing in which the long-run marginal cost price was applied to *all* units of water sold was found in practice (although instances of selective marginal cost pricing were found). The disjuncture between neo-classical pricing advocacy and the practice of water pricing is stark. Most theorists pose the question: why is there a general failure to implement marginal cost pricing? While this question is certainly valid, an alternative and equally valid question is seldom asked: why do (neo-classical) economic theorists continue to advocate marginal cost pricing in the face of overwhelming evidence that such pricing is an anathema to citizens, government and water managers alike and that political-economic realities universally and persistently render the implementation of "pure" marginal cost pricing unfeasible? The answers to both of these questions lie in a more serious analysis of the political-economy of pricing.

4.5.3.2 Equity frameworks

A striking feature of the pricing experiences studied is the general absence of a rigorous equity impact analysis.[108] The fundamental reason for this appears to be a lack of consensus on the meaning of equity. A clear and common understanding of the meaning of equity and the development of clear (and attainable) equity goals would greatly facilitate both the development of tariff policy and the evaluation of the effectiveness of the implementation of that policy. *A key challenge in tariff design is the establishment of an appropriate equity framework.* The notion of what is equitable and fair may vary significantly, particularly where there are large disparities in wealth. The provision of guidelines and tools to aid policy makers in the development of such a framework can make an important contribution to tariff reform in developing countries.

4.5.4 Some institutional and political-economy considerations

4.5.4.1 Governance

Institutional arrangements have a profound effect on pricing decisions and outcomes. In particular, the institutional arrangements affect who makes the decisions and what the distributional impact of these decisions are. The economic concept externality can be understood also in terms of institutions and governance, that is, where there are people who are affected by a decision but who are not party to that decision, an

[108] The Los Angeles tariff reform of 1992 is the exception. When Los Angeles restructured its tariffs in 1992, considerable attention was paid to the impact on equity. The tariff restructuring resulted in consumer tariffs being reduced for 70% of domestic consumers with costs shifted onto larger (wealthier) consumers (City of Los Angeles, 1992). However, the negative impact on a small minority of relatively wealthy residents in the San Fernando Valley resulted in refinements to the tariff, reducing consumer bills for larger consumers. This was considered to be (or marketed as) an improvement in equity by the Citizen Committee which oversaw the tariff review, however, this committee was weighted in favour of the San Fernando residents. Using an alternative frame of reference, the equity improvement becomes questionable.

externality exists.[109] As a general democratic principle it seems important that people who are affected by a decision should have a say in that decision. If this principle is accepted, then institutional and governance arrangements should be designed so as to enable this.

Within the water sector this has two basic implications. First, water resource management should take place at a catchment level (one or more catchments).[110] Second, there is a need for political oversight in the management of water services because of the important social good nature of water. A generic model for political oversight of the management of water services is shown in Figure 24.

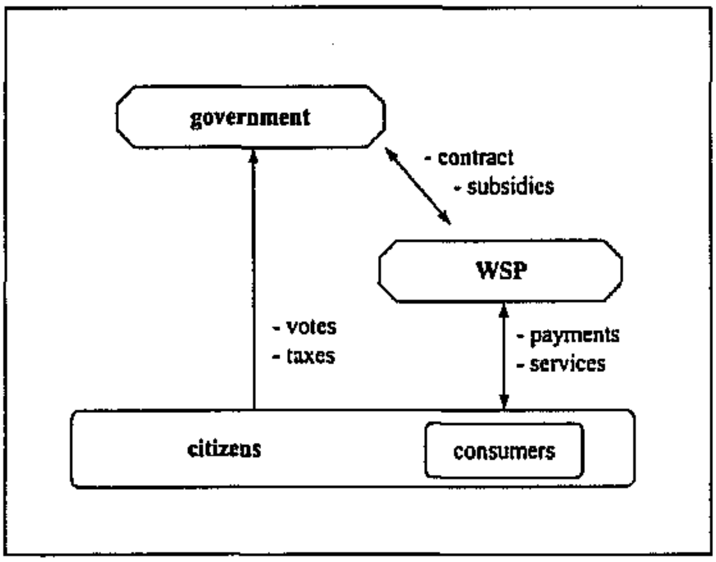

Figure 24: Governance in the water sector

The following features are of note in this model. First, a distinction is drawn between citizens and consumers. Citizens interact with representative (democratic) government primarily through the voting process and the payment of taxes. Consumers consume services supplied by a the water services provider (WSP) (only water services are of interest in this context) and make direct payments to the WSP for these services. (In developing countries not all citizens have access to water services and hence the distinction between consumers and citizens is particularly important.) Second, a distinction is made between government and the WSP (even though the WSP may be part of government). This distinction is made to draw attention to the separation of political and technical functions. Citizen representation and tax collection is a political function. Service delivery is a technical function (though it may have important political ramifications).[111] Third, the political function (labelled government in the figure) can take place at a number of levels, neighbourhood government, city government, regional (district) government and/or national government. Fourth, the WSP, whose primary function is to provide water services to existing and new consumers, and to collect payments (service fees) from consumers,

[109] The philosophical rational that free markets are in everyone's best interests because all trades are voluntary (and hence trades are only undertaken if both parties gain, or at least do not lose) *fails precisely at the point where there are externalities*, that is, when third party effects are not taken into account in the exchange.

[110] As this is the direction in which South Africa is moving, and because this is not within the scope of this research project, catchment management issues are not discussed here.

[111] In the sense that it affects the distribution of benefits (and costs).

could be a government department (local, regional or national), a public utility or a private company. Similarly, the WSP could operate at the neighbourhood, city, regional or country scale. Hence, within this basic governance model, a whole range of possibilities exist.

The four most important questions related to the governance of water services are as follows: At what level should the political oversight be exercised? How should the political oversight be exercised? What institutional model is appropriate for the WSP? At what scale should the WSP operate?

There are no universally correct answers to these questions. For example, the case studies show examples of political oversight being exercised effectively at both the country and city levels, of well-run local, regional and national scale WSPs, and of different (but successful) forms of ownership and control.

4.5.4.2 Privatisation

Although the successful management of water services may be associated with a wide range of governance arrangements (as indicated above), there are factors which may hinder the achievement of this goal. These include the lack of availability of adequate resources, lack of managerial skills, patronage, corruption and the absence of clear objectives and managerial mandates. Many neo-classical economists contended that privatisation provides a governance structure which obviates these factors. However, the fact that privatisation itself is not necessarily a panacea is made apparent by the poor experiences of private management in Monterrey and Los Angeles early this century.[112] Both failures of private management can be blamed, at least in part, on an inadequate regulatory environment. The warning of Postel is therefore apt: "there is ample reason for heightened vigilance" because "given the pace at which privatisation is occurring, it seems unlikely that adequate rules and regulations are in place in many cases to protect the resource base, ecosystems and the poor" (Postel, 1997, xxix; see also Cramer, 1998).

4.5.4.3 Responses to significant price increases

Fundamental restructuring of tariffs in Tucson and Los Angeles which had the impact of significantly increasing water bills generated significant consumer opposition, even in the context of relative consumer affluence. In the case of Tucson, it resulted in an explicit policy of incremental change. In Los Angeles the tariffs were revised to accommodate the disaffected consumers who represented a powerful interest group (that is, they were wealthy). These two experiences provide salutary (though slightly different) lessons for advocates of radical tariff reform.

Resistance on the part of consumers to large tariff increases is an understandable and natural phenomenon. However, the likely consequences of this resistance to tariff reform ought to be understood by the tariff reformer. Failure to do this may undermine the objectives of the original reform. In Tucson, the tariff reform was used as a pretext for certain interest groups to achieve essentially unrelated political ends. However, the process generated a lack of trust between citizens and elected representatives that was to have longer term implications such as the hindrance of the pace of further tariff reform.

[112] These experiences were not isolated nor unique. A number of other cities experienced similar problems. See, for example, Blake (1956).

In both Tucson and Los Angeles, the negative response of wealthy consumers to tariff increases was underestimated. The tariff reform had, in both cases, shifted costs significantly to larger and, ipso facto, wealthier consumers. In both instances, wealthy consumers succeeded in having the primary negative impact of the tariff ameliorated. If tariff reform advocates are serious about shifting costs onto larger consumers, it will be necessary for them to develop strategies to counter the reactive but politically significant responses of the minority of large consumers who are disaffected by the changes.

4.5.4.4 Marginal cost pricing

The case studies show unequivocally that Political-economy factors mitigate against the implementation of full long-run marginal cost pricing (in which the long-run marginal cost price is applied to all units of water sold) where these costs are significantly above average historic costs. Increases in the marginal price of water above average historic cost, even within a rising block structure, have been resisted and WSPs have not applied these same marginal rates to commerce and industry.[113] Reaction to high marginal rates has been marked, even (and perhaps especially) in wealthy communities who perceive it to be unfair. The fact that no instances of full marginal cost pricing in the case of urban water supply were found in the tariff survey further supports this contention.

4.5.5 Methodological implications

4.5.5.1 Changing the starting premises

The neo-classical approach to pricing, as outlined in Working Paper 1, commences with a consideration of Pareto-efficient allocation in perfect markets and then seeks to adjust this for market failures, equity considerations and other practical considerations. Environmentalists within the neo-classical school concerned with sustainability adopt essentially the same model. Their primary concern and contribution is the development of valuation techniques for the environment (that is, corrections for market failure *vis-à-vis* the environment). In the case of water supply, where both equity and sustainability considerations are of paramount importance, this neo-classical model essentially fails. *In the light of this, it is preferable to change the premises and reverse the process by starting out with well developed equity and sustainability frameworks, and, within these frameworks, examine the ways in which efficiency in water use can be improved.*

4.5.5.2 A contextualised approach

Such an approach must take into account the political-economy context for it is this context which will determine the likely parameters of the equity and sustainability frameworks. The extent of the protection of the environment and the degree of equity desired are essentially political decisions which will be influenced by the political-economy balance of power. Any policy advocacy which is to stand a realistic chance of successful implementation must be firmly rooted within such a contextualised political-economy analysis. *The implication of this is that policy advocacy must be undertaken on a case by case basis, with a proper understanding of the political-economy at both the country and city level.* Notwithstanding this, within a specific

[113] With the exception of Gaborone, although this is under revision.

country context, it may be possible to develop a generalisable methodology which is applicable to a number of cities and towns.

4.5.5.3 Developing a political-economy informed pricing methodology

The above arguments suggest that a new pricing methodology that is sensitive to political-economy issues would comprise the following elements:

1. **Contextual understanding**. The development of an understanding of the political-economy context at the country and city level.

2. **Equity framework**. The development of an equity framework that addresses itself to political-economic realities.

3. **Sustainability framework**. Similarly, the development of a sustainability framework that responds to political-economic realities.

4. **Efficiency of resource use**. The development of a consensual understanding of resource efficiency in general and water use efficiency in particular.

5. **Indicators**. The development of a consensual understanding of appropriate and practical *sets* of indicators for equity, sustainability and resource efficiency, in particular, water use efficiency.

6. **Pricing objectives and goals**. The development of explicit pricing objectives together with measurable goals.

7. **Determination of price structure and setting price levels**. The pricing structure is developed and price levels determined so as to achieve the objectives defined above. Associated (non-price) policies aimed at achieving these objectives are also developed.

8. **Measurement of impacts and refinements to pricing**. This approach emphasises the iterative nature of the pricing process whereby improvements are made so that the objectives are more fully achieved. The availability of practical measures whereby the extent of attainment of the specified objectives can be assessed greatly assists this incremental reform process.

Using this framework, methods to assist in the development of a pricing policy are reviewed in the following section.

5. Methods to measure efficiency, equity and financial sustainability

A review of measurement methods that may be helpful in the development of urban water pricing policies is reported in Working Paper 4 ("Modelling urban water demand to understand efficiency and equity impacts: methods to inform urban water pricing policy"). The first part of the Working Paper looks at the theoretical and empirical literature which focuses on the relationship between prices and water demand. The neo-classical theories of end-use and intermediate-use water demands relating to the consumer and producer respectively are reviewed with the view to determining the implications of the theory for empirical analysis. The methodologies employed in empirical analysis are then examined in detail. The focus of these methodologies is on the determination of the price-elasticity of the demand for water. The results of empirical studies are reported and conclusions drawn. The second part of the working paper examines the theoretical and empirical issues related to welfare measurement, income distribution and inequality in the context of urban water demand and pricing. The third part of the working paper discusses the role of financial models in evaluating the financial sustainability of service provision and the financial impacts of tariff reform. Only key points arising from this review are presented here.

5.1 The measurement of efficiency

5.1.1 Why measure price-elasticity of demand?

The neo-classical claim of the Pareto-optimality of marginal cost pricing is contingent on the demand for water being responsive to changes in its price. More precisely, the Pareto-optimality claim requires that water demand is price-elastic, that is, that the absolute value of the price-elasticity of water demand is greater or equal to one. There is, therefore, a large empirical literature which focuses on the price-elasticity of demand of water. Methodological issues are of considerable importance and are discussed first. Thereafter the empirical evidence is presented and conclusions drawn.

5.1.2 Methodology

The following key points arose from the review of the theory and methodology of water demand studies undertaken to determine the price-elasticity of demand.

Linear and log *forms of the demand equation* are most commonly used in the literature even though these are formally inconsistent with the neo-classical theory of consumer behaviour.

The *choice of independent variables* is often constrained for practical reasons. The most important explanatory variables are household income, weather and price. Other variables that may be important are household size and irrigation area. In developing countries the modelling of supply side constraints is also likely to be important.

Where two-part, increasing or decreasing block pricing schedules are used, the marginal price is not equal to the average price and a decision has to be made concerning the *specification of the price variable*. In general, Nordin's method of specifying the marginal price and a difference variable appears to be favoured in the literature although there is little consensus as to the validity of the model. (See Working Paper 4.)

In general, micro-level *data sets* are to be preferred to aggregated data sets. However micro-level data may not be available or may be of dubious accuracy. This is particularly the case in developing countries. The use of cross-section analysis to estimate demand curves relies on the dubious assumption that price-elasticities derived from inter-consumer comparisons of demand are equivalent to and can be applied to inter-temporal variations in price for the same consumers. It is also prone to the problem of heteroscedasticity, particularly in developing country contexts. Although time-series analysis circumvents this, it has limitations of its own: where price changes are small this method is likely to be inaccurate because it assumes a stationary underlying trend which is unlikely to be true; where price changes are large the resulting measure is not a true point elasticity because the demand curve would have shifted at the same time. Pooled data analysis has the advantage of requiring less data, however, the limitations of both time-series and cross-section analysis are included in this methodology. No wholly satisfactory data set exists in practice, hence compromises must be made. These need to be borne in mind when interpreting the results of empirical analysis. In practice, the selection of the data set is likely to be constrained by practical factors such as the availability and reliability of data. *The best data that a water utility can easily collect should* be used as a general yard stick for demand modelling if the model builders wish the model to have widespread and repeated use in any particular context.

The *choice of estimation technique* may be important, particularly where price is itself a function of consumption. In general, the assumptions necessary for the ordinary least squares (OLS) technique to give valid estimates do not hold when the pricing structure is non-linear. Other estimating techniques, namely instrumental variables and two- or three-stage least squares have been used in an attempt to overcome the problem of simultaneity. However these techniques may give rise to other equally serious econometric problems, particularly multicollinearity in two- and three-stage estimation techniques, and the results are sensitive to the model specification. *Regression analysis in the presence of a non-linear price function therefore is inherently problematic and great caution needs to be exercised when interpreting the results arising from this analysis.*

Hewitt and Hanemann (1995) used a *discrete-continuous choice model* in an attempt to overcome the problems of simultaneity present in other regression models. However, the model is considerably more complex. Furthermore, the consistency and reliability of the results obtained are questionable.

Where price increases are significant, the calculation of point-elasticities is unlikely to be appropriate. *Arc elasticities* provide a measure of the average response of demand to price over the relevant price and quantity range. This "rough and ready" method has been used infrequently in practice even though, in certain contexts, it can provide a robust measure of demand response to price which is not fraught with the theoretical and practical problems associated with the other more complex methods discussed here. Such a method may be particularly applicable in developing country contexts as Katzman (1977) has demonstrated.

Rather surprisingly much of the literature fails to recognise that the *price-elasticity of demand is it itself function of price*. Furthermore, assumptions concerning the form of the demand curve (linear, isoelastic, among others) are frequently made without justification. *Where price reform moves the price outside the range of historic experience, the application of statistical regression techniques to historical data is generally not helpful to predict the demand response to these changes.*

Although income is universally included as an independent variable, few studies report *price elasticities as a function of income.* This is surprising as it is well known that price elasticities generally (though not always) will be higher (in absolute value) for lower income households than for higher income households, other factors held constant.

Lucas (1976) made the important point that the parameters estimated from an econometric model are dependent on the policy prevailing at the time and will change if there is a policy change. Therefore significant changes in the price structure and/or price level will render the price-elasticity estimates obtained under different conditions invalid.

5.1.3 The empirical evidence

Hanemann (1997) surveyed the literature on price-elasticities of demand undertaken in the United States since 1950. These results are depicted in Figure 25. Estimates for a range of countries and contexts are presented in Working Paper 4.

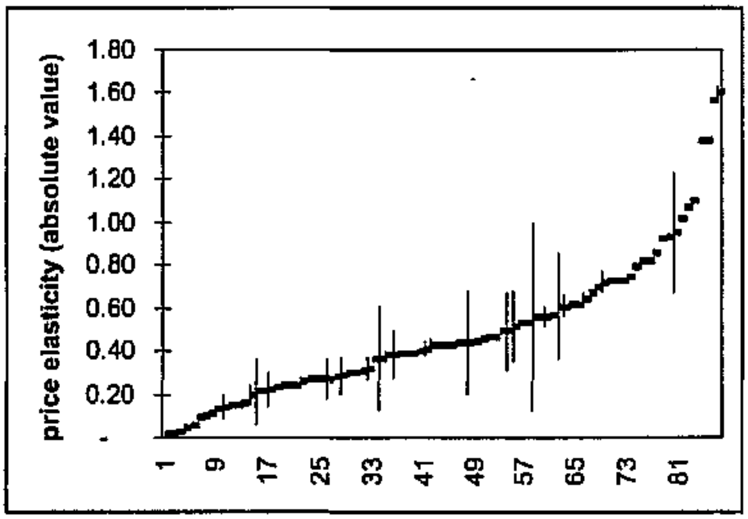

Figure 25: Price-elasticity estimates - water demand in the USA

Approximately one third of estimates are in the range 0 - 0.3, a further third in the range 0.3 to 0.6 and the remaining third larger than 0.6. *Less than one tenth of estimates show that demand is elastic* (> 1). Carver and Boland (1980) make the important point that comparisons between dissimilar studies are fraught with difficulties and should be avoided. However, examination of sub-groups within the set of estimates for water demand in the USA reveals that *in all the sub-groups* (grouped by type of use, time of use, location and type of data), *a wide range of estimates exists*. (See Working Paper 4.)

Key points arising from the review of the empirical evidence are summarised below.

The empirical data ably demonstrates that *methodology matters* and profoundly impacts on the results of the analysis of water demand. (See Working Paper 4.)

In addition to method, *the quality and nature of the data profoundly influences the results*, yet there is little discussion in the literature on data reliability. In developing countries, data reliability is a particular problem. (See Working Paper 4 for typical sources of and reasons for data unreliability.)

Any estimate of the price-elasticity of demand has a *confidence interval* attached to it. For example, if an estimated price-elasticity is -0.5, there may be a 90% probability that that actual value lies in the range -0.2 to -0.8. Obviously the implications of an actual price-elasticity of -0.2 are very different to -0.8, yet the estimate is only able to say that the actual value lies somewhere in this range with a 90% probability. In the light of this, it is remarkable how little attention is given to this aspect of price-elasticity estimates in the literature. The question of confidence intervals becomes even more important when considerations of data uncertainty and the impact of methodology on results are also included in the interpretation of confidence intervals. In fact, the uncertainties attached to many estimates may be so large that they are in fact meaningless for most practical purposes.

The water demand study by Cairncross and Kinnear (1992), one of the few undertaken in developing countries, confirms the fact that there is a *minimum threshold consumption which consumers value very highly*. They found an effective zero price-elasticity of demand even in the context where households pay an average of 55% of their income for between 25 and 30 lcd of water from vendors.

Peak seasonal *outdoor demand* is likely to be more elastic than that for indoor usage, *ceteris paribus*. The excellent study by Howe and Linaweaver (1967) demonstrates the impact of garden irrigation (sprinkling) on *peak demand* and system capacity *costs* in particular.

It is remarkable that only a few of the studies reviewed calculate and *quote price-elasticity as a function of household income*. Agthe and Billings (1987) reported price elasticities by income groups showing that in the case of a mildly increasing block pricing structure in Tucson, price elasticities decreased as income increased. A similar (though more striking) pattern was found by Renwick (1996). She calculated price elasticities which ranged from -0.53 for low-income, -0.21 for middle income and -0.11 for high income groups.

Very few of the water demand studies reported in the literature discuss *equity* issues. Agthe and Billings (1987) argue for a steeper inclining block structure in Tucson on the basis of the assertion of combined equity and efficiency improvements. Martin and Wilder (1992) modelled delinquency rates as a function of price and household income. They found a strong inverse relationship between income and delinquency rates and note that "low income households find it more difficult to remain current in paying water bills and are consequently more likely to face cutoff ", and further that "the burden of increased rates includes the loss of service by some households" (Martin and Wilder, 1992: 99). Renwick (1996) found in her study area that price policy may shift the conservation burden to lower income households. Cairncross and Kinnear (1992) found that pricing can discriminate against the poor because at low (subsistence) levels of consumption the price-elasticity of demand may be zero. Equity issues are discussed more fully in the next section.

Nieswiadomy and Cobb (1993) undertook to analyse the *impact of rate structure* on price-elasticity. Their results suggested that increasing block structures were more conservation orientated than other rate structures.

Renwick (1996) modelled the adoption of *water saving technologies*. She found that price policy, non-price policy and technology change may all reduce household water demand; households with higher incomes are more likely to adopt water efficient irrigation technologies compared to lower income household when subsidies are provided for water saving appliances The point concerning household discount rates made by Pearce *et al* (1990a) is important in this regard: poor (and elderly) households are likely to apply very much higher implicit discount rates in their decisions to purchase water saving devices because they are more risk averse and the opportunity cost of the money used to purchase the goods is much higher than for higher income households. This further supports the findings of Renwick (1996) and may have important policy implications. For example, Woodwell (1992) asserts that *supply side investments in water saving technology (even at the consumer level) may be much more efficient than using marginal cost pricing* and relying on households and industries to invest in water saving technologies.[114]

Few studies disaggregate (or aggregate) the data in accordance with the different demand characteristics of different groups of households. Renwick (1996) found that the *composition of the aggregate does matter*. She found that policy responsiveness and thus the distribution of the conservation burden differ depending on the policy instrument and the characteristics of the household classes. In the context of developing countries, income inequalities may be extreme and thus there may be wide disparities in income even within income stratified groups of consumers. This should be borne in mind when drawing policy conclusions from empirical results.

Renwick (1996) found that *policy sequencing* (for example, pricing versus restrictions) may influence the reduction in demand attributable to a particular policy instrument when more than one policy is implemented.

There is uncontrovertible evidence that the implementation of *metering* and the imposition of a non-zero marginal price significantly impacts on water demand (see Working Paper 4).

Hogarty and Mackay (1975) used arc elasticities and time-series data to calculate demand responses to *large changes in the marginal price*. They obtained mean elasticities of between -0.56 and -0.86 (though these were not statistically significantly different from one another) for the price increase and close to zero for the price decrease. They attribute the elasticity of the price responsiveness to a combination of income and substitution effects. The income effect arises because higher water tariffs may reduce discretionary income by a much higher proportion than total income in the short term because a large proportion of total income may be pre-allocated (housing and car payments, for example). The substitution effect arises from the adoption of new practices (for example, fixed leaks, shorter showers, brick in the toilet cistern, water efficient settings on clothes and dish washing machines). The asymmetry in demand response to price changes may arise from the tendency for some of the substitution effects to be "less reversible" (for example, the fixing of leaks).

[114] "Data specific to Denver show that the potential gains in aggregate consumer surplus attributable to supplier-financed investments in improved water-use efficiency are many times larger than potential gains from reformed [marginal cost] pricing. An expanded efficient pricing rule which incorporates these supplier-financed investments, promises substantial improvements in economic efficiency" (Woodwell, 1992).

Relatively few studies have been undertaken on *industrial water demand*. The results confirm the expectations that the characteristics of water demand differ significantly between industrial sectors and that sectoral studies are more useful than studies of aggregate industrial demand. Renzetti found that firms that have experienced relatively high water expenditures are also the firms whose water demands are predicted to be the most sensitive to changes in water prices. He interprets this to mean "low industrial water prices may also discourage these firms from adopting water-conserving technologies or undertaking research and development into water conservation. Thus *the most significant implication of under-pricing water for industrial use may not be that it encourages excess consumption in the short-run but that it allows these water using practices to become embedded in the firm's technology and capital stock in the long-run*" (1992a: 401, own emphasis). Renzetti's results also showed that water intake and recirculation were substitutes. This is a significant finding because it means that *an increase in water prices will lead to a reduction in water intake and greater recycling*. Similarly, he found that discharge and recirculation are substitutes. This is also an important finding because it means that *an increase in discharge fees will result in greater recirculation and hence also a reduction in water intake* (1992a).

5.1.4 Conclusions

Although the exposition of the theory of water demand is relatively straightforward, it is no easy matter to *apply* this theory in a general and consistent matter to the empirical analysis of water demand. This is borne out by the fact, noted by Hanemann (1997), that almost all empirical modelling of water demand that has been recorded in the peer review literature to date is formally inconsistent with the neo-classical theory of preferences and demand. Deaton and Muellbauer make the equally damning point that demand theory is very often used in a "highly cavalier" fashion with little attention being paid to formal consistency between theory and application (1980: 80).

The review of the empirical literature on water demand showed that *there is considerable controversy and little agreement on three key methodological considerations*: the choice of the appropriate equation form, the specification of the price variable and the choice of estimation technique. It was shown that all three impact significantly on the empirical results. There is therefore considerable *methodologically induced "noise"* in all water demand estimates.

If the lack of data availability and reliability, which are particular problems in developing countries, is added to the methodologically induced uncertainties, then it may be expected that the results obtained from empirical studies are likely to have very *wide confidence intervals* rendering the results to all intents and purposes meaningless. Indeed, the review of the empirical results presented in this section confirms this expectation. The results show unambiguously that methodology impacts significantly on the results and that the results, in general, have very wide confidence intervals.

A further important limitation of empirical analysis arises from the *Lucas critique*. This states that the parameters estimated from an econometric model are dependent on the policy prevailing at the time and will change if there is a policy change. Therefore, significant changes in the price structure or price level outside the historical range will render the application of price-elasticity estimates obtained under different conditions invalid.

Lack of homogeneity amongst consumers as a whole means that *aggregate estimates* of price elasticities gloss over very real differences between consumers.

The usefulness of this kind of empirical demand analysis for *welfare analysis* is highly questionable. This is because welfare analysis requires the examination of the demand behaviour of individual households rather than the community as a whole (or groups of households). The use of a "representative household" to model welfare impacts, a method often employed to circumvent this problem, may yield highly misleading results, particularly where income disparities are stark (which typically is the case in developing countries). It is therefore not surprising that equity and welfare issues are almost totally ignored in the literature on water demand (see below).

The *disaggregation* of consumers into more homogeneous stratified groups will enhance the efficacy of water demand analysis. Housing type or census tract (that is, enumerator area) may be appropriate means of grouping residential households (Saleth and Dinar, 1997).

Results from different demand studies are generally *not comparable* with one another. Similarly, the results of demand studies are generally *not transferable* from one context to another. Very few water demand studies have been undertaken in developing country contexts. This means that an understanding of water demand in a particular developing country context cannot rely on the empirical findings of other studies.

The calculation of *point elasticity estimates* in a developing country context may be inappropriate. There are no a priori grounds for assuming the demand curve to be of any particular form. Point elasticities are only accurate at the respective mean values of the estimating equation. Lack of homogeneity amongst consumers means that the estimate of the price-elasticity at the mean value is not all that useful (particularly for the purposes of welfare analysis). However, when moving away from the mean value, different assumptions concerning the form of the demand curve will influence the estimated price elasticities away from the mean. Hence the estimation of arc elasticities may be more appropriate.

There appears to be little merit in employing complex methodologies which attempt to estimate *point elasticities* of demand.

In conclusion, a methodology for the analysis of demand in developing countries is needed which (1 is appropriate in terms of the accuracy of the available data and the level of confidence required for the predictions; (2) does not treat consumers as homogenous aggregates; (3) lends itself to welfare analysis (because of the importance of equity issues); (4) is able to make predictions of demand response and welfare effects over a wide range of income and demand values, that is, it is not dependent on point elasticities and functional form assumptions; (5) is not resource intensive (in terms of methodology and data requirements); and (6) is widely applicable but context specific.

5.2 The measurement of welfare

This section is concerned with the measurement of social welfare. This is a particular concern in relation to water pricing in developing countries because water is a basic necessity and because of the prevalence of highly skewed income distributions in these countries.

5.2.1 Measuring consumer welfare

Much of the neo-classical literature concerning welfare analysis in relation to water demand uses Marshallian consumer surplus as the measure of consumer welfare, which may be defined as "the excess of the price which he [the consumer] would be willing to pay rather than go without the thing, over that which he does pay" (Marshall, 1920). This approach to the evaluation of consumer welfare is only valid for the evaluation of *individual consumer welfare*.[115] The approach therefore requires that the changes in the welfare of each individual (or possibly household)[116] be measured. This means that price-elasticities of demand for each individual household are required. This is typically not available and hence an analysis of the type described above is simply not possible. An alternative is to measure the welfare change of a so-called representative household. However, this approach is clearly problematic, especially in a context where welfare inequalities between households are significant.

Willingness-to-pay is an alternative approach to the analysis of water demand and consumer welfare. The premise here is that the supply of a service should match the demand for the service as measured by the consumers' willingness-to-pay. Where consumers are price-takers, which is typically the case for urban piped water supplies, the marginal willingness-to-pay is simply the price of the water and is the same for all consumers that face that same price. Where no market for urban water exists, researches have used contingent valuation studies to estimate consumes willingness-to-pay for water. This methodology has been advocated and popularised by the World Bank. Essentially, contingent valuation or willingness-to-pay (WTP) studies create a hypothetical market for water by setting up an auction or bidding process ("game") with respondents (potential consumers) in a structured survey. Various techniques are introduced purportedly to reduce the three kinds of bias that may arise, namely, strategic bias, starting point bias and hypothetical bias (see Whittington *et al*, 1990).[117]

Cairncross and Kinnear (1992) are critical of contingent valuation studies:

[115] The validity of Marshallian consumer surplus also requires that there are no wealth effects, which is typically not true. Equivalent or Compensated Variation may be calculated to account for wealth effects, though this analysis is seldom undertaken in the empirical literature. For further discussion, see Working Paper 4.

[116] The transition from individual welfare to household welfare is, however, not straightforward (Deaton, 1997).

[117] A recent review of the administration of contingent valuation studies in developing countries is given by Whittington (1998) who is rather sanguine about the value of these studies.

> Most studies have used the "conditional" approach, in which the potential consumers are asked how much they would be willing to pay for the given level of service, although the response to such questions may be biased in several ways. Respondents may be unaccustomed to answering hypothetical questions, may answer in such a way as to finish the interview as soon as possible, or may give deliberately false replies with a view to pleasing the interviewer, or to obtaining a water supply at the cheapest possible price. A further weakness of the approach is that it can only focus on the consumer's decision whether or not to use and pay for the water supply. The method cannot be used to assess the degree to which charging for the water will lead consumers to reduce their consumption; those who do not currently pay for water have difficulty enough in stating how much they use at present, without having to guess how much they would use under hypothetical circumstances." (1992: 183)

Experience in other fields suggests that contingent valuation tends to over-estimate willingness-to-pay (see, for example, Loomis *et al*, 1996). At a more fundamental level, contingent valuation may be criticised for undertaking an "income-blind" valuation, particularly if the CV is aggregated across a community to derive a social value. This point is made clearly by van Horen (1996: 18): "if a poor person places a value of a Rand on something, it has a higher value for that person than a one Rand valuation from the rich person; therefore to derive a social valuation by aggregating all individual valuations is highly problematic."[118] Goldblatt (1997: 119f) notes two further limitations of contingent valuation studies.[119] The first, which he calls "double contingency", refers to the fact that consumers are asked to value a service outside of their experience, namely both an improved *level* of service (for example, yard taps compared to communal taps) *and* an unknown future *quantity* of water consumed. In this context, volumetric based bids for water are particularly problematic. The second limitation is that CV studies are unable to take into account the effect of political and social factors and the impact that these may have on both demand and payments. Goldblatt (1997) cites the example of consumer boycotts in South Africa prior to 1994 and the hypothesised "culture of non-payment" arising from this.

5.2.2 Measuring social welfare

The standard neo-classical approach to the evaluation of consumer welfare (presented above) is not able to account for the social evaluation of inequality. Social welfare functions have been developed for this purpose and are described in Working Paper 4. However, there is a distinct danger when reducing the measure of welfare, inequality, poverty or distribution into a single scalar number (which is what social welfare functions do). This is because there is always substantial uncertainty about how to weight the distribution (for example, the degree of preference for equality or reduced poverty, and how to measure the poverty line in the latter case). Another reason is that the representation of welfare inequality or extent of poverty by just one number hides the richer detail that lies beneath its calculation.

On the basis of the above reasoning, Deaton (1997) advocates the use of graphical techniques for representing distributions. One common technique is the use of Lorenz curves (or integrals thereof) which gives graphical representation to measures of inequality. However, simple density functions, and in particular nonparametric density functions, can often be a very useful tool for analysing distribution and Deaton is a

[118] Cited in Goldblatt (1997: 27).

[119] Goldblatt (1997) presents an excellent review of contingent valuation studies.

strong advocate of this approach (1997: 169). An advantage of using nonparametric density functions is that they are not dependent on any particular economic theory (and consequently the assumptions implicit or explicit in the theory). Rather, *nonparametric density functions allow the data to speak for themselves, unfiltered and untainted by theory*. In particular, the joint density of welfare and consumption can be used to describe the differential effects of price reform on the well-being of the rich and poor. This is a particular useful tool for assessing the impacts of water price reform in developing countries. The mathematics of estimating nonparametric density functions are explained in Working Paper 4.

5.2.3 The empirical evidence

Given the important influence that price reform may have on welfare and equity, the lack of empirical literature on the subject is remarkable. Four kinds of studies are briefly examined in Working Paper 4: (1) the determination of the income-elasticity of demand, (2) the demand for access to water, (3) review of contingent valuation studies, and (4) measuring changes in welfare using the Marshallian consumer surplus method. No applications of the kind of nonparametric analysis advocated by Deaton (1997) were found in relation to water price reforms. Key points are highlighted here.

5.2.3.1 Income elasticity of demand

The available (though sparse) empirical evidence indicates that water demand has a low income elasticity of demand, typically less than -0.3. It should be noted that the estimation of the income-elasticity of demand for water is open to the same criticisms as those applied to the estimation of the price-elasticity of demand.

Methodological implications. Therefore, in general, either arc-type measurements of income-elasticities of demand or nonparametric bivariate analysis of the consumption and income density distributions appear to be the preferred methods of analysis. These are not susceptible to the problems of the (parametric) regression analysis critiqued above (and in more detail in Working Paper 4).

5.2.3.2 Demand for access

There is very little data available on the price-elasticity of demand for access to urban water supplies. Existing data suggests that the demand for (official) connections is both a function of the cost of these connections as well as the relative availability and cost of alternatives, including illegal connections.[120] If alternatives are available, then the price-elasticity of demand is likely to be higher than otherwise. Illegal connections could arise as a result of an unfulfilled demand due to a the lack of institutional capacity or adequate infrastructure to make the connections.[121] The price-elasticity of demand for connections is also likely to be a function of income and is likely to be much higher for low income households compared to high income households. The availability, functioning and efficiency of the household credit market could also be an important factor affecting the demand for new connections.[122]

[120] For example, in Bogotá and Jakarta, illegal connections have been quite common in poor neighbourhoods and have been related to the high cost of connections (Bahl and Linn, 1992: 298). McPhail (1994) also concluded that in the urban areas of Tunis, it appears that the most important obstacle in connecting to the piped water system is the utility-required cash down payment.

[121] This is reported to be the case in Rabat (McPhail, 1993).

[122] See Singh *et al*, 1993.

Methodological implications. Contingent valuation methods can be used to assess the willingness to pay for individual household connections to a piped water system. However, poor households will generally not be able to pay the full capital cost of the connection and hence the value of undertaking contingent valuation surveys *solely* for this purpose is questionable. Contingent valuation surveys can be used to obtain an estimate of how much households would be willing to pay *on a monthly basis* for a private water connection (see below).

5.2.3.3 Contingent valuation

Goldblatt's (1997) excellent review of contingent valuation studies is used as the primary source for the evidence presented here. Goldblatt (1997) notes that remarkably few studies have been undertaken in the water supply sector in general. It is also apparent from his review that even fewer willingness-to-pay studies on water have been undertaken in urban areas. The available evidence on water vending suggests that where public supplies are not adequate, it is the poor who end up paying most (per unit) for water and it is not unusual for these households to spend up to 20% of their income on water and sometimes even more than this (Goldblatt, 1997: 25, Cairncross and Kinnear, 1992). A number of studies found willingness-to-pay surprisingly high (Whittington *et al*, 1989, McPhail, 1993). However, it is not possible to generalise from these results. Meta-surveys have been undertaken in an attempt to understand the key factors affecting willingness-to-pay. Determinants of willingness-to-pay may be divided into three categories: socio-economic and demographic, the nature of the supply and available alternatives, and the perception of the role of government. Although household income was found to be an important determinant, it is not necessarily the overriding determinant (Goldblatt, 1997: 30). Gender and education have been found to be statistically significant determinants of willingness-to-pay. The difference in the characteristics between existing and proposed improvements to supplies is a strong determinant of willingness-to-pay; so is the amount that people are currently paying for water. It has been found, not surprisingly, that people are willing to pay substantially more for private connections than access to a public tap (Goldblatt, 1997: 30). Lastly, the attitude of the community towards government and the perception of the role and responsibility of government as well as the *likelihood and expectation* that the government will provide subsidised services significantly influences willingness-to-pay. The World Bank has noted that "the sense of entitlement and equity may be a significant obstacle to the charging of realistic prices for water" (World Bank Water Demand Research Team, 1993: 58).

Goldblatt (1997) undertook a contingent valuation study of willingness-to-pay in two informal urban settlements in South Africa. His study found that there was almost 100 percent agreement amongst the households surveyed that payments for water supplies were necessary; some 64% of households would only connect to a piped water supply system if their monthly expenditure was below five percent of their income (thus the results were broadly supportive or the traditional "five percent rule"); this amount equated more or less to the operating cost of a full level of service *but only for a very small amount of water* and could not cover operating costs for the *likely* consumption from a private connection nor the capital costs. There were two very distinct limitations to the study. First, households could estimate how much they were willing to pay on a monthly basis but were unable to estimate *how much* water they would consume with a private household connection, and in particular the marginal value of the increased consumption.[123] Second, the survey was unable to determine how *political and social factors* affect willingness-to-pay. The report noted that the results of a willingness-to-pay study "[do] not negate the possibility that political will is the transcendent force controlling the speed of improvements in water supply" and further that it does not provide answers to "the *moral questions concerning the welfare role of government*, and whether water supplies, and other urban services, are a good vehicle for pursuing welfare strategies" (Goldblatt, 1997: 117). For example, Goldblatt argues that "although poor urban residents are willing to pay an amount adequate to cover the [costs of] their water supplies, *it [may] not [be] appropriate to expect low-income households to spend five percent of their income on water alone.* Given the importance of water as a basic need, it could be argued that it provides a useful vehicle for subsidisation of the poor" (1997: 117). In fact, the results of the survey support this argument. Households *were* having to pay for water from vendors from public standpipes and *were* consuming *less than 15 lcd* which is generally regarded as inadequate (See Working Paper 2). This may have to do with supply constraints (wide spacing of public taps), but it is equally probable that the small consumption arises from financial constraints, that is, the high cost of the water from vendors. The last point is that the reliability of willingness-to-pay surveys to predict consumer behaviour can only be ascertained by conducting follow-up studies in the communities after they have received improved water surveys. Very few follow-up studies have been undertaken.

Methodological implications. Contingent valuation surveys of willingness to pay cannot be used to demonstrate price-quantity relationships, nor are they useful for predicting the *rate* of connecting to a network, although they can give an indication of a maximum amount that households may be willing to pay on a monthly basis for improved water supplies. The latter result needs to be interpreted cautiously as it does not take into account the political and social context of services provision. Also, typically there may be a proportion of households who may prove to be *unable* to pay for services even though they may be *willing* to pay.

5.2.3.4 Consumer surplus and welfare

Renzetti, noting that very few studies have been undertaken which examine the welfare effects of water price reform, undertook such an analysis for Vancouver, Canada (1992b). The methodology and results of his study are reviewed and reported in Working Paper 4. Only key points are summarised here. Renzetti's starting premise is that marginal cost pricing will maximise social welfare. In order to analyse the overall welfare effects of a change in the pricing schema used, he assumes that *the distribution of household water demand is identical to the distribution of incomes* and then makes use of a "representative household" to make the Marshallian consumer surplus welfare evaluations. The results of the regression analysis of water demand show an income-elasticity of less than 0.1 which contradicts the assumption used to generate the "representative household". The estimates of the price-elasticity of household demand were found not to be statistically significant but were used nevertheless. The price elasticity for demand for water was calculated as an average point elasticity irrespective of consumer income. This is a problem for the validity of the welfare analysis undertaken. A separate demand equation was calculated for

[123] Goldblatt notes that the results "suggest that respondents made their bids based on a percent of budget available for water supply or on a total monthly amount they were willing to pay and not on a valuation of a quantity of water *per se*" (1997: 120).

aggregate industrial demand. The change in aggregate welfare was estimated by measuring the change in each user group's consumer surplus, assuming that the demand for water is independent of the demand for outputs from the commercial sector, and the industrial sector is either perfectly competitive or faces a linear demand curve (1992b: 158). These are not particularly plausible assumptions. Quite apart from this, Renzetti's analysis in unable to take the distribution effects between households into account.

Renzetti's finds that implementing a revenue constrained two-part price with a fixed charge to make up the deficit and a marginal price based on off peak short-run marginal costs and peak long-run marginal costs results in an overall increase in welfare of about 4% compared to average cost pricing. The price changes result in a increase in aggregate consumer surplus in the industrial sector and a reduction in aggregate consumer surplus in the residential sector.

Methodological implications. The restrictive assumptions necessary for the calculation of the overall welfare effect of price reform using Marshallian consumer surplus mean that the results obtained from the analysis may be misleading. The use of a representative household and the assumptions required to sustain this are especially problematic. Moreover, the method is not able to analyse the inter-household welfare distribution implications of water price reform, a topic that is important in a developing country context. It may therefore be concluded that Renzetti's methodology is not suitable for the analysis of the welfare effects of price reform in general, and in developing countries in particular.

5.2.3.5 Distribution analysis using nonparametric density functions

No studies of distribution or inequality in relation to the provision and pricing of water have been reported in the literature. Deaton (1997) has used this approach successfully to study the distributional implications of reform to the price of rice in Thailand and the implementation of an age-qualified state pension in South Africa.[124]

Methodological implications. Nonparametric density functions appear to be a promising methodology for use in the analysis of the distribution implications of water policy and pricing reform. This method is applied to a case study of water pricing in a South African city. The case study is presented in Working Paper 5.

5.2.4 Conclusions

Social welfare analysis requires that the welfare of all households is examined. Welfare analysis that relies on the analysis of a representative consumer is therefore flawed. The social welfare function can be a useful tool in analysing welfare, however, the reduction of welfare measures to a single scalar number is problematic because it hides much more than it illuminates. An alternative approach to welfare measurement is the use of nonparametric density functions. The advantages of this method is that it is descriptive of the data and is theoretically neutral, that is, the results obtained are not dependent on any theoretical assumptions. The method can also be used to examine the likely distribution impacts of price reform.

The empirical literature on the welfare effects of water price reform is very weak. It is proposed that nonparametric density functions offer a practical methodology for the

[124] See Deaton (1997, Chapter 3).

analysis of the welfare impacts of water price reform. This methodology is applied in the case study in Working Paper 5.

5.3 Modelling financial sustainability

This section is concerned with tools to assist in the design of financially sustainable investment and tariff policies. National fiscal constraints in development countries have resulted in increasing pressures for the water sector in general, and the urban water sector in particular, to be financially self-sufficient and sustainable. In South Africa, outside of specific and quantified subsidies, local authorities are required to generate adequate local revenues to cover all the costs associated with water services.

A set of spreadsheet based financial models has been developed to assist South African local authorities in assessing the long-term financial viability of alternative investment strategies and tariff policies and have been fairly widely used (PDG, 1998f). These models are briefly described here.

5.3.1 Assessing the financial viability of alternative investment strategies

Local water authorities face a number of important investment decisions. One of these relates to deciding on the appropriate mix of service levels to provide. As indicated in Section 2, both the capital and operating costs of water services are dependent on the level of service provided and the amount of the service consumed, both of which are inter-related. If a WSP must finance a capital investment programme by borrowing, then the level as well as the type of investment has important recurrent cost implications. For example, consider a five year investment programme as shown in Figure 26. The direct operating costs associated with the investment as well as the debt service obligations resulting from borrowing money for the capital investment are shown. (A real interest rate of 5% per annum and a borrowing period of 10 years has been assumed. This is purely for the purpose of illustration.)

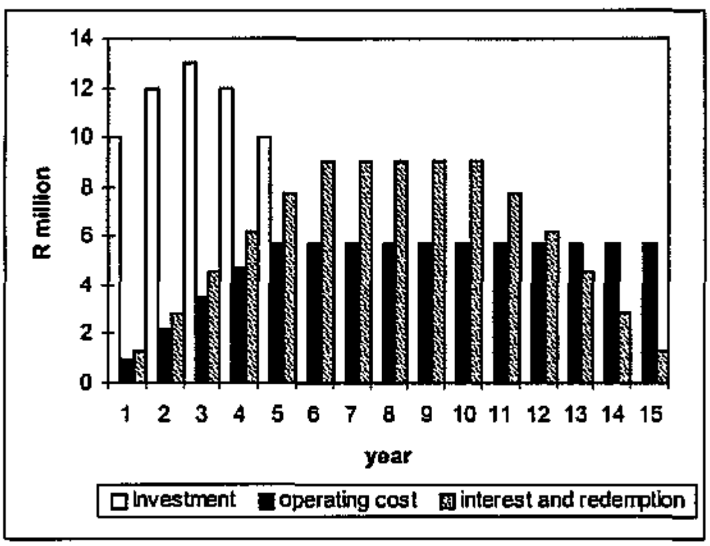

Figure 26: 5 year investment programme with recurrent cost implications - an example

The increase in recurrent costs (the sum of the direct operating costs and the interest and redemption charges) will place pressure on the operating account of the WSP and an increase in tariffs will typically be necessary. For the purposes of illustration, the net and cumulative cash flows linked to the above investment are shown in Figure 27. On the basis of the assumptions used, an annual real revenue increase of 4% is required for the WSP to break even over a 15-year period.

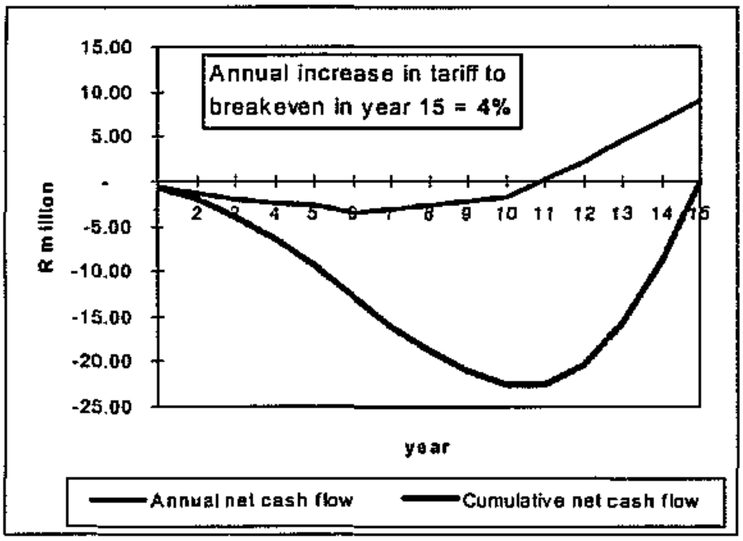

Figure 27: Illustrative annual and cumulative net cash flows linked to an investment

The modelling of WSP investments and their operating implications allows the sensitivity of assumptions and outcomes to be tested and is a useful decision making tool. For example, the question may be posed: is an annual 4% real increase in tariffs over a 15 year period politically sustainable? Alternative investment or financing policies could be developed and assessed which may require lower and more politically acceptable revenue increases. Financial models of the urban water retail function are described in PDG (1994e and 1998f). (See also the Appendix 1.)

5.3.2 Financial modelling of water tariffs

The impact of changes in the water tariff structure and level may be modelled in a similar manner. The financial models referenced above provide a standardised tool that may be used for this purpose (PDG, 1994e, 1998f). However, such a standardised tool has its limitations in terms of its flexibility and it may sometimes be more cost-effective to develop purpose specific models. For example, an 11-block tariff model was developed for DWAF in order to model the effects of the new water conservation orientated tariff in Hermanus. Another tariff model was developed specifically for the analysis of tariff reform in Grahamstown (see Working Paper 5).

5.3.3 Conclusions

Spreadsheet based modelling of a WSP finances can be a useful tool for assessing the financial viability of alternative investment strategies and tariff policies.

6. Pricing policy goals and principles - a review

The goals and principles informing existing water pricing policy in South Africa (described in Section 2.4) are critically assessed here in relation to the review of theory and practice presented in Sections 3. and 4. and drawing on the discussion presented in Working Paper 3 ("Principles and goals for urban water pricing in South Africa - a discussion document").

For the purposes of this discussion it is useful to make a distinction between goals and principles, with the latter being defined as "general laws and guides to action".

6.1 Pricing policy goals

Four primary national water policy goals are clearly identified in the National Water Act of 1998: improving social equity, ensuring ecological sustainability, ensuring financial sustainability and improving efficiency.

Improving *social equity* is important because the South African Bill of Rights establishes the right to equality as a fundamental human right.

Equality has two dimensions: equality of opportunity (access), and equality of income or wealth. It is evident from the constitution that South Africa is committed to improving both dimensions and that this informs government policy.[125] This is because equality of opportunity will not address inequality adequately in the context of a highly skewed distribution of income and wealth arising from past discriminatory policies.

Ensuring *ecological sustainability* is important because South Africa is committed to following a development path that is environmentally sustainable. With respect to water resources, ecological sustainability may be defined such that "the availability and quality of water resources inherited by future generations should be no worse than they are at present" (DWAF, 1998).

Ensuring *financial sustainability* is essential to ensure that that the necessary financial resources are made available to provide water services in a sustainable manner. The goal of financial sustainability does not necessarily mean that users should bear the full cost of water services, however, it does mean that whatever revenue source is used, it should be both dependable and sustainable.

Improving *efficiency* is important in the sense that *maximum benefit* should be derived from the available resources. How efficiency and benefit are defined is important; this is discussed below.

The national water pricing strategy accepts these four goals as the starting point for its deliberations and asserts that *each of these goals are of equal importance* (DWAF, 1998).

[125] The constitution states that in order to promote the achievement of equality, "legislative and other measures designed to protect or advance persons, or categories of persons, disadvantaged by unfair discrimination" may be taken. The vision informing South African economic policy includes the redistribution of income and opportunities in favour of the poor (DOF, 1996).

Comment: There is likely to be a broad consensus on the four broad policy goals outlined above and they accord well with the literature reviewed. However, interpretations of the precise definition of these goals and how they should be achieved are likely to vary. Therefore, it is desirable that these goals are more precisely defined. This is undertaken in the next section which presents a set of principles for the achievement of the policy goals.

6.2 Pricing policy principles: guides to action

In this section the broad policy goals are clarified (as necessary) and a set of principles to guide their attainment proposed.

6.2.1 Principles to promote equity

The implications of the equity goal for water pricing policy goals are two-fold: universal access to at least a basic supply should be promoted, and pricing policies should seek to reduce (or at least not exacerbate) income inequalities.

The right to a basic water supply is asserted in the 1997 White Paper National Water Policy for South Africa: "the right to equality requires access by all South Africans to, and benefit from the nation's water resources, and an end to discrimination with regard to access to water on the basis of race, class and gender" (DWAF, 1997a: 7). Moreover the constitution commits the government to "take reasonable legislative and other measures within its available resources to achieve the progressive realisation" of this right.

On the basis of the above, the following principles (or guides to action) are proposed as a means of promoting equity:

1. In the *allocation of water* between sectors, water use for basic human needs should enjoy priority.

2. In the *allocation of financial resources*, the provision of services to meet basic needs for water should enjoy priority. This implies the effective targeting of subsidies.

3. Water and other pricing policies at the very least should *not jeopardise access* to the basic needs amount of water, and preferably promote such access.

4. The impact of water price reform on inequality with respect to access to water resources in particular, and on income-inequality in general, should be recognised and taken into consideration when proposing water price reform.

5. Water pricing reform, at the very least, should not increase inequality in access or income, and preferably reduce inequality. This implies targeted subsidies for poor consumers.

Comment: These principles mark a departure from neo-classical economics which separates the pricing process from the analysis of equity issues. The rationale for explicitly incorporating equity concerns into pricing decisions has been presented in Section 3. . Principles 1, 2 and 3 are already explicitly part of national policy. Principles 4 and 5 are implicit in national policy.

6.2.2 Principles to promote ecological sustainability

The reviews of pricing theory and practice have shown that the goal of ecological sustainability is unlikely to be achieved solely through a pricing strategy (although appropriate pricing can contribute to ecological sustainability) and other interventions will be necessary. These would typically include legislative interventions such as the stipulation of minimum flow requirements. These, in turn, will influence the availability and relative scarcity of water and hence may affect pricing strategies.

The following three principles are proposed in relation to ecological sustainability:

1. Legislative intervention is necessary to secure ecological sustainability.

2. External environmental costs are internalised into the water price.

3. Higher water prices will generally promote ecological sustainability but not necessarily guarantee it. Moreover, the equity implications of higher prices must be taken into account.

Comment: The first principle is explicit and the second principle implicit in existing national policy.

6.2.3 Principles to promote financial sustainability

The goal of financial sustainability is uncontroversial. However, there is strong divergence in opinion on how this goal should be realised. On the one hand, the costs of water supplies could be fully funded through tax revenues or, on the other hand, through user charges. Both systems can ensure financial sustainability. Thus the arguments as to how financial sustainability should be achieved are really related to equity and efficiency impacts: how the shares of benefits and costs are allocated and what incentives or disincentives these create for the efficient use of resources.

The national water resource pricing strategy document proposes the general principle that "the full financial cost of supplying water should be recovered from water users, including the cost of capital" which is qualified by the following equity principle: "it is important that the introduction of realistic pricing for water does not further penalise disadvantaged communities who were already penalised during the apartheid era" (DWAF, 1998, 1997a). The implicit argument here is that full cost recovery will promote the efficient use of resources, but that equity requires that previously disadvantaged communities people receive assistance. However, these principles do not acknowledge the public good nature of water services with the motivation that at least some of the costs of water services be funded from the tax base (national and local).[126]

In this context, three general principles related to financial sustainability are proposed:

1. Full cost recovery from users is not necessarily desirable from both an equity and efficiency point of view.

2. Nevertheless, it is generally desirable that consumers face a positive marginal price implying that at least a portion of revenue should be derived from a volume related charge (see "Principles to promote efficiency" below).

[126] For further discussion of this, see Working Paper 2.

3. Within a defined context of subsidies and inter-government transfers from the national tax base, local water services should be financial sustainable, that is, revenue from water tariffs and other local revenue sources should be sufficient to cover ongoing costs (both capital and operating).

Comment: An unqualified principle which states that waters services should be fully paid for through user charges would be inconsistent in the light of the emphasis placed on the equity goal. Hence it is better to provide a qualified principle as proposed above.

6.2.4 Principles to promote efficiency

Although the general goal of efficiency is likely to be uncontroversial, there are very different understandings of what this actually means in practice. Different definitions of efficiency have been discussed in Section 3. . The review of theory showed that an exclusive focus on allocative *efficiency* is inappropriate. Technical efficiency is a more direct measure of the efficiency of resource use and can be useful in assessing the efficiency impacts of pricing reform. Optimal beneficial use emphasises the social value of water and the need for social choice in the way in which water is allocated and used.

The general principles that arise from this are as follows:

1. Pricing policy should recognise the both the economic and social nature of water and make use of all three definitions of efficiency as appropriate to the particular context.
2. Higher prices will generally promote the more efficient use of water, however, the equity impacts need to be assessed and taken into account.
3. Where practical and cost-effective, payment should be in proportion to the amount consumed.
4. Prices should promote the development of competitive businesses. Hence business tariffs should not be loaded with excessive taxes or cross-subsidy requirements.

Comment: The first principle rejects the neo-classical "price equals marginal cost" rule as the exclusive basis for promoting water use efficiency (see Working Paper 1). The second principle recognises that water demand is somewhat price responsive (see Working Paper 4). Principle 3 is important because there is unambiguous evidence that metering water and requiring consumers to pay in proportion to the amount of water consumed greatly increases the efficiency of both water use and water management (see Working Paper 2).

6.2.5 Reconciling conflicting principles

It is clear from the above that it may not be possible to achieve all of the objectives simultaneously, and therefore that trade-offs between the goals (and the principles associated with each) may be required. This raises the issue of governance, that is, who decides and how decisions are made, which is discussed in the next section.

6.3 Governance: who decides?

6.3.1 Reconciling goals and interests

The fact that potential trade-offs exist between the different goals of water pricing policy means that *context and political-economy matter.*[127] Water prices mediate the extent to which the different policy goals are realised: they affect the distribution of benefits and costs, they determine the nature and distribution of incentives, and they typically impact on the financial sustainability of services. Beecher *et al* (1991) have described the process of establishing tariffs as a "continual balancing act among the divergent and often competing perspectives of utilities, consumers and society." It is more than this: the tariff setting process requires the balancing of competing political-economy interests. Hence the political-economy context influences and is intrinsic to the *process* of setting water tariffs as it will influence the relative weight placed on the primary goals of water pricing as shown in Figure 28.

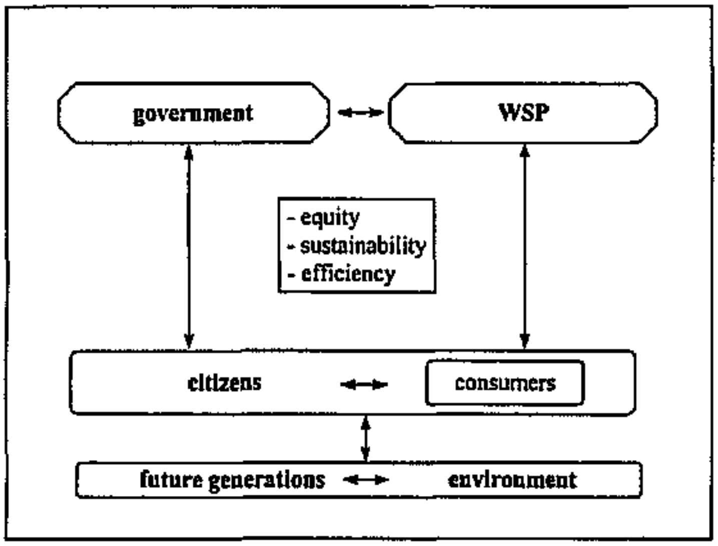

Figure 28: Political-economy affects weighting of goals

The key actors (or "interest groups") are the consumers (or customers), citizens, government and the water services provider (WSP). Important indirect "interest groups" are future generations and the environment. The governance and power relationships between the key actors will determine the relative weight placed on the equity, sustainability and efficiency goals, and hence on the pricing outcome.

6.3.2 Governance and water pricing in South Africa

6.3.2.1 First tier pricing

First tier pricing is not within the scope of this project, however, it has a direct impact on second and third tier prices, and hence is briefly outlined and evaluated here.

The institutional context pertaining in South Africa has been described in Section 2.5. The National Water Act of 1998 establishes DWAF as the custodian of the national water resource. DWAF has responsibility to establish $p_{environment}$, p_{raw} and $p_{effluent}$ (refer to Figure 15) and to regulate the allocation of water between the major water using

[127] For a more detailed discussion on this topic, see Working Paper 2.

sectors (including the environment). Hence DWAF is responsible for promoting the equitable, sustainable and efficient use of water at the national water resource level. The means of attaining and balancing these three goals at the national level is discussed in the National Water Pricing Strategy document and summarised below (DWAF, 1998).

Equity is promoted through making available 25 lcd free of charge to second and third tier water suppliers. **Comment**: This equity policy, although desirable, it likely to be administratively cumbersome and financially insignificant. Hence the wisdom of this policy is questionable.

Ecological sustainability is ensured through the establishment of an ecological reserve (a legislative intervention), environmental management at the catchment level (whose costs are recovered through the price of water in that catchment) and water quality control (legislative and pricing interventions in accordance with a "polluter pays" philosophy). **Comment**: This strategy is sound, though few details of how it will be applied in practice are available. The major burden of ensuring ecological sustainability falls at this national water resource level and hence the efficacy of the proposed approaches are particularly important. For example, first tier tariffs should, as a general rule, internalise external environmental costs related to water resource development as far as is practicable.

Financial sustainability is ensured through full financial cost recovery (including the capital costs of scheme development) from "major users" of bulk raw water schemes (first tier water). The "major users" are municipalities, industries, mines, power generation facilities and irrigators. **Comment**: Notwithstanding the comments on financial sustainability made above ("Principles to promote financial sustainability"), this policy (operating at the first tier) is both pragmatic and desirable.

Efficiency is promoted through "the introduction of economic incentives in water-stressed catchments to encourage conservation of water and its shift from low to high value use" which "can be done administratively or by using market-related mechanisms" (DWAF, 1998: 7). "The economic charge would attempt to reflect the scarcity value of water" (1998: 11). **Comment**: The policy is very vague and the economic arguments confusing. Little attention has been given to this aspect because the focus of the pricing strategy is on achieving financial cost-recovery as the short-term (five year) goal and "economic" resource pricing as a medium term (more than five years) goal.

6.3.2.2 Second tier pricing

The predominant institutional arrangements for setting second tier prices are shown in Figure 16. It is important to note here that Water Boards, who set $p_{wholesale}$ for much of the water supplied to urban areas in South Africa, are not directly accountable to customers or consumers, although there is consumer representation on Water Boards who are also regulated by DWAF.

Comment: The fact that Water Boards have no direct accountability to citizens or consumers means that is inappropriate for the wholesale price to mediate the sometimes conflicting goals of equity, sustainability and efficiency. This has direct implications for pricing policy at the wholesale level which is taken up later in the report.

6.3.2.3 Third tier pricing

The basic governance model discussed in Section 4.5.4 (and shown in Figure 24) may be adapted to describe the institutional context in South Africa with respect to water retail (third tier pricing). The adapted model is shown in Figure 29.

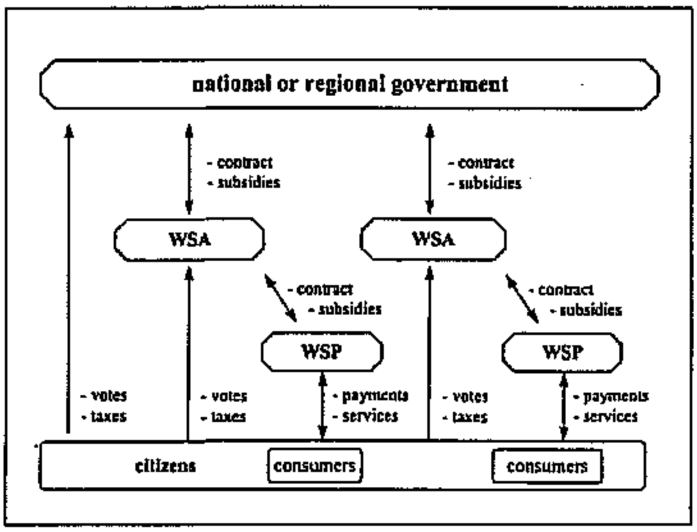

Figure 29: Governance of water services in South Africa

In many cases the retail WSP is part of the water services authority (WSA) (that is, the city (local) government), however, this is not necessarily the case.[128] In this model (prevalent in South Africa), democratic local government has political oversight over the WSP and will typically have final say over water tariffs. This model enables the goals of equity, sustainability and efficiency to be negotiated and reconciled largely at a local level. National or regional equity issues may be negotiated at the national or regional government level and enacted through taxes and transfers, and national or regional sustainability and efficiency issues can be enacted though legislation and/or other appropriate measures (see "first tier pricing" above).

Comment: This is an essentially sound model for setting water prices at the third tier (provided that there is adequate environmental protection of the water resource which should be managed at the catchment level and enacted through legislative intervention, first tier water pricing for extraction and pollution charges for effluent discharges, as indicated in the discussion of first tier pricing).

6.4 Governance: general principles of good management practice

Another aspect of governance has to do with the principles of good management or administrative practice. The following principles of good practice are generally recognised and should apply:

1. Tariffs should be fair in that they treat all consumers in the same circumstances in a consistent manner.

[128] This model includes the possibility of the WSP being an autonomous public or private agency contracted to local government to undertake the function of water retail. Where the WSP is privatised, additional governance issues come into play such as the ability of the private WSP to exert undue influence. These issues have been discussed in Section 3..

2. Tariffs and subsidies should be clear and easily understood.
3. Tariff enforcement should be fair and consistent.
4. The benefits derived from implementing a tariff (or tariff reform) must exceed the cost of implementation, that is, they should be cost-effective.
5. Tariffs should seek to generate revenue that is reasonably stable and predictable.
6. Consumers should have easy access to relevant information.

Comment: There is likely to be general consensus on these principles, most of which are contained in the White Paper on Local Government. Note that the notion of fairness has been more carefully defined and does not necessarily mean that the price of water should be the same for all consumers. The principle of clarity and understanding implies a general preference for simplicity and an avoidance of complex pricing systems.

7. Pricing policy recommendations

Pricing policy recommendation are made in this section for first tier (raw water extraction), wholesale and retail water pricing. These recommendations arise from the summarised discussion presented in earlier sections as well as the more detail arguments put forward in the set of working papers.

7.1 First tier water pricing

Although first tier pricing is not strictly within the scope of this project, some recommendations relating to first tier pricing have arisen from the discussion and are summarised here.

1. **First tier water subsidy**. The existing policy states that the water necessary for a basic domestic supply should be supplied free of charge. Although the sentiment of this policy is admirable, its efficacy in practice is doubtful. First, the cost of raw water relative to the infrastructure costs at the second and third tiers is reasonably small. Second, the cost of the free water must be borne by the other water uses in the same system, which simply means that the cost of the remaining water will be increased proportionately, resulting in effectively the same average cost for the total amount of water supplied. Third, such a subsidy is complex to administer. In the light of this, it is recommended that all first tier water be priced at cost (resource charge plus full financial cost of infrastructure plus catchment management charge) and that the subsidy for basic water supply be effected directly at the third tier along the lines discussed for retail water pricing. One possible source of the funding for the retail subsidy could be a resource tax on all first tier water abstraction.

2. **Assurance of supply**. The financial cost of first tier water should be related to the assurance of supply required by the respective users.

3. **Composition of first tier water price**. The first tier water price should comprise the following components: an abstraction charge, an infrastructure charge, a catchment management charge and an effluent charge. The abstraction charge is the "resource charge" and should be related to the relative scarcity of water in the catchment. The infrastructure charge should be based on actual costs for that system. The catchment management charge should be related to the costs of managing the catchment including remedial costs that are to be borne by all users. The effluent charge should be levied on polluters in accordance with the "polluter pays" principle.

7.2 Wholesale water pricing

On the basis of the discussion presented in this report (and in more detail in Working Papers 1, 2 and 3), the following policy recommendations pertaining to wholesale (second tier) water pricing are made:

1. **Ring-fencing**: The water wholesale function should be ring-fenced as a separate business unit and regarded primarily as a commercial operation whose aim is to deliver water at the required quality and reliability at the lowest possible cost.

2. **Cost-based pricing**. The wholesale price should be set as a sum of the price (or cost) of the raw water and the costs entailed in the wholesale function (typically treatment, conveyance and storage).[129]

3. **Calculation of costs**. There are three generally accepted approaches of calculating or accounting for capital costs, namely, the *funding approach*, the *depreciation approach* and the *rate of return approach*.[130] Fund accounting has been used for many years by water boards and other public sector utilities, and is therefore well understood in that sector. It is also reasonably objective and could therefore be monitored or regulated without too much difficulty. However, fund accounting is less well accepted in capital markets where depreciation accounting is the norm, preferably based on the current value of assets. The dependence of water boards on external loan finance – a situation which is likely to become more rather than less significant – suggests a move towards depreciation accounting. **Comment**: Some water boards are involved in exercises to investigate the implications of switching from fund to depreciation accounting and this is an appropriate first step. However, it is desirable that a uniform approach to cost accounting be adopted for the purpose of establishing wholesale water prices in South Africa.

4. **Cross-subsidisation**. As a general principle, there should not be cross-subsidisation between consumers supplied by a wholesale WSP because this is typically not transparent and it is not subject to direct political review or control. However, there is a pragmatic argument for a uniform wholesale price where cost differentials between wholesale consumers are not large.

5. **Performance indicators**. It is difficult for an outside agency to accurately monitor wholesale costs because the exact cost-structure will be specific to local conditions. Nevertheless the development of performance indicators and best-practice benchmarks may provide useful references for comparison between different wholesale WSPs.

6. **Institutional support costs for the third tier**. The costs of supporting institutional development at the third tier should be accounted for separately. It is preferable that the revenue for these costs come from the national budget (or a national levy on first tier water sales) as this is more equitable. (Areas in most need of institutional support may not have capable wholesale WSPs to assist.) Failing that, the revenue may be obtained through a uniform surcharge of bulk treated water sales. It is recommended that the equitable share subsidy is not used for this purpose.

7.3 Retail urban water pricing

On the basis of the discussion presented above (and in more detail in Working Papers 1, 2 and 3), the following policy recommendations pertaining to retail (third tier) water pricing are made:

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[129] Where raw water is purchased from a government owned water scheme, the purchase price of the raw water should be used in the cost calculation. Where the extraction of raw water is managed directly by the second tier WSP, the cost of the raw water should be calculated in accordance with national water pricing policy.

[130] Each approach and their respective advantages and disadvantages are discussed in Working Paper 3.

1. **Governance.** Retail water tariff levels should continue to be determined or mediated at the local level by municipalities through locally elected political representatives.

2. **Definition of a minimum basic water supply.** A minimum basic water supply should be regarded as access to 25 lcd in South Africa as a whole.

3. **Definition of a target basic water supply.** A target basic water supply in urban areas should be regarded as access to (*and consumption of*) 50 lcd.[131] This implies a general preference for on-site supplies in urban areas.[132] The cost implications of grey water disposal need to be examined. There is a large cost differential between on-site grey water disposal and a piped network to carry grey water away from the site. The potential for developing intermediate solutions for the disposal of grey water should be examined.

4. **Capital cost subsidy for basic supply.** To the extent that it is financially feasible, the capital costs of the provision of infrastructure which makes 50 lcd available and accessible to households which otherwise would not be able to afford it and be willing to pay for it should be subsidised. (Current policy is for 25 lcd.)

5. **Cost of basic access (connecting).** On purely equity grounds there should be a *zero access price for a basic* domestic water supply *where affordability is constrained and where implementation of a non-zero access price limits access.* Requiring a partial contribution from households towards the cost of access may be important, especially in rural areas, to achieve development goals, to match a purely supply side approach with demand responsiveness and to improve the sustainability of systems.

6. **Basic consumption subsidy.** There are strong social and equity grounds for making available an affordable life-line tariff which will encourage (or at least not discourage) the use of a certain minimum amount of water (50 lcd) necessary to maintain basic health standards.[133] Such subsidies should also apply to communal standpipes and other restricted supplies.

7. **Volume related pricing for unrestricted on-site supplies.** Where domestic water use is unrestricted, it is important that consumers face a positive marginal price for additional water used in excess of that needed for basic domestic needs (50 lcd).

8. **Full cost recovery for non-domestic users.** Non-domestic users should pay at least the full costs (directly or indirectly) of the water services provided (both capital and operating).

9. **Encouraging water-use efficiency and conservation: domestic users.** Domestic water usage in excess of 200 lcd in South Africa may be considered to be luxury

[131] Higher consumption to achieve health benefits is particularly important where living densities are high as is the case in urban areas. For a full definition of a basic water supply see the Glossary. See also Working Papers 2 and 3.

[132] Off-site access typically constrains consumption to less than 30 lcd. See Working Papers 2 and 3.

[133] The imposition of volume related pricing at a significant level amongst poor households for low levels of consumption may have the unintended effect of discouraging the adequate use of water and therefore is not recommended.

use.[134] Therefore, there should be strong incentives that encourage water conservation where consumption exceeds 200 lcd. These incentives should include higher tariffs which could be related to the average incremental cost of new water resource development. Higher tariffs should be complemented by education and informative billing. Seasonal tariffs may be warranted in certain areas.

10. **Encouraging water use efficiency and conservation: non-domestic users.** The establishment of best-practice water-use benchmarks by consumer type and the implementation of disincentive or penalty tariffs for the wasteful use of water will encourage investments in water saving technologies and practices.

11. **WSP investments in conservation.** WSPs should apply cost-benefit analyses to investments in water savings in relation to supply augmentation. The scope of WSP investments in water savings may include the full or partial subsidisation of water saving technologies including plumbing and appliances at the consumer level. Supply side investments of this nature may be particularly important among poor and older households where credit markets are prone to failure.

12. **Revenue sufficiency.** Outside of known, well-defined, quantified and secure inter-governmental transfers, revenue from tariffs (including property taxes) should fully recover costs and ensure financial sustainability.

13. **New industrial demand.** Water using industries should face the correct economic incentives when making investments in new capacity. This means that the cost or price that new water using investments face should be related to the incremental cost of capacity expansion in that water supply system.

14. **Cross-subsidies.** Residential consumers should not cross-subsidise non-residential consumers. Cross-subsidies from non-residential to residential consumers should be limited to reasonable levels and should not jeopardise the international competitiveness of industries.

Comment: The existing policies for retail water tariffs reviewed in Section 2.4 (The South African context: water policy) are broadly in line with those proposed here. The differences are as follows: (1) The policies outlined above are less specific than existing policies. This is deliberately so because the local trade-offs between equity, sustainability and efficiency need to be mediated through a political process at the local level.[135] (2) The policies seek to *encourage* the use of 50 lcd or more, rather than just 25 lcd. There are strong public health grounds for this as already indicated. (3) Excessive domestic consumption is conceived as more than 200 lcd (rather than 250 lcd). (4) These "switch-points" are kept as a per capita figure rather than translated into a set consumption per connection per month (as is done in the National Water Supply Regulations). This is because the translation from lcd to a volume per

[134] This assertion is supported by three facts. First, it is possible to enjoy a high standard of living while using less that 200 lcd. Second, in many *developed* countries, average domestic per capita use is significantly below 200 lcd. Third, in South Africa, many people do not have access to adequate water supplies and often consume much less water than is necessary to achieve a healthy living environment. In this context, consumption in excess of 200 lcd can be considered to be a luxury. For further discussion of these points, see Working Papers 2 and 3.

[135] In the governance model proposed, the national trade-offs between equity, sustainability and efficiency are mediated at the national level through appropriate first tier water pricing (by catchment) and national subsidy policy to promote universal access to basic water supplies. Hence the remaining trade-offs should be mediated at the local political level.

connection depends on local demographic factors and should be done locally (although guidelines are needed and are discussed in a later section). (5) The pricing policy for new industrial water use investments is both old and new. It is old in the sense that it was stated in the 1986 DWAF publication "The Water Resources of South Africa" (DWAF, 1986), however, the policy was never implemented and therefore is, in a sense, new. (6) The policy on revenue sufficiency is slightly altered from existing policy. It does not require all revenue to be derived directly from water tariffs and (which is the current policy), but allows for a portion to be derived from property taxes and subsidies. The reason for this is the potential progressive equity implications of such a policy. (7) The recommendation against cross-subsidies from residents to businesses through water prices is new (though it is intimated in the Local Government White Paper (DCD, 1998). (8) The policy recommendation for supply side investments in water savings is new.

A methodology to implement these policies is proposed in the next section.

8. Proposed retail pricing methodology

A methodology for the implementation of the retail (third tier) water tariff policy recommendations is proposed in this section. (A methodology for the determination of wholesale tariffs is not discussed because the implementation of the policy recommendations are relatively straight forward.) The emphasis of the discussion is on practical implementation. The discussion draws on all of the working papers.

At the outset it is important to note that there is no universal "model" for setting retail water prices. Each context has its own peculiarities and particular challenges that must be addressed. What is proposed is a generalised methodology which can be applied to a variety of contexts.

It is also important to note that a set of guidelines for setting urban water tariffs in South Africa already exists (PDG, 1998d and PDG, 1998abce). In addition to these *guidelines*, a *Water Supply Services Model* (*WSSM*) has been developed for the analysis of investments and tariff reform and is widely used (PDG, 1994e, 1998f). These tools have made (and are making) an important contribution to the improvement of water management in the urban sector. It is the intention that the methodology proposed here build on what has come before. Certain additions and amendments to the existing *guidelines* and *WSSM* are proposed. These are highlighted as comments in the text that follows.

8.1 Proposed retail pricing process

A general approach to water pricing was proposed in Section 4.6.5. The approach recommended the following steps:

1. **Understand context.** Develop an understanding of the national policy context and local (city level) context.
2. **Set pricing goals.** Define and reach consensus on the equity, sustainability and efficiency goals related to water pricing, and in particular, on the prioritisation and weighting of these goals. **Comment:** the setting of more explicit and practical goals is new.
3. **Develop indicators.** Develop and reach consensus on an appropriate and practical set of indicators for determining the influence of price reform on the defined equity, sustainability and efficiency goals. **Comment:** many of the proposed indicators are new.
4. **Establish best practice principles.** Reach consensus on the specific and practical meaning of the best practice principles for pricing policy.
5. **Define price structure and set level.** Develop pricing structure and determine price level with reference to the defined goals and principles. **Comment:** some new guidelines are presented.
6. **Evaluate impacts.** Evaluate the impacts of the price reform in relation to the defined objectives.

7. **Refine price structure and level.** Refine the price structure and level incrementally so as to better achieve the defined goals and to adhere more closely to the best practice principles.

This approach emphasises the iterative nature of the pricing process whereby improvements are made so that the objectives are more fully achieved. The availability of practical indicators, whereby the extent of attainment of the specified objectives can be assessed, greatly assists this incremental reform process.

8.2 Understanding the context

The following types of contextual information are important to inform the water pricing process: existing policies and legislation, governance structure, demographics and income, economic profile, water resources context, consumer and consumption data, and financial data. These data requirements thus largely mirror those provided for the national context, only they are specific to the local water supply area and are more detailed. The data requirements are presented below because they inform the development of the *specific pricing* goals and *performance indicators* which may be used to *assess* the efficacy of pricing reform. Much of the data presented below should be available from the Water Services Development Plan which is required by the Water Services Act of 1997. Data requirements are also set out in the existing *guidelines* (PDG, 1998a-e) and in the *WSSM*.

8.2.1 Policies and legislation

Relevant national and regional policies and legislation must be understood. These have been reviewed in Section 2.4.

8.2.2 Governance structure

An understanding of the governance structure is required, in particular, which agencies are responsible for the various functions of water supply, who makes decisions and how these are made. Governance structures prevalent in South Africa have been reviewed in Section 2.5. It is important to note the distinction made between the water services authority (WSA) and the water services provider (WSP) in the Water Services Act of 1997. The WSA retains overall political responsibility for the provision of water services in the area of jurisdiction of the WSA. The actual *functions* related to the provision of services (management, physical operation and maintenance, capital investment, revenue collection from water sales etc.) are carried out by the WSP in terms of a contract with the WSA. The WSA is local government. Thus where municipalities carry out the functions of the WSP, then the WSA and the WSP are the same entity. However, this may not always be the case.

8.2.3 Historical context

It is important that there is knowledge and understanding of the historical development of water supplies and pricing in the area. In particular, the reasons underlying any significant past changes in water policies and implementation, and responses to these changes, should be understood. (See the discussion of water pricing reform in Tucson, Arizona and Los Angeles, California which is presented in Working Paper 2.) Historical information on previous water shortages and the reasons for and responses to these is also important. **Comment**: The emphasis on historical context is new.

8.2.4 Demographics and income

The following demographic and income information is relevant to the process of retail water pricing: (see also PDG, 1998c)

- **Supply area**: Geographic definition of the water supply area. In most cases, the boundaries of the supply area should coincide with the boundaries of the municipality. However, this is not always the case and where such exceptions exist it is particularly important to make a careful note of them.
- **Population**. Total population in the supply area. This data should be sourced from the latest national population census (which should generally be the most accurate and preferred source of information) and adjusted to the current year using the population growth estimate. Historic information may also be valuable. Notes should be made where the supply area boundaries do not coincide with census enumerator boundaries and what adjustments have been made to take this into account. Local knowledge should also be used.
- **Growth**. Estimated population growth for the population in the supply area. This should be derived from census data. Local knowledge may also be important.
- **Income**. Household income distribution in the supply area. Obtained from census data or local surveys and adjusted to the current year.
- **Household size**. Household size distribution in the supply area, from census data and local surveys.
- **Property values**. The status of the valuation roll and the distribution of single residential property values from the valuation roll.

The supply area and population data are required for the Water Services Development Plan. Income, household size and property values are required in order to be able to measure equity impacts of pricing reform (see "indicators" below).

This data could be summarised as follows (data is illustrative):

Table 12 provides a summary of the demographic data for the supply area for the current year by adjusting the available data (typically available for a previous year only) in accordance with a calculated growth rate.

Table 12: Summary population and income data for supply area (data is illustrative)

	Year 1 1991	Year 2 1996	% growth (91 to 96)	Current year 1998
Population	300 000	339 400	2.5%	**336 600**
Consumer price index	100	147	8%	171
Nominal income (R/cap pa)	3000	4557	8.7%	**5 333**
Real income (R/cap pa) (base yr)	3000	3100	0.65%	3119
Household size (average)	5.20	5.00	-0.78%	**4.92**

Source: Census data. Note: Year 2 = year of latest census, Year 1 = the previous census, white blocks show input data and data sourced directly from the census, shaded data blocks are calculated.

Table 13 shows the household size distribution for the supply area. This data is important because it provides a guideline for the conversion of the per capita consumption guideline to a consumption per connection figure. This data is also used for the analysis of the equity impact of a given tariff structure.

Table 13: Household size distribution in whole supply area (data is illustrative)

H-hold size	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Distribution of households															
% households	5	13.5	17.5	18	15.5	10	6	4	2.7	2	1.5	1.2	1.1	1	1
cumulative %	5	18.5	36	54	69.5	79.5	85.5	89.5	92.2	94.2	95.7	96.9	98	99	100
Distribution of population															
% population	1	5.5	10.7	14.6	15.8	12.2	8.5	6.5	4.9	3.1	3.4	2.9	2.9	2.8	4.1
cumulative %	1	6.5	17.2	31.8	47.6	59.8	68.4	74.9	79.8	83.9	87.2	90.2	93.1	95.9	100

Source: Census data

Table 14 shows household size data by enumerator area. This data is available from the Census. The data shows how household size distribution varies by geographic area and is useful for assessing the feasibility of implementing connection based volumetric life-line allocations by geographic area and analysing the equity impacts of such a policy. **Comment**: Household size distributions in the format presented here are not used in the Management Guidelines and the WSSM. These are needed to evaluate the impact of translating a lcd guideline or benchmark to a consumption per consumer unit (connection).

Table 14: Household size distribution by enumerator area (data is illustrative)

Enumerator area	1	2	3	...	15	16	17	...	29	30	31	...	53	54	55
no. of households	130	110	90		150	170	160		100	80	180		140	128	230
ave. h-hold size	2.5	2.7	3.1		4.4	4.6	4.7		6.1	6.3	6.4		8.1	8.3	8.6
standard deviation	1.0	1.2	1.4		1.6	1.7	1.7		2.0	2.1	2.4		3.3	3.2	3.9
max. h-hold size	5	6	8		6	8	9		12	11	13		15	13	18

Source: Census data. Note: Enumerator areas have been ranked in order of average household size.

Table 15 shows the household income distribution within the supply area. The data is presented by decile. This is recommended because it is a standard format and enables inter-year comparison to measure progress. **Comment**: The income distribution data used in the WSSM is different to that shown above. A decile based representation of the data is recommended as it provides useful information on the equity of income distribution. In particular, this can be tracked over time so as to determine whether or not income distribution is becoming more equal. More importantly, specific water price reforms can be evaluated in terms of its impact on income distribution. (Such an exercise is not undertaken in the current guidelines and the WSSM.

Table 15: Household income distribution in supply area (data is illustrative)

(households ranked by income)	first 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	last 10%
Ave. household income (R/month)	400	600	900	1400	2100	3000	4300	6000	8000	12000
Share of total household income (%)	1.0	1.6	2.3	3.6	5.4	7.8	11.1	15.5	20.7	31.0
Cum. share of total hh income (%)	1.0	2.6	4.9	8.5	14.0	21.7	32.8	48.3	69.0	100.0
Cumulative % of households	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Source: Census data.

This data could be illustrated graphically as follows:

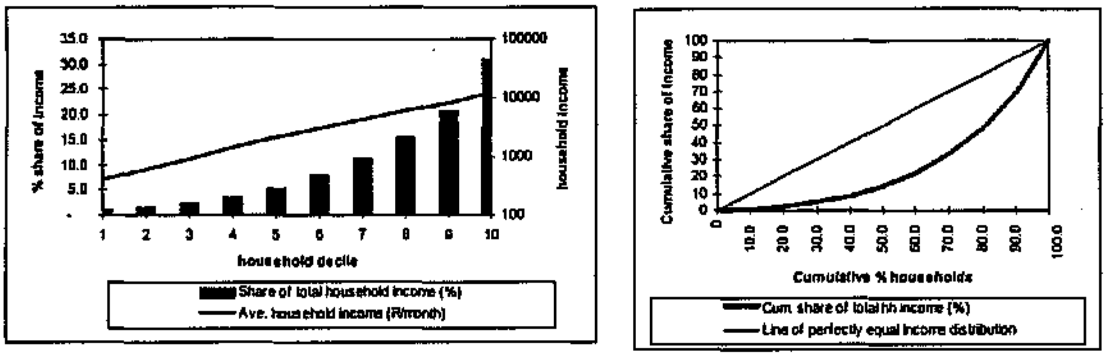

Figure 30: Household income distribution (illustrative)

Table 16 gives a summary of the status of valuation roll. This summary data may be used to make a number of important strategic decisions. For example, the estimate of the number of properties not on the valuation roll (and if possible the relative income profile of these properties) will give an indication of the equity implications of using property taxes as a source of income for the water service). Also, the total property value of consumer type will enable a first approximation of the relative property tax burden for different income policies related to water supply.

Table 16: Status of valuation roll (data is illustrative)

Properties	No. on roll	Total value (R million)	Estimated number of properties not on roll
Residential			
- single family	40 000	4 000	3 000
- multiple family	5 000	1 500	0
Industrial	200	400	0
Commercial	500	250	0
Institutional	200	100	0
TOTAL	**45 900**	**6 250**	**3 000**

Source: Local authority valuation roll.

Table 17 shows the distribution of single residential property values within the supply area. Again, this data is presented in a decile format for the reasons presented above. This data can be used to calculate the progressivity of different property tax structures. This data could be represented graphically in the same way as shown for household income distribution above.

Table 17: Single residential property value distribution in supply area (data is illustrative)

(properties ranked by value)	first 10%	next 10%	next 10%	next 10%	Next 10%	next 10%	next 10%	next 10%	next 10%	last 10%
Average property value (R 000)	15	23	33	45	60	80	110	160	220	300
Share of total property value (%)	1.4	2.2	3.2	4.3	5.7	7.6	10.5	15.3	21.0	28.7
Cum. Share of total property val. (%)	1.4	3.6	6.8	11.1	16.8	24.5	35.0	50.3	71.3	100.0
Cumulative % of households	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Source: Local authority valuation roll.

Comment: The guidelines and WSSM neither recommend nor use property taxes as a source of income for water services. Hence the data requirements set out above are new. The guidelines presented below recommend the use of property taxes for at least a portion of water services because of their progressivity (see below).

8.2.5 Economic profile

An understanding of economic activity within the water supply area is important. In particular, information on large water intensive economic activities should be gathered. This information should be readily available to local authorities. This information is mainly for contextual purposes, however, the identification of, and economic information on, large water users (in particular industrial users) is particularly important. See the *guidelines* (PDG, 1998cd)

8.2.6 Water resources context

It is important that local decision makers have an understanding and knowledge of both the existing water sources and future water supply options, their yield at different levels of assurance and their costs. This data should be available from the wholesale WSP (usually a water board) and/or the catchment management agency. This information could be summarised as follows (the data is purely illustrative):

Table 18: Water resource data for system X serving urban area Y (data is illustrative)

(Data for whole raw water supply system) (Current data: 1998)	Assurance of supply %	Yield million kl pa	Cost c/kl	Comment
Current water supply	98%	3.2	150	Schemes ...
	80%	5.1	94	
Next water supply	98%	1.5	300	Scheme ... to come on stream in the year 2002.
	80%	2.3	196	
		Water used		
Current water use		2.6		Below average use.
Future water use		3.5		In year 2003

Source: Water Board, Catchment management agency or DWAF.

Summarising the data in this simplified manner is useful because it provides an easily accessible picture of the relative abundance or scarcity of water and the relative costs of future water resources development in relation to current costs. Data in this format can be communicated easily to local decision makers. See PDG (1998bf).

8.3.8 Water services data

A key determinant of equity is the universal availability of adequate water services. It is therefore desirable to collate the following information in relation to the current access to water services in the supply area:

- **On-site connections and metering.** The number of consumers directly connected to the piped water network (that is, with on-site supplies) by major consumer type (domestic, industrial ...). The extent of metering (by category) and the status of metering. Are all read? How frequently? What are the problems?
- **Illegal connections.** Estimate of the number of unauthorised connections.
- **Service gap**: the number of households and other potential customers without on-site water services.
- **Communal (public) standpipes**: Description of existing public communal standpipe provision.
- **Off-network supplies**: Description of consumers not obtaining water from the piped water network.
- **Water vending**: Description of water vending activities.

This information should be provided as a matter of course in the five yearly Water Services Development Plan and the annual progress report. The data could be usefully summarised in the following way. **Comment**: Explicit summary tables on the "services gap" such as those proposed above are not presented in the guidelines nor the WSSM.

Table 19 summarises the connection and metering data. When the data is presented in this format, the "metering gaps" are easy to identify and quantify.

Table 19: On-site connections and metering (data is illustrative)

Consumer category	On-site connections	% with meters	% of meters read regularly	Frequency of meter reading
	Number	%	%	months
Residential - single dwelling				
- flow unrestricted	30 000	100%	80%	monthly
- flow restricted	10 000	0%	n/a	n/a
Residential - multi-family				
- common group meter	4 000	100%	100%	monthly
- individually metered	1 000	100%	100%	monthly
Industrial	200	100%	100%	monthly
Commercial	500	100%	100%	monthly
Institutional	200	100%	80%	monthly
TOTAL	45 900	78%	83%	monthly

Source: Water Services Development Plan; Local authority.

Table 20 quantifies the service gap, that is, the number of consumers (households or industries) that do not have an on-site supply.

Table 20: Service gap (on-site water supply)

Consumer category	Potential customers [1] (1998)	Actual customers [2] (1998)	Service Gap [3]	
	number	number	number	%
Residential	48 000	45 000	3000	6.3
Industrial	200	200	0	0
Commercial	500	500	0	0
Institutional	200	200	0	0
TOTAL	48 900	45 900	3 000	6.1

Source: Water Services Development Plan. Notes: 1. The number of customers that would result in 100% coverage with on-site water supplies. 2. The number of customers with an on-site water supply and which is managed by the WSP. 3. The difference between potential and actual customers.

Table 21 provides an overview of the status of communal water supplies within the supply area. Providing summary data in this format enables problem areas to be easily identified. For example, certain performance targets related to the number of households per standpipe and average walking distance could be established and monitored with the help of the data summarised in this table.

Table 21: Communal (public) standpipes: summary of status (data is illustrative)

	Planned [1]		Emergency [2]		Total / Average
Number of public standpipes	20	+++ [3]	5	+++ [3]	25
Number of h-holds reliant on ...	200	+++	± 300	+	± 500
Households per standpipe	10	+++	± 60	+	± 20
Average walking distance	± 50m	+++	± 150m	++	± 110m
% standpipes metered	100%	+++	0%	+++	80%

Source: Water Services Development Plan. Notes: 1. *Planned* refers to formal provision of communal standpipes. 2. *Emergency* refers to adhoc, temporary or emergency provision of standpipes. 3. *Reliability and accuracy* of the data where + = poor, ++ = fair and +++ = good.

Table 22 provides a summary description of off-network supplies. This data is needed to develop an accurate overall picture of water supply and water use within the supply area. Off-network supplies and usage are often ignored. Policies which do not take off-network supplies into account may have unintended consequences.

Table 22: Description of off-network supplies (data is illustrative)

Type	Number	Total quantity kl per month	Comment
Residential boreholes			
- with permits	150	3 000	
- without permits	± 500	10 000?	assumed to be proportional
Industrial boreholes			
- with permits	20	20 000	
- without permits	± 5	4 000?	assumed to be proportional
Direct industrial extraction from ...	2	50 000	Industry X and Y
Total		**87 000**	

Source: Water Services Development Plan.

Table 23 provides a summary of vending activities within the supply area. The consequences of policy and pricing decisions on water vending should also be taken into account.

Table 23: Summary of vending activities in area of supply (data is illustrative)

	Formal	Informal	Total
Significance of vending activities [1]	insignificant	Moderate	
Number of vendors [2]	0 +++	? +	
Number of households purchasing [2]	0 +++	? +	

Source: Water Services Development Plan. Notes: 1. Subjective evaluation: extensive, moderate, insignificant. 2. Reliability and accuracy of the data, where + = poor, ++ = fair and +++ = good.

8.2.7 Water use data

An accurate picture of current and historical water use in the water supply area is highly desirable. The desirable data includes the following:

- **Total treated water purchased:** Total treated water purchased (monthly for the last 5 years to 15 years) and growth in total water use. It is useful to look at the long term trend in total water purchases (or total water use).[136]
- **Water use by consumer type:** Total water use by consumer type (monthly, for the last year at least, but preferably for the last 5 years). The make-up of water use strongly influences the pattern of demand.
- **Unaccounted-for water:** Measurement of unaccounted-for water. This should be calculated as follows. A = total water purchased. B = total metered water distributed. C = estimate of unmetered water distributed. D = water losses = A - B - C. E = total water unaccounted-for = A - B. F = percentage total unaccounted-for water = 100E / A.
- **Seasonal water use.** Analysis of seasonal distribution of water consumption, and relationship between weather and water use (by major consumer category).
- **Peak demand.** The analysis of peak demand, in particular, peak 24 hour demand.
- **Distribution of consumption.** The distribution of consumption within each major consumer category.

Some of this data could be usefully summarised in the following format.

[136] Historical data may be difficult to obtain or interpret where supply boundaries have changed. Instituting good record keeping now will make future analysis easier and more reliable.

The overall distribution of water consumption between the major water consumers is summarised in Table 24. **Comment**: The data requirements set out in the guidelines and WSSM are not explicit about the value of examining historical data. An understanding of how water-use patterns have changed over time is highly informative.

Table 24: Distribution of water use by consumer type

	1988	1994	1995	1996	1997	1998	Trend
Residential	60	61	62	62	64	63	increasing
Industrial	20	18	16	17	15	17	slightly decreasing
Commercial	12	14	14	16	14	14	steady
Institutional	8	7	8	5	7	6	slightly decreasing

Source: Water Services Development Plan

Unaccounted-for water is summarised in Table 25. In addition to the following summary table, it is also useful to record how this has changed over time and to determine the trend, that is, extent of improvement or deterioration over time.

Table 25: Calculation on unaccounted-for water (data is illustrative)

	1998 kl	1998 %	Comment
Total water purchased (A)	100 000	100%	Total treated water supplied
Total water billed (B)	85 000	85%	Sum of water metered and billed
Unaccounted for water (A-B)	**10 000**	**15%**	
Unmetered water use (C)	7 000	5%	(method of estimation)
Water losses (A-B-C)	8 000	8%	

Source: Water Services Development Plan

The nature of the seasonal pattern of water use may be determined through the collection and representation of the data presented in Table 26. This data is useful to determine the revenue impact and efficiency impacts of alternative tariff structures. **Comment**: The guidelines and WSSM do not undertake an explicit analysis of the seasonality of water consumption, how this relates to water availability and the impact that this has on system design and costs.

Table 26: Analysis of seasonal water use (data is illustrative)

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall													
monthly rainfall (average)	mm	15	20	30	45	65	75	85	80	75	55	35	20
standard deviation	%	10	12	11	9	13	15	11	16	15	11	12	10
% deviation from minimum	%	-	-	64	145	255	309	364	336	309	200	91	-
Total water use													
monthly total water use	kl	105	98	90	80	75	70	68	70	75	85	95	105
% deviation from minimum	%	51	41	30	15	8	-	-	-	8	23	37	51
Domestic water use													
monthly domestic water use	kl	75	68	59	50	41	35	31	33	37	48	62	75
% deviation from minimum	%	127	106	79	52	24	-	-	-	12	45	88	127
% total water use	%	71	69	66	63	55	50	46	47	49	56	65	71

Source: Rainfall from local weather station. Water use data from WSP. Note: 1. Minimum calculated as average of the three lowest figures out of the 12.

The above data could be illustrated as follows:

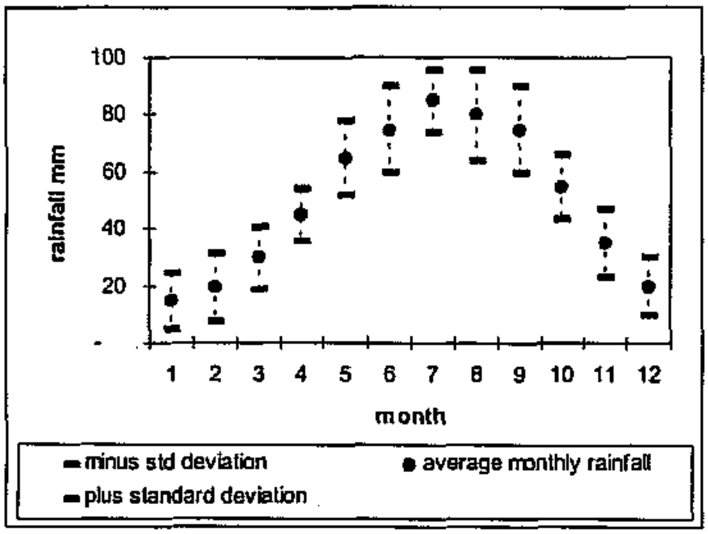

Figure 31 : Seasonal rainfall pattern (illustrative)

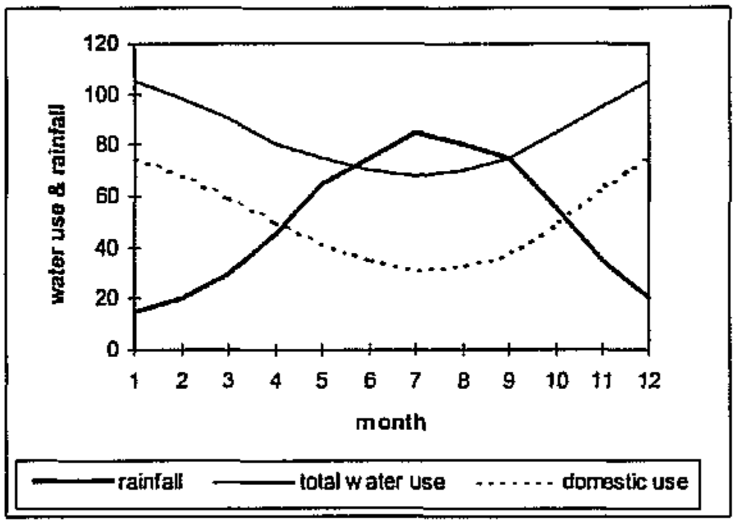

Figure 32: Seasonal water use pattern (illustrative)

Consumption distribution is summarised in Table 27. **Comment**: Although consumption distribution data is used in the WSSM, the format is different to that proposed above. The decile format presented above has the advantage that it is not reliant of the definition of consumption categories and hence allows for better data comparability. (This format is proposed as an addition and not a substitute to that used in the WSSM.)

Table 27: Consumption distribution - metered single residential (data is illustrative)

(consumers ranked by consumption)	first 10%	next 10%	next 10%	Nex t 10%	next 10%	next 10%	next 10%	next 10%	next 10%	last 10%
Ave. consumption (kl/month)	3	5	8	13	20	30	40	55	68	80
Share of consumption (%)	0.9	1.6	2.5	4.0	6.2	9.3	12.4	17.1	21.1	24.8
Cum. share of consumption (%)	0.9	2.5	5.0	9.0	15.2	24.5	37.0	54.0	75.2	100
Cumulative % of consumers	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Source: WSP consumption data.

This data is represented in graphical form in Figure 33.

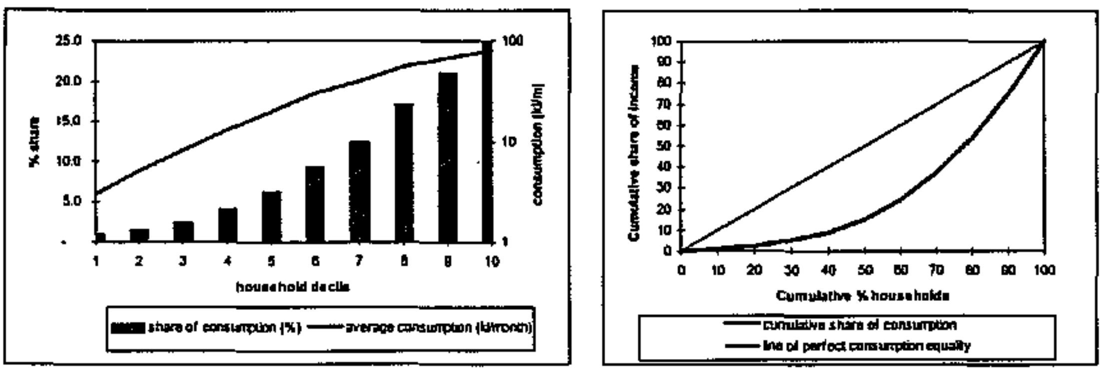

Figure 33: Consumption distribution - single residential (illustrative)

8.2.8 Financial and tariff data

The following financial and tariff data are necessary:

- **Costs**: A summary of costs by function.
- **Revenue**: A summary of revenues by source.
- **Tariffs**: Details of the existing tariff structure.

A *breakdown* could be conceptualised in a format which is the same or similar to that presented in Table 28 with reference Figure 34 (source: PDG, 1998d).

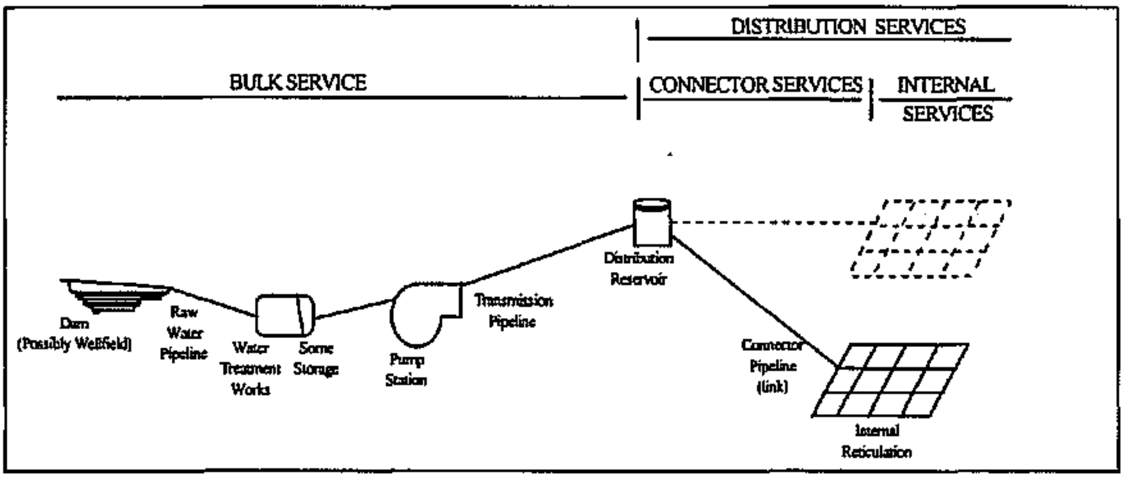

Figure 34: Components of water supply system

The schema assumes that treated water is purchased from a wholesale WSP. If this is not the case, the wholesale water function should be set up as a separate cost centre and a unit c/kl cost calculated for the bulk water function.[137]

In the case of small local authorities, it may be more practical to collapse the "connector" and "internal reticulation" categories into one. In this case a decision must be made as to whether to calculate the unit cost on a volume or connection basis. This will depend on a judgement as to which is the most important cost driver: volume or number of connections.

Providing the cost breakdown in the format demonstrated will enable the WSA, and more importantly, local political representatives to understand the factors influencing water costs in the local area. This cost breakdown is used in the practical guidelines for tariff design given in a later section.

[137] An example of how this is done where a municipality manages it's own bulk water supply is shown in Working Paper 5.

Table 28: Retail WSP cost breakdown

Infrastructure	bulk treated water [1] A	"connector" (city level) [2] B	internal reticulation [3] C
Capital costs related to:	*volume* (annual and daily peak) determines design capacity	*volume* (hourly peak) determines design capacity	neighbourhood *plot* size, peak flow for fire, pressure,
Operating costs related to:	mainly energy and chemicals which are *volume* related	extent of infrastructure and hence the *volume* (hourly peak)	length of pipe network, pipe materials, age of network, customer support costs (meter reading, billing, etc.)
Allocation of retail WSP's annual costs: [4]			
Overheads & administration[5]		overhead and administration costs allocated across these two functions	
Staff costs [6]		non-specific staff costs allocated across these two functions	
General expenses [7]		allocated across these two functions	
Maintenance [8]		f(city level infrastructure)	f(neighbourhood infrastructure, no. & type of connections)
Capital charges		f (outstanding loans: city level infrastructure)	f (outstanding loans: local infrastructure, connections)
Contributions		allocated across these two functions	
Other		allocated across these two functions	
Purchase of treated water	f (volume, assurance of supply)		
Calculation of unit costs:			
unit	**c/kl**	**c/kl**	**R / connection**
calculation	annual cost / water sold	annual cost / water sold	annual costs / number of connections
Comment	uniform bulk water cost for whole supply area	uniform cost for whole supply area	by consumer type and area or neighbourhood

Notes: 1: *Bulk treated water*: the supply of bulk treated water to the supply area. This is usually undertaken by a Water Board and this is assumed in this table. 2. *Connector infrastructure*: this is "city level" water infrastructure, for example, storage and major link pipelines, whose costs are mainly volume related. 3. *Internal reticulation*: this is the neighbourhood or local street level reticulation including the *individual connections*, that is, the link from the street to the on-site plumbing, including the meter and the associated support costs. 4. The cost categories follow the IMTA guidelines. See PDG (1998d: Table 4). 5. *Overheads and administration*: If possible, this should be separated out from staff costs. For example, management, head-office rental and financial management would fall under this category. 6. *Staff costs*: where possible, these should be allocated to specific functions, for example, maintenance. 7. *General expenses* excluding bulk water purchase - see below. 8. *Maintenance and repairs*: direct maintenance and repair costs for each of the two different groups of infrastructure, including staff costs if possible.

The *WSSM* uses a cost allocation which is compatible with the one given above, and both are compatible with the IMTA guidelines. Further discussion of cost allocation is given in PDG (1998d).

The *sources of income* may be usefully summarised as shown in Table 29. The relative reliance on external versus internal sources, property taxes versus fixed fees and volume related sales is readily established from such a summary. Note that these sources of income are available to a *combined* WSA and WSP. Where these are separate entities, the potential sources of income will be different for the WSA and WSP respectively.

Table 29: Summary of income sources (data is illustrative)

	Annual income R 000	% distribution
Local sources	**8 000**	**80**
Property taxes - general	0	0
Property tax – specific	1 000	10
Fixed water fees	1 500	15
Volume related water sales	5 500	55
External sources	**2 000**	**20**
Inter-government grants	1 500	15
Other	500	5
Total	**10 000**	**100**

Source: WSP financial statements.

The income from water sales can be further subdivided into water sales to residential and non-residential consumers, and the latter category into institutional, commercial and industrial. See PDG (1998df).

The details of existing *tariff structures and levels* may vary widely between supply areas. Hence it is not possible to provide a blue print for how these should be summarised and presented. Nevertheless, the following information is important and should be presented in summary form: (see PDG, 1998d)

- The nature and level of *dedicated property taxes.*
- The nature and level of water related *fixed charges*..
- The nature and level of *volume related* charges.
- The nature and level of *connection fees* for new connections.
- The nature and level of *infrastructure fees* for new infrastructure development (at city and neighbourhood level)

- The *differentiation of charges* (all of the above) by consumer category, connection type, consumer characteristic, area, season etc.
- The *frequency* with which these varies fees and tariffs are levied.

8.2.9 Concluding remarks

An outline and *illustration* of the kind of data needed to inform the pricing reform process has been presented in this section. Additional comment on data requirements is presented in PDG (1998def). Instances where the data formats differ, or where additional data requirements have been proposed, have been noted above. It will be readily apparent from this that the tariff setting process is complex as it requires numerous factors to be taken into consideration. How this data could be used as a basis for tariff reform is demonstrated in the following section.

8.3 Setting measurable pricing and management goals

The broad pricing reform goals of improving equity and efficiency, and ensuring sustainability have been highlighted and discussed previously. In this section, specific indicators are proposed which will assist water managers and decision makers in setting more specific and measurable goals.

In general, for the reasons already outlined, it is neither desirable nor possible to set specific universal goals which are applicable to all urban areas in South Africa. Hence, in most cases, only the indicators themselves are proposed and not specific targets.

8.3.1 Financial sustainability

Financial sustainability requires revenues to exceed costs over the long run and the ability of the WSP to raise capital finance to sustain and expand its operations. The following indicators are proposed which may be used to establish specific financial sustainability goals in each urban area:

- **annual revenue target**: The actual revenue target will depend on a number of factors. In general, though, total revenue in any year should at least match total expenditure.
- **cash flow ratio**: Annual revenue / annual expenses. This should, in general, be greater than or equal to one.
- **water sales revenue / operating expenses**: The degree to which operating costs (excluding debt service) are covered by revenue from water sales. In general, this should be greater than one. **Comment**: This is new.
- **financial dependence**: The ratio of external revenue (inter-government grants) to total revenue. The smaller the ratio the greater the financial autonomy. It may not be possible (nor necessarily desirable) for this ratio to be small in all circumstances. **Comment**: This is new.
- **debt to revenue ratio**: Specific targets will depend on local circumstances. Other related ratios that may be useful are: debt service to revenue ratio, debt service to locally raised revenue ratio, debt service to revenue from water sales ratio, current

assets / current liabilities, net fixed assets / total assets, total debt over total assets and current liabilities / total debt.

- **non-payment**. The percentage of the annual billed amount which is written off as bad debt.

Other performance targets, in particular those that reduce costs or increase technical efficiency, may also enhance financial sustainability. These are discussed under "efficiency" below.

8.3.2 Ecological sustainability

The environmental costs of water resource development are included in the first tier water price. Further, the ecological reserve, set aside as a priority allocation at the first tier level, will help to ensure ecological sustainability. In addition to this, a catchment management charge will be levied at the first or second tier level to recover the costs of catchment management (which may have a significant environmental management component). Finally, a "resource charge" will reflect the scarcity value of water which will help also help to promote ecological sustainability. Therefore, on the water supply side, the goal of ecological sustainability is essentially taken care of through first and second tier pricing and other water management policies. *Thus there is no need for any further explicit ecological sustainability goals for water supply at the third tier.*

8.3.3 Equity

The following indicators are proposed which may be used to establish specific equity goals in each *urban* area, or to measure the equity impacts of price reform:

- **service gap (minimum basic)**: The percentage of households without *access* to a minimum basic water service. The short term goal should be 0%, however it may be desirable to set annual interim targets.

- **service gap (target basic)**: The percentage of households without *access* to a target basic water service. The five-year goal should be 0%, however it may be desirable to set annual interim targets.

- **adequacy of consumption**: The percentage of households (or population) in the supply *consuming* less than 50 lcd. The ultimate target should be 0%. The impact of pricing reform on this figure should be carefully monitored.

- **maximum budget share**: The "5% rule" expresses a general social preference that households spend *less than 5%* of their incomes on water services. An appropriate equity indicator to use may therefore be the estimated percentage of households spending more than 5% of their income on water services. The general goal should be to reduce this percentage over time and to take particular note of the impact of price reform on the budget share spent on water services amongst poor households. **Comment**: If anything, the 5% rule may be too high, and hence it is recommended that a lower target be used if possible. Macleod (1997) proposes a "2% rule of thumb".

- **progressivity**. In view of the social and political importance of reducing income inequalities in South Africa, water pricing reform should not exacerbate income inequality. The appropriate indicator of progressivity (or regressivity) of pricing reform is to examine the *budget share* spent on water services by population decile (ranked by income) before and after the reform.

Comment: Additional explicit equity targets are proposed here.

8.3.4 Establishing specific measurable efficiency goals

The following indicators are proposed which may be used to establish specific efficiency goals in each urban area:

- **Unaccounted-for water**. This should be less than 15%.
- **Meter coverage**: The percentage of individual connections metered. The extent of district metering (for water management and water loss detection purposes).
- **Water losses**. Water losses are a function of both institutional efficiency and physical characteristics (such as pipe materials and age of the network). WSPs should establish what their water losses are and should aim to improve losses so long as these improvements are cost-effective.[138]
- **Commercial and institutional water-use efficiencies**. The penetration of water saving technologies in businesses and institutions? It may be desirable to set policies and targets related to the penetration of low-flush toilets, low-flow faucets and showerheads, banning automatic flushing urinals etc. This is particularly important in relation to new investments that may be influenced through *building codes*. **Comment**: Measuring the penetration of water saving devises in institutions and business is a new performance indicator that is being proposed. This indicator may not be appropriate in all contexts and should probable be a longer-term aim. One method of achieving this could be by requiring public disclosure. Random audits could be implemented to ensure correspondence between disclosure and actual implementation.
- **Household water use efficiencies**. The percentage of households using more than 200 lcd may be used as one indicator of the extent of high water use in the domestic sector. Another indicator may be the percentage of domestic consumption in excess of 200 lcd. These indicators will provide an estimate of the potential scope for water conservation in the domestic sector. **Comment**: These are new indicators.
- **Industrial water use efficiencies**. Industrial water use efficiencies can be calculated in a number of ways. These are shown in Table 30 with reference to Figure 35.

[138] Investments in water saving are only cost-effective if the cost of the investment is less than the discounted present value of the water saved. The appropriate value of the water saved is the full long-run marginal cost of replacing that water (and not the short-run average or marginal cost of the existing water supply). This calculation is also sensitive to the choice of discount rate.

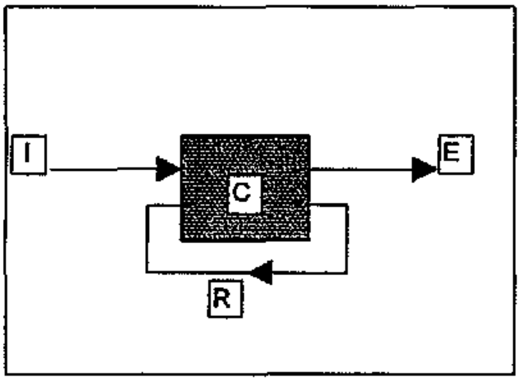

Figure 35: Calculating industrial water use efficiency

Table 30: Calculating technical water use efficiencies (data is illustrative)

Parameters	Symbol	Units	baseline	ex. 1[1]	ex. 2[1]	ex. 3[1]
Intake	I	kl / day	100	**80**	80	**60**
Effluent	E	kl / day	60	60	**40**	**30**
Consumption	C = I - E	kl / day	40	20	40	30
Recycle	R	kl / day	300	300	300	300
Gross use	I + R	kl / day	400	380	380	360
Unit of output	O	kg	1	1	1	1
Technical efficiency						
Consumptive use	C / I	%	40%	25%	50%	50%
Recycle ratio	R / (R + I)	%	75%	79%	79%	83%
Specific water use	I / O	kl / kg	100	80	80	60
Specific effluent production	E / O	kl / kg	60	60	40	30
Specific consumptive use	C / O	kl / kg	40	20	40	30

NOTE: 1. Examples 1, 2 and 3 show the influence of changing different input parameters on the various efficiency indicators (compared to the baseline). The input parameters which have been modified are shown in bold typeface.

The most useful ratios to use are the recycle ratio, specific water use and specific effluent production. The WSP may wish to request large water using industries within their area of supply to disclose these efficiencies annually and compare them to available best practice benchmarks. Penalties may be applied in cases where water is clearly wastefully used.

Comment: The proposed performance indicators are not used widely at present.

8.3.5 Making trade-offs

It may not be possible to achieve all of the goals simultaneous. Specific priorities will depend on local circumstances and hence it is desirable that the prioritisation of goals and negotiation of trade-offs between goals be undertaken at the local level with appropriate political and customer representation (see the discussion on governance in Section 6.3). Overall system efficiency should also be examined at the river basin level by the relevant catchment management authority.

8.4 Establishing best practice principles

Best practice principles in relation to the governance of water services and water pricing were proposed in Section 6.4. The practical implications of this are discussed here.

Fairness. The notion of fairness is inherently subjective. The implication of this is that the fairness of tariff reform can only be tested within a democratic political realm. This point therefore stresses the need for retail tariff reform to be subject to the democratic political process. See the discussion presented in the *guidelines* (PDG, 1998d).

Easily understood tariffs. There should be a general preference for simple (non-complex) tariff structures which are easily understood.

Transparent and targeted subsidies. Subsidies should be clearly targeted and the subsidy amounts known (transparent). The efficacy of targeting and transparency of different subsidy options are shown in Table 31 and recommendations as to the preferred options (in terms of these two criteria) are made.

Table 31: Subsidy targeting and transparency

Subsidy type and description	Targeting	Trans-parency	Recom-mended
Capital subsidies			
free provision of communal standpipes	good	good	✓
income-qualified reticulation subsidy for on-site connections	depends on efficiency of income screening	fair	✓
area-based reticulation subsidy for on-site connections	depends on spatial income distribution	good	✓
Connection subsidies			
income-qualified connection fee subsidy	depends on efficiency of income screening	fair	✓
area-based connection fee subsidy	depends on spatial income distribution	good	✓
Recurrent subsidies			
subsidised communal standpipe water	good	good	✓
subsidised restricted-flow on-site access	good	good	✓
universal direct credit	poor	good	✗
income qualified direct credit	depends on efficiency of income screening	good	✓
area-based direct credit	depends on spatial income distribution	good	~
universal quantity based life-line	fair	fair	~
income-qualified quantity based life-line	depends on efficiency of income screening	fair	✓
area and quantity based life-line	depends on spatial income distribution	fair	~
subsidised tariff (all quantities)	poor	fair	✗

Note: ~ = depends

Comment: It is notable that the universal quantity based life-line is not a well targeted subsidy in terms of favouring poor households.

Consistent and fair enforcement. This implies that tariffs are politically acceptable and emphases the point that tariff reform must be subject to due political process. Equally, the WSP must have the *capability* and *willingness* to enforce revenue collection. In the context where access to water is regarded as a constitutional right and cutting off domestic supplies because of non-payment is not politically desirable and/or feasible, an alternative aid to tariff enforcement is to replace unrestricted on-site access with restricted on-site access (flow and pressure restrictions) or communal access through a public standpipe.

Cost-effective reform. The principle that the benefits of any action should always exceed the costs should be implemented wherever practical. The two principle application of this principle are to metering and investments in water saving. In the case of metering, it may not always be cost-effective to meter. Cost-benefit analysis in relation to investments in water savings has already been discussed elsewhere.

Stable and predictable revenue. Revenue which is based on a mix of fixed fees and volume related tariffs will be more stable than one which relies exclusively on a volume related tariff. However, the benefits of this must be weighed against the efficiency, water conserving and cost advantages of higher marginal tariffs which would result if greater reliance is placed on volume related tariffs. Uncertainty in relation to both the underlying consumption data (distribution) and behavioural responses to price changes implies that, in general, a *cautious and incremental approach to pricing reform should be adopted.* There may, however, be circumstances where significant and relatively rapid changes in pricing structures and levels may be desirable.

Improving communication. Consumers have a right to be fully informed and it is the responsibility of the WSP to facilitate this. There are a number of important areas where communication can be improved. First, the *language* capability of the WSP should match the customer base (both existing and potential). Second, consumers should have ready *telephonic access* to the WSP to relay complaints, feedback and queries related to their service. Third, there monthly water bill should convey the relevant information. in a clear, readable and easily understood manner. This is called *informative billing* and marks a distinct departure from the prevailing current practice.

8.5 Tariff design guidelines

These are presented in the following section.

8.6 Tariff reform: getting from here to there

In the previous section, some guidelines for designing tariffs were given. In many cases the existing tariff structure may be quite different from that obtained using the above guidelines. If this is the case,. then the *process* of tariff reform, that is, moving from the existing situation to that proposed needs to be addressed. Some cautionary points are made about this process in this section.

Starting from what is. Price reform must start with the existing pricing structure and levels. It is neither possible nor desirable to wipe the slate clean and start afresh. It is for this reason that so much emphasis has been placed on "understanding the context" and on establishing the goals of pricing reform in relation to practical indicators based on existing performance.

Incremental reform. The dangers of radical tariff reform have been made clear in the review of pricing experiences (see Working Paper 2). Hence it is strongly recommended that an incremental approach to tariff reform be adopted. Where large changes in the tariff structure or level are desirable, it is recommended that they be implemented over a number of years. However, there may be instances where a more radical approach to tariff reform is politically feasible and desirable.

An iterative process. The tariff reform being advocated here is an iterative one. That is, as the incremental reforms are implemented they are assessed against the performance goals that have been set. This enables progress to be measured. Any unexpected results will also show up in the evaluation which can then be examined in greater detail as warranted.

Incremental approach to improving data. Existing data may not always be adequate. An incremental approach to improving the reliability and accuracy of available data should also be adopted in parallel with the tariff reform process.

Scenario and sensitivity analysis - the use of spreadsheets. Spreadsheets provide a useful tool for scenario analysis. For example, where significant changes in price level are planned over a period of time, different price-elasticity of demand assumptions can be used to test the sensitivity of the demand (and hence revenue) projections in response to price changes using different elasticity estimates. The most probably range of price-elasticities is between -0.2 and -0.6. Though larger price elasticities may sometimes occur. The sensitivity of projections to other key assumptions such as interest rate and discount rate may also be tested using a spreadsheet modelling approach. The WSSM is a possible tool that may be used (PDG, 1998f). However, in many instances, developing smaller custom designed spreadsheets to test specific scenarios may be more appropriate.

Histograms and non-parametric density functions. Histograms provide an accessible tool for analysing distributions. They are, however, a rough and ready tool and may miss important patterns in the data distribution because of the coarseness of the analysis. In many cases, the reliability of the data may not warrant a more fine grained analysis. Where this is warranted, non-parametric density functions may be an appropriate tool. These are described in Working Paper 4.

8.7 Summary and conclusions

In this section, a methodology for setting urban water prices was proposed. The approach emphasised the fact that setting water prices is an *iterative process*, comprising the steps of understanding the context, establishing measurable goals, designing the tariff, evaluating the impact and refining the price structure. The kinds of data needed for this exercise were set out. A number of indicators that can be used to set practical and context specific pricing (and management) goals were proposed. Practical guidelines for determining the desirable actual price structure and levels, as well as implementing equitable and targeted subsidies are set out in the following section. Finally some cautionary remarks were made about the process of price reforms and the need to adopt an incremental approach.

9. Tariff design - some practical guidelines

On the basis of the recommendations made above, some practical guidelines for tariff design are proposed in this section. The guidelines provide a coarse-grained approach which is helpful to assess the broad feasibility of different subsidy and tariff structure options. Once a broad outline has been worked out following this approach, the estimates can be refined through a more detailed approach (through the use of the *guidelines*, the *WSSM* and/or a custom made tariff model). It should be noted that the guidelines presented here differ from those presented in the *guidelines* in a number of respects. These differences are highlighted in the discussion.

9.1 Some basic definitions and assumptions

1. **Notation**. A summary of the notion used in these guidelines is given in Appendix 3.

2. **Classification of costs**. The guidelines presented below rely on the classification water services costs into "fixed" and "variable" costs based on the cost breakdown given in Table 28. The fixed costs (C_F) are made up of the costs related primarily to the neighbourhood reticulation and individual customer support (Column C in Table 28). These are considered to be fixed because once the investment has been made, unit costs are essentially constant for a given number of consumers and level, distribution and standard of service.[139] The variable costs (C_V) are related to both the operating *and capital* (debt service) costs of bulk treated water supply and city level reticulation (Columns A and B in Table 28). The capital costs are considered to be variable because the capacity of this infrastructure is directly related to future projections of overall demand and hence the costs are dynamic over time. The total annual cost (C_{TOTAL}) is the sum of the fixed and variable costs. In summary:

   $$C_{TOTAL} = C_F + C_V$$

   Comment: This distinction is slightly different to that given in the guidelines in that it is more simplified. However, the difference should not be significant. The simplification is justified on the basis of the coarse-grained approach proposed here.

3. **Classification of revenues**. The total revenue requirement (R_{TOTAL}) is assumed to be equal to C_{TOTAL}. This assumes revenue neutrality (which is recommended, although the guidelines proposed here are not contingent on this assumption). The total revenue is made up of revenues from fixed fees (R_{FF}) and water sales (R_{WS}). Fixed fee revenue may be made up of revenue from property taxes (R_{PTAX}) and/or direct charges ($R_{CHARGES}$). In summary:

   $$R_{TOTAL} = C_{TOTAL}$$

   $$R_{TOTAL} = R_{FF} + R_{WS}$$

[139] Changes in costs over time arising from improved institutional efficiencies, changes in customer distribution etc. are not considered here.

$R_{FF} = R_{PTAX} + R_{CHARGES}$

Comment: The possibility of receiving revenues for water services from the property tax is new. This source of funds is not considered nor evaluated in the guidelines and in the WSSM.

4. **Classification of volumes**. The total bulk treated water purchased (or self-supplied) should be the ultimate quantity reference point (Q_{TOTAL}). Q_{SOLD} is the total volume sold (metered and billed), Q_{UAW} is the unaccounted-for water = Q_{TOTAL} - Q_{SOLD}. Q_{NR} is the estimate of non-revenue water supplied. Estimated losses (Q_{LOSSES}) is calculated as the difference, that is Q_{TOTAL} - Q_{SOLD} - Q_{NR}. The total water sold Q_{SOLD} is made up of total residential billing (Q_{RES}) and total non-residential billing (Q_{NRES}). Q_{NRES} may be further categorised into total institutional billing (Q_{INS}), total commercial billing (Q_{COM}) and total industrial billing (Q_{IND}). Non-revenue water (Q_{NR}) includes an estimate of water supplied to communal standpipes (Q_{CST}) and water supplied to restricted on-site residential supplies (Q_{ON-R}). (It is assumed that restricted on-site supplies are not metered. If they are metered, then they are included in Q_{RES}). In summary:

   $Q_{TOTAL} = Q_{SOLD} + Q_{UAW}$

   $Q_{UAW} = Q_{NR} + Q_{LOSSES}$

   $Q_{SOLD} = Q_{RES} + Q_{NRES}$

   $Q_{NRES} = Q_{IND} + Q_{COM} + Q_{INS}$

   $Q_{NR} = Q_{CST} + Q_{ON-R} + Q_{OTHER}$

5. **Normal residential consumption**. Normal residential consumption is defined as 50 lcd to 200 lcd. Consumption of at least 50 lcd is socially desirable from a public health point of view. Consumption of more than 200 lcd is considered to be luxury consumption in the South African context.

6. **Adjustments for non-payment**. The tariffs below are calculated on the assumption of 100% payment. If there is non-payment, the calculated tariffs should be adjusted by a non-payment adjustment factor (NPAF) as follows:

   $NPAF = 100 / (100 - NP\%)$ where

   $NP\% = \%$ non-payment = $(R_{BILLED} - R_{ACTUAL}) / R_{BILLED}$

   For example, if non-payment is 10%, then NPAF = 1.11.

7. **Introduction of subsidies**. In the approach put forward here, all of the *initial* revenue and cost calculations undertaken are based on actual current costs assuming that there are *no subsidies*. The subsidies are then added explicitly later as indicated. This approach has been adopted because the initial exclusion of subsidies clarifies the actual full revenue requirements in relation to actual costs, thus, when the subsidies are added, their impact can be evaluated in this context. **Comment**: This is an important process point that is implicit in the WSSM and the guidelines though it is dealt with in a much more explicit way here.

8. **Cross-subsidies**. In this exercise, cross-subsidies are only considered within the domestic sector. However, the analysis can be readily extended to cross-subsidies between the non-residential and residential sector.

9.2 Understanding the revenue trade-offs

1. **Revenue from water sales.** The proportion of revenue to be derived directly from water sales is one of the fundamental decisions that need to be taken in water tariff design. The higher the proportion of revenue obtained from fixed fees, the more stable and predictable the revenue and the lower the average volume related tariff. However, low volumetric water tariffs may not be desirable as they may provide insufficient incentives for efficient water use. Calculating a benchmark for the recommended "minimum" revenue from water sales is a useful first step in clarifying the trade-offs related to this decision.

2. **Revenue from water sales - a benchmark.** It is proposed that an appropriate benchmark figure to be used as the minimum revenue requirement from water sales ($\mathbf{R_{WS\text{-}MIN}}$) is $R_{WS\text{-}MIN} = C_V$. This is an appropriate benchmark figure to use because C_V is largely a function of volume. Hence, *at least* these costs should be covered by revenue directly related to water sales. Reducing this revenue requirement would inappropriately reduce the incentive for consumers to use water wisely as the marginal cost of water use (to users) would be below the average cost (to society) of supplying that water. **Comment**: This benchmark is new.

3. **Revenue from fixed fees - a benchmark.** The same logic may be applied to the calculation of a benchmark for the maximum revenue from fixed fees ($\mathbf{R_{FF\text{-}MAX}}$), which is simply $R_{FF\text{-}MAX} = C_F$.[140] **Comment**: This benchmark is new.

4. **Property taxes as a source of fixed fee revenue for water.** The most important motivation for using this source of income is that property taxes probably represent the most progressive way of raising fixed fee revenue for water services. This is because it is likely that household incomes are fairly closely correlated with property value. The use of property taxes as a full (or partial) source of revenue for water services is quite common for this reason. An added advantage is that the progressivity of this tariff can be enhanced by implementing rebates for low property values (the unit rate could be lowered or waived altogether).[141] There are three important disadvantages to the use of property rates, particularly in development countries. First, revenue from property taxes is constrained while the demands on this source of revenue are large.[142] Second, enforcing the payment of property taxes may be difficult. Third, property valuation systems may be incomplete.[143] Perhaps for these reasons, there appears to have been a general move away from reliance on property taxes as a source of revenue for water services in the newly amalgamated South African cities and towns. This, in turn, appears to have influenced national policy.[144] In the light of both the advantages and

[140] Where water use is highly seasonal, for example, in a "holiday community", fixed fees are an important source of stable revenue and hence it may be desirable to set R_{FF} to C_F and not to regard this benchmark only as a maximum.

[141] Another motivation is that property value is usually related to the quality of services provided, including water. However, this relationship is unlikely to be linear.

[142] Many local services to not have ready alternative sources of income.

[143] Poorer areas are often not included in the valuation roll.

[144] National water policy advocates full cost recovery *within* the water sector, implying that property taxes are not a favoured means of raising revenue for water services. However, the Local Government white paper recognises the potential role of property taxes as a source of income for all locally managed services.

disadvantages of the use of property taxes for water revenue, it is desirable that some *compromise* be struck. At least some revenue for water services be raised from property taxes because of the equity advantages, but that this not impose an undue burden on the property tax system. **Comment**: The current policies and practice tend to ignore property taxes as a progressive source of revenue for water services.

5. **Institutional implications of using property taxes.** The use of property taxes as a source of revenue for water services has the implication that the WSP must be reliant on local government for a portion of its revenue. In other words, full financial and managerial autonomy of the WSP is not possible in these circumstances. It has been argued elsewhere in this report that full financial and managerial autonomy is not necessarily desirable. The equity advantages of using this source of revenue may outweigh any potential benefits accruing from full financial autonomy.

6. **Testing the feasibility of a property tax.** It is a straight forward matter to calculate the required property tax (levied at a fixed rate per Rand of property value) to raise different proportions of the "fixed" revenue requirement for water services (R_{FF}), provided there is a complete (and widely accepted) valuation roll. The relative burden of the water related property tax on the property tax system as a whole can be easily calculated. The relative burden on different income groups can also be calculated provided the relationship between property value and household income is known. Unfortunately, the data necessary to understand this relationship is not always readily available.

7. **Direct charges.** Fixed revenues can also be derived from monthly (or annual) charges levied directly on water consumers ($R_{CHARGES}$). The economic rationale is that these fees can be based on actual estimates of costs. The relevant costs here are the fixed costs related to neighbourhood infrastructure and the individual connection (for example, direct customer support costs such as meter reading, billing and revenue collection, and the neighbourhood infrastructure maintenance costs (C_F). A *fair allocation* of costs is difficult to achieve in practice because most WSPs do not record the cost information in suitable formats and, even if suitable information is available, the allocation of joint costs may be arbitrary (See PDG, 1998d). More importantly, a cost based fixed fee system such as this is likely to have a *regressive impact on income distribution* for two reasons. First, it is often more expensive to serve poor neighbourhoods.[145] Second, small (and, typically, poorer) households end up paying more per unit of water consumed than larger (and typically, richer) households because of the fixed fee component. For these reasons, direct fixed fees are not favoured in many countries and numerous local governments in urban areas in South Africa have either phased these fees out or have only nominal fees. One way of circumventing the regressivity of such a tariff structure is to waive (or reduce) fixed fees for poor households. For example, fixed fees could be income-qualified or area based. The efficacy of these approaches in targeting poor households will depend on the accuracy of the income screening process and the degree to which incomes are homogenous within defined areas.

[145] Both capital and maintenance costs may be higher due to physical factors such as topography, density, layout and distance from existing infrastructure.

8. **Testing the financial and equity impacts of fixed fees.** The financial and equity impacts of different fixed fee structures can easily be calculated using financial, income and water distribution data (of the kind identified in Section 8.2) and simple spreadsheet based models (see PDG, 1998f). Examples are shown in Section 10.

9.3 Some tariff benchmarks

1. **Recommended "minimum" volumetric tariff (T_{MIN}).** The recommended minimum volumetric tariff is simply $R_{WS\text{-}MIN}$ divided by the projected water sales over the relevant period (Q_{SOLD}). The rational for using this figure as a minimum benchmark has been explained above. Specific equity concerns may mean that the actual tariff is set below T_{MIN} in very specific circumstances. (Subsidy issues are discussed below.) **Comment**: This benchmark is new. In summary:

   $T_{MIN} = R_{WS\text{-}MIN} / Q_{SOLD}$

2. **Maximum life-line tariff ($T_{LL\text{-}MAX}$).** The maximum life-line tariff should be less than or equal to the marginal operating cost (which excludes all capital charges). See PDG (1998d).

3. **Maximum average tariff constrained by revenue neutrality (T_{MAX}).** The maximum average volumetric tariff that can be levied whilst still maintaining revenue neutrality can be calculated by dividing the total revenue (R_{TOTAL}) by the total volume of water sold (Q_{SOLD}). **Comment**: This is called the AHC tariff with zero fixed fees in the guidelines. In summary:

   $T_{MAX} = R_{TOTAL} / Q_{SOLD}$

4. **Determining a (rough) benchmark long-run marginal volumetric tariff (T_{MC}).** A rough estimate of the long-run marginal cost of supplying bulk treated water to the supply area can be obtained by summing the <u>average incremental cost</u> of future (first tier) water resource development (in the relevant water system) and the marginal cost of capacity expansion of the wholesale (second tier) infrastructure. It is important to bear in mind that this rough estimate is just that, a *rough* estimate. Numerous subjective assumptions, judgements and estimates are required to arrive at this estimate which should be considered an order of magnitude figure only. (See Working Paper 1 for a more detailed discussion of the problems associated with estimating marginal costs in the water sector.)

5. **Implications of moving from T_{MIN} to T_{MAX}.** In practice, changing the average volumetric tariff from T_{MIN} to T_{MAX} could have *either a progressive or a regressive impact* on income distribution, depending on both the progressivity of the fixed fee that is being substituted (property taxes are typically progressive and direct fees regressive) and the income elasticity of demand. Experience indicates that the income elasticity of demand is low, hence increasing the volumetric water tariff whilst holding all other things constant typically will have a regressive impact on income distribution. There is, therefore, a direct *trade-off* between the efficiency gains of higher water prices (higher marginal water prices are likely to induce consumers to use water less wastefully) and the regressive equity impacts arising from larger budget shares of expenditure on water services by poor households. *The aim is to strike a compromise between these two goals (efficiency and equity),*

by maintaining both a significant marginal water price and retaining the progressive equity impacts. Ways to achieve this are discussed below. First, subsidy design is discussed. **Comment**: The income distribution implications of moving between T_{MIN} and T_{MAX} are not explicitly considered in the guidelines and WSSM.

6. **Adjustments for non-payment.** The above tariffs should be adjusted for non-payment using the non-payment adjustment factor (NPAF)

9.4 More detailed cost breakdown

1. **Residential - non-residential breakdown.** If separate cost centres are maintained for different major consumer types, then aggregate costs and revenue requirements for each consumer category will be known. Typically this is not the case and a cost breakdown must be estimated. An estimate of the residential and non-residential variable costs ($C_{V\text{-}RES}$ and $C_{V\text{-}NRES}$) may be obtained by multiplying Q_{RES} and Q_{NRES} by T_{MIN}, C_F can be apportioned on the same basis if better information on the distribution of fixed costs between residential and non-residential consumers is not available. **Comment**: This method is a simplified version of that presented in the guidelines. These costs may be used to calculate separate revenue requirements and tariff benchmarks for residential and non-residential consumption, although this is not shown here. In summary:

$C_{V\text{-}RES} = Q_{RES} \times T_{MIN}$

$C_{V\text{-}NRES} = Q_{NRES} \times T_{MIN}$

$C_{F\text{-}RES} = Q_{RES} / Q_{SOLD} \times C_F$ (if more information not available)

$C_{F\text{-}NRES} = C_F - C_{F\text{-}RES}$ (if more information not available)

$C_{RES} = C_{F\text{-}RES} + C_{V\text{-}RES}$

$C_{NRES} = C_{F\text{-}NRES} + C_{V\text{-}NRES}$

9.5 Residential subsidies

9.5.1 Subsidy principles

1. **Introduction of subsidies.** It should be noted that no subsidies have been included up to this point in the tariff design guidelines.

2. **Implementing a rational subsidy policy.** The primary objectives of subsidy policy in the water sector are three-fold: first, to ensure universal *access* to a minimum basic water supply; second, to ensure access to a target basic water supply; third, to ensure that consumption of at least 50 lcd is affordable. The objectives should be prioritised in the same order. In addition to these basic equity objectives, subsidies should be effectively targeted and transparent. **Comment**: This explicit prioritisation of the subsidies in the tariff design process is new.

3. **Subsidy sources.** There are four sources of subsidy for water services in urban areas in South Africa. First, housing subsidies, which may be used to fund neighbourhood infrastructure including water reticulation. Second, bulk

infrastructure subsidies (called CMIP), which are directly linked to housing subsidies and may be used to fund bulk infrastructure, including water treatment, storage and conveyance. Third, recurrent subsidies linked to the "equitable share policy". The intention is that the equitable share subsidy be used to subsidise the recurrent costs of basic services for poor households.[146] Fourth, cross-subsidies subsidies may be generated from property taxes, direct charges and/or water sales.

4. **Bulk infrastructure subsidies**. The CMIP bulk infrastructure grant is not well targeted. To the extent that it is used for bulk water infrastructure, it will have the general impact of lowering the unit cost of bulk water supplied to all consumers. In fact, such a subsidy benefits large consumers more than it does small consumers and hence is also inequitable. For these reasons, and as a general principle, *the subsidisation of bulk infrastructure is not recommended.*

9.5.2 Access subsidies (AS)

1. **Housing subsidies**. These are once-off end-user capital subsidies based on an income qualification. The intention is that the household decides how the subsidy is spent and what level of water (and other service) service is desirable. Recipients of housing subsidies (or developers on their behalf) typically choose on-site unrestricted flow water services. This is a national subsidy. In theory, it is an equitable subsidy, however, this assumes both universal access to the subsidy and effective screening. Whilst it is the intention that all income qualifying households in South Africa receive the housing subsidy, the presence of national budget constraints and the potential for administrative failings mean that this is not likely to occur in practice. The following question thus arises: *how should neighbourhood water infrastructure be funded in the absence (or incomplete presence) of the housing subsidy?*

2. **Subsidising neighbourhood reticulation**. The extent to which neighbourhood reticulation can be financed and subsidised by the retail WSP depends on a number of factors such as the existing service coverage, the service targets set (both the level of service and the timing), the cost of services, the ability of the WSP to raise capital loans, the cost of loans and household income distribution. These factors lend themselves to financial modelling. *It is recommended that a model of the type already referred to be used to inform the investment planning* (PDG, 1998f). Once a decision has been made on achievable and sustainable goals for service coverage and levels of service (which includes universal access to basic water services),[147] the annual debt-service costs related to loans for investments in neighbourhood reticulation (AS_{RET}) that will be borne by the WSP should be added to C_F (see below).

3. **Subsidising connection fees**. Provided that all (or a very large majority of) households in the supply have access to *at least* a minimum basic (communal) water supply, then there is a strong equity argument for promoting on-site access by subsidising the connection fees. (Where a significant number of households do

[146] The Department of Constitutional Development is in the process of developing guidelines for the application of these subsidies. However, in terms of the constitution, it is likely local governments will be able to have full and final say on how these subsidies are use. Thus, from a practical point of view, the "equitable share" will yield a source of funds which may be put to a wide range of applications.

[147] See the goals related to the "service gap" suggested in Section 8.3.

not have access to even a basic communal water supply, *the first subsidy priority should be to provide these households with a minimum basic water supply.*) Where universal unrestricted- flow on-site access is not financially sustainable (which may be determined in the investment-tariff modelling exercise referred to above) then there is an argument for providing differential subsidies for restricted and unrestricted on-site access and requiring a household contribution in the latter case. Connection fee subsidies should be income qualified. If that is not possible, or unlikely to work well, then an area-based qualification could be used as a second-best alternative. Another possibility it for the WSP to finance the connection fee (at a subsidised or zero interest rate) and require households to pay the connection fee over a number of months (typically 6 to 12 months). The annual subsidy costs (or debt-service costs of the required loans) related to new connections (AS_{CON}) that will be borne by the WSP should be added to C_F (see below).

4. **Securing universal access.** The combination of the above access-related subsidies should secure universal access to at least a basic water supply, and preferably an on-site water supply in the supply area within a reasonable period of time (5 years). *It is important that this access subsidy framework be established first and as a priority before addressing the question of recurrent subsidies.*

9.5.3 New cost baseline

1. **Quantifying increased finance charges related to increased access.** The WSP financed neighbourhood reticulation and connection fee subsidies will have an impact on the total annual fixed costs (C_F). For clarity the adjusted total annual cost figure will be called C_{F+} ($=C_F + AS_{RET} + AS_{CON}$) where the $_+$ refers to the fact that the capital finance costs of securing universal access have been taken into account. In this way, the capital related fixed cost impact of securing universal access (for various service level and timing scenarios) can be readily determined.

2. **Quantifying other recurrent costs related to increased access.** Adding new consumers onto the network will have implications for other recurrent costs. These costs will be both fixed costs and variable costs. The fixed costs are made up of neighbourhood infrastructure maintenance and direct customer support costs (metering, billing, revenue collections etc.) The magnitude of the *fixed costs* will depend on the level of service provided (off-site, on-site). The *variable costs* are made up of the volume related bulk infrastructure costs and will depend on the additional quantity of water consumed. The former cost can be roughly quantified on the basis of an estimated unit fixed cost per new consumer (by type of service) multiplied by the number of new connections (by type of connection). The latter cost can roughly quantified as $T_{MIN} \times Q_{NEW}$ where Q_{NEW} is the estimated additional water consumption arising from the new connections. These costs can be added to C_{F+} and C_V respectively. Hence including the addition recurrent costs will result in increased revenue requirements denoted as follows: $R_{TOTAL++} = C_{F++} + C_{V++}$ where the $_{++}$ refers to the fact that *both the capital finance and recurrent costs* of improving access to water services in the supply area have been taken into account. Hence T_{MAX++} can be calculated. The overall impact of increasing access can be assessed by comparing T_{MAX++} to T_{MAX}. This assumes no external subsidies for recurrent costs. These are included below. **Comment**: The WSSM model provides a tool to analyse the financial impact of increasing access to services. The approach adopted here is similar, only it has been simplified.

9.5.4 Recurrent subsidies

1. **Sources of recurrent subsidies.** The two sources of recurrent subsidies are the inter-government "equitable share subsidies" (SS_{ES}) and locally derived cross-subsidies (SS_{CS}) . The quantity of the former is likely to be known. although the share allocated specifically to water must be decided (SS_{ESW}) . The quantity of revenue arising from cross-subsidies depends on the design of the tariff and local demographic, economic and political factors. In view of the fact that it is all but impossible to quantify the total availability of recurrent subsidies, it is more appropriate to develop and quantify a hierarchy of recurrent subsidy needs and to determine the feasibility of meeting these. The following approach is recommended.

2. **Prioritisation of recurrent subsidies.** The principle of equity implies that subsidies should be targeted to those most in need. In the context of water supplies, this means that recurrent subsidies should be prioritised as follows. *First* to households without on-site access. Second, to households with restricted-flow on-site access. Third, to basic domestic consumption (<50 lcd) for low-income households. *Last*, to basic domestic consumption for all other households. **Comment**: This explicit prioritisation of the subsidies in the tariff design process is new.

9.5.5 Quantifying maximum recurrent subsidies needs

1. **Off-site subsidies.** Households who do not have on-site access to water are generally amongst the poorest in any given urban water supply area. Further, off-site access automatically implies a severe restriction on per capita use (typically significantly less than 25 lcd). *Fees levied on users of off-site water which discourage water use are therefore not recommended unless they are absolutely essential for the financial survival of the WSP and (most importantly) that households with on-site access are not receiving recurrent water subsidies.* The financial feasibility of providing free water to households with off-site access therefore should be examined first. A rough estimate of the maximum total subsidy needed ($RS_{OFF-MAX}$) may be calculated as the total quantity of water supplied to communal standpipes (Q_{CST}) multiplied by T_{MAX++}.[148]

2. **Restricted on-site subsidies.** Households with (unmetered) restricted on-site water supplies should be the second priority for subsidies. The rationale follows that given above for off-site supplies and a rough quantification of the maximum subsidy ($RS_{ON-R-MAX}$) may be estimated on the same basis ($Q_{ON-R} \times (T_{MAX++} - T_{LL})$ where T_{LL} is the lifeline tariff implemented which is less than T_{LL-MAX}.

3. **Unrestricted on-site subsidies.** Households with unrestricted (metered) on-site supplies should be the *last* priority for recurrent subsidies. It is recommended that if this subsidy is implemented, it is based on a maximum consumption of 50 lcd. Hence, a rough estimate of the maximum recurrent subsidy for this category ($RS_{ON-U-MAX}$) may be calculated as follows: (total population in supply area less estimates of population with off-site supplies and restricted on-site supplies) × 50 lcd × ($T_{MAX++} - T_{LL}$) where T_{LL} is the lifeline tariff implemented which is less than T_{LL-MAX}. **Comment**: These are very approximate estimates, nevertheless, such

[148] A more accurate estimate may be obtained if the direct operating and maintenance costs of communal standpipes, excluding the cost of the water, are known. These can be added to ($T_{MIN} \times Q_{CST}$).

estimates are not calculated in the guidelines and the WSSM and are useful indicators of the potential subsidy burden.

4. **Metering and on-site subsidies.** The subsidy framework being proposed here is equitable *only if* all unrestricted-flow on-site connections are metered. If this is not the case, subsidies for metered on-site water connections should not be implemented until metering is (near) universal. The use of subsidies in this way also could be used to encourage the acceptance of metering programmes.

9.5.6 Quantifying a feasible recurrent subsidy

1. **Off-setting recurrent subsidy needs against the equitable share.** The maximum recurrent subsidy needs calculated above (RS_{OFF}, $RS_{ON\text{-}R}$, $RS_{ON\text{-}U}$) should first be off-set against the equitable share subsidy allocated to water (SS_{ESW}). If $SS_{ESW} \geq (RS_{OFF} + RS_{ON\text{-}R} + RS_{ON\text{-}U})$, then all of the "maximum" subsidy needs calculated above can be met from external sources. Typically, however, this will not be the case and there will be a *net residual* recurrent subsidy need $\mathbf{RS_{NET}}$.

2. **Net recurrent subsidy requirement.** There are two possible approaches to addressing the net recurrent subsidy need (RS_{NET}). The first is to examine the impact of meeting this recurrent subsidy requirement through cross-subsidies. The second is to reduce the recurrent subsidy requirement. **Comment**: Separating out the external subsidy from the internal subsidy in this explicit way is new.

3. **Calculating the cross-subsidy burden.** In order to quantify the cross subsidy impact, it is necessary to estimate the share of total income coming from residential consumers. (It is assumed here that there is no cross-subsidy from non-residential consumers.) The total revenue requirement from residential consumers (R_{RES}) can be estimated as ($T_{MAX++} \times Q_{RES}$) - SS_{ESW}. Hence the cross-subsidy burden on the residential sector can be estimated roughly as follows: $CS_{BURDEN} = RS_{NET} / (R_{RES} - RS_{NET})$. For example, if the net recurrent subsidy need is R20 million and the total income from residential water consumers is R100 million, then the CS_{BURDEN} = 25%, which means that the average contribution from paying residential consumers would have to increase by 25% to meet the recurrent subsidy requirement. **Comment**: Quantifying the cross-subsidy burden is new. Note that this method can be readily extended to examine the cross-subsidy burden for all water consumers in the supply area.

4. **What is a reasonable cross-subsidy?** Unfortunately, there are no clear cut answers to this question which must be determined locally. However the following guidelines may be useful: a cross subsidy burden of 25% or more is likely to be difficult to implement politically whereas a cross-subsidy burden of 15% or less is likely to be more feasible.

5. **Reducing the cross-subsidy burden.** If the "maximum" cross-subsidy requirement proves to be too burdensome, then it may be reduced by first reducing $RS_{ON\text{-}U}$ (to zero if necessary), then $RS_{ON\text{-}R}$ (again to zero if necessary), then RS_{OFF} until $CS_{BURDEN} \leq x\%$ (whatever the locally determined feasible figure is). The final feasible cross-subsidy amount is called RS_{CS}. **Comment**: This explicit prioritisation of the recurrent subsidy is new.

6. **Total recurrent subsidy.** Hence the total recurrent subsidy (RS_{TOTAL}) is the sum of SS_{ESW} and SS_{CS}.

9.6 Residential tariff design

9.6.1 Applying the recurrent subsidies

1. **Applying the recurrent subsidy.** As indicated above, the calculated feasible recurrent subsidy should go towards off-site water supplies first, then restricted on-site water supplies and then unrestricted on-site water supplies with consumption of less than 50 lcd.

2. **Off-site water supplies.** As noted above, if financially feasible, off-site water supplies should be made free. If this is not possible, the maximum water fees should be based on T_{LL-MAX}. See also the discussion of tariffs for communal standpipes in the *guidelines* (PDG, 1998d).

3. **Restricted on-site supplies.** The above logic also should be applied to restricted flow on-site water supplies.

4. **Unrestricted on-site supplies.** Recurrent subsidies should be applied *only if* full or very significant subsidisation is applied to off-site and restricted flow on-site water supplies. Two principal subsidy options exist: direct credit or life-line. (The case of unmetered on-site supplies are discussed separately below.)

5. **Direct credit subsidies.** Income qualified direct credit subsidies probably represent the most transparent subsidy mechanism for unrestricted metered supplies. Each income qualifying household receives a monthly credit for Rx. This is off-set against the bill. The credit should be sufficient to pay for 50 lcd at the "normal consumption" tariff (see below). The 50 lcd should be translated to a monthly consumption figure based on an analysis of household size distribution (see below). An alternative to income-qualification is area-qualification provided household incomes are fairly homogenous within the defined areas.

6. **Life-line tariffs.** Life-line tariffs provide an alternative recurrent subsidy mechanism for unrestricted on-site water supplies. The cut-off should be based on 50 lcd (if possible), else 25 lcd. This should be translated to a monthly consumption figure based on an analysis of household size distribution (see below). The maximum tariff should be set at T_{LL-MAX} or lower, if possible (provided the subsidy needs of households with off-site and restricted on-site supplies are already accounted for). For an equity and targeting point of view, it is preferable that the life-line tariff is income qualified.

7. **Choosing between direct credit and life-line.** On balance, the income qualified direct credit tariff is likely to be both more targeted and transparent than the life-line tariff and it should be considered as a feasible and possibly preferable alternative to the life-line tariff.

9.6.2 Volumetric tariffs

1. **Normal residential consumption.** If water conservation is important in the local and regional context (that is, if T_{MC} is higher than T_{MAX++}), then, to promote conservation, normal residential consumption should be priced at T_{MAX++} (unless revenue stability was particularly important - see "fixed fees" below). Otherwise, normal water consumption could be priced anywhere between T_{MIN} and T_{MAX} depending on the impact of the equity trade-offs described above.

2. **Luxury consumption.** If T_{MC} is higher than T_{MAX++}, then luxury consumption (> 200 lcd) should be priced at T_{MC} (or at least somewhere between T_{MAX++} and T_{MC}).
3. **Two or three step tariffs.** What is being proposed is a two or three step (block) tariff. If a direct credit subsidy is implemented, then a two-block tariff is proposed, with the first block set at T_{MAX++} and the second block set at the T_{MC} (if $T_{MC} > T_{MAX++}$). The break point should be at 200 lcd (translated to a kl/month figure based on an analysis of household size distribution - see below). If a life-line subsidy is implemented, then a three-block tariff is proposed, with the first block set equal to the lifeline (see above) and the remaining two blocks set in the same way as the two-block tariff. The two-block tariff with a direct credit is simpler than the three-block tariff and is preferred. . **Comment**: The recommendation of using direct credits and a two-block tariff as a possible (and perhaps preferable) alternative to the three-block tariff is new.
4. **Multi-block tariffs.** Tariffs with more than three blocks are not recommended as they are unnecessarily complicated and have no advantages over the simpler two or three block tariffs proposed here

9.6.3 Fixed fees for residential consumption

1. **Unmetered unrestricted on-site supplies.** It is not possible to implement a volumetric tariff for unmetered supplies. Revenue can be collected either through direct charges or property taxes (see "Making up the balance" below). Where average consumption per unmetered connection is large, it is particular important that metering be implemented as a priority for efficiency, water conservation and equity reasons. More detailed guidelines are presented in PDG (1998d).
2. **Making up the balance.** The balance of the residential income requirement should be made up from property taxes or direct charges. Property taxes are preferred because they are much more progressive (see "Understanding the revenue trade-offs" above). If direct charges are implemented, these should be waived or reduced for poor households or in poor areas. **Comment**: The recommendation that at least a portion of income come from the property tax is new.
3. **Fixed fees for revenue stability.** In certain instances, fixed fees may be particularly important for revenue stability and equity. This is typically the case in "holiday communities". See *guidelines* (PDG, 1998d).
4. **Equity and fixed fees.** The implementation of a significant fixed fee for residential consumers in cases where consumption is very low may have regressive impacts on equity. Charging a low volumetric rate for low levels of consumption is only effective as a poverty alleviation measure if the fixed fee for poor consumers is waived or is very small. There are three alternative mechanisms for addressing this issue. First, an income qualified fixed fee. Second, a progressive property tax with a minimum threshold, that is, property values below a certain threshold are exempted from the water-related property tax. Third, implementation of a fixed fee which only "kicks in" at a certain minimum threshold consumption.

9.6.4 Multi-unit residential

1. **Multiple units with common meter.** Where multiple residential units share a common meter, it is not possible to bill individual residential units in direct proportion to their actual use. The *guidelines* suggest that either a uniform

volumetric charge be implemented (based on total consumption), or that a block tariff be implemented based on the concept of residential unit equivalents (RUES) (See the discussion in PDG, 1998d). It is recommended that this decision be left to WSAs. The experience in New York suggests that supply-side investment in water saving devices may be an appropriate option if water conservation goals are important (see Working Paper 2).

9.7 Non-residential tariffs

1. **Cost based tariffs.** Non-residential tariffs should be based on cost. If water conservation is important, then the tariff should be based on T_{MAX} with no fixed fees, else it could be based on T_{MIN} with the remaining revenue raised from direct fixed charges based on actual costs (if these are known) or average costs per connection, or property taxes.
2. **Cross-subsidies.** If cross subsidies are implemented, then these should be from non-residential to residential consumers and not the other way round. ("Special deals" involving subsidised water services for industries should be strongly discouraged by national policy.) In this case, the appropriate maximum tariff benchmark is T_{MAX++}.
3. **RUES**. The application of the "residential unit equivalent" concept to non-residential consumption is not recommended. There is no logical basis for the definition of a RUE in this context and the system is likely to be administratively cumbersome. **Comment**: This is a departure from the existing guidelines.
4. **Further research.** More detailed research on industrial and commercial tariffs is currently being undertaken by the WRC and hence more detailed guidelines are not presented here. See also *guidelines* (PDG, 1998d).

9.8 Seasonal tariffs

1. **Residential.** Where two or three block tariffs are implemented with the upper block set at or near T_{MC}, then seasonal variations in tariff will be catered for within the existing tariff structure.
2. **Non-residential.** Where peak seasonal use is an issue, seasonal tariffs can be introduced for non-residential consumers. One method of doing this is to measure the differential between peak season and low season water use and to charge the differential water use at T_{MC}. (See Working Paper 2 for examples in Los Angeles and Tucson.)

9.9 Translating lcd to kl per consumer unit

1. **Motivation for lcd based switch-points.** The policy recommendations for the target-basic and luxury consumption switch-points (50 lcd and 200 lcd respectively) are deliberately based on per capita consumption figures because it is recognised that household size distributions may vary widely by locality. Hence national guidelines based on "kl / consumer unit" (kl/CU) are inappropriate

because their impacts may be highly inequitable. Guidance on how to translate lcd to kl/CU for a specific supply area are given here.

2. **Household size known.** If the WSA or WSP has information on household size for every household, then the WSP can easily calculate the switch-points for each household. The kl/CU equivalents for the two switch-points are shown in Table 32. Typically, however, this information is not known.

Table 32: Translating lcd to kl/CU based on household size

Household size	2	3	4	5	6	7	8	9	10
50 lcd = x kl/month	3	4.5	6	7.5	9	10.5	12	13.5	15
200 lcd = x kl/month	12	18	24	30	36	42	49	55	61

3. **Examining overall household size distribution.** Data on the overall distribution of household size in the supply area is available from the Census. This information can be usefully represented as shown in Figure 36. For example, the illustrative data presented in the figure shows that 90% of households have a household size of less than or equal to 7 and 95% of households a household size of less than or equal to 8.

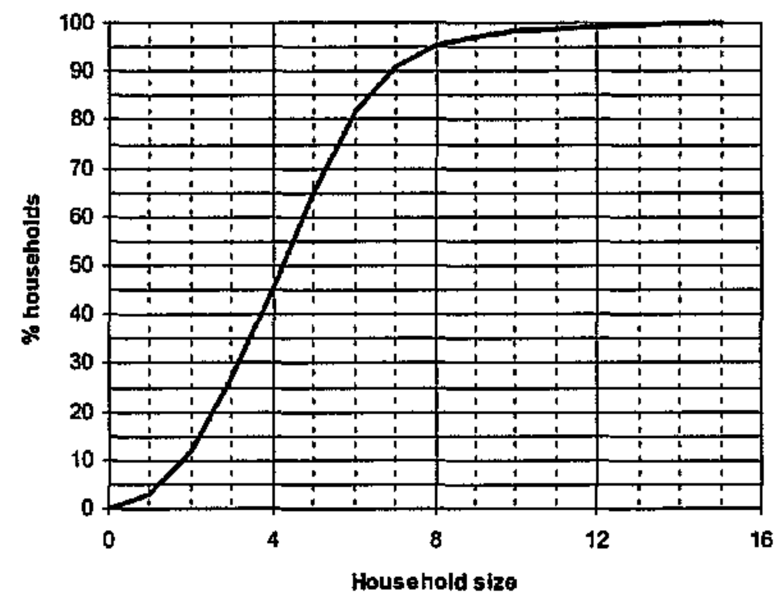

Figure 36: Household size distribution

4. **Examining household size distribution by area.** Information on household size distribution by enumerator area is also available from the Census. For example, data for Grahamstown is shown in Figure 37 separated into Grahamstown West ("black") and East ("white"). This data shows that larger households (more than 8) are more prevalent in Grahamstown East compared to Grahamstown West and that it would be equitable to use different switch points in each area and, if feasible, to use different switch-points by Enumerator area.

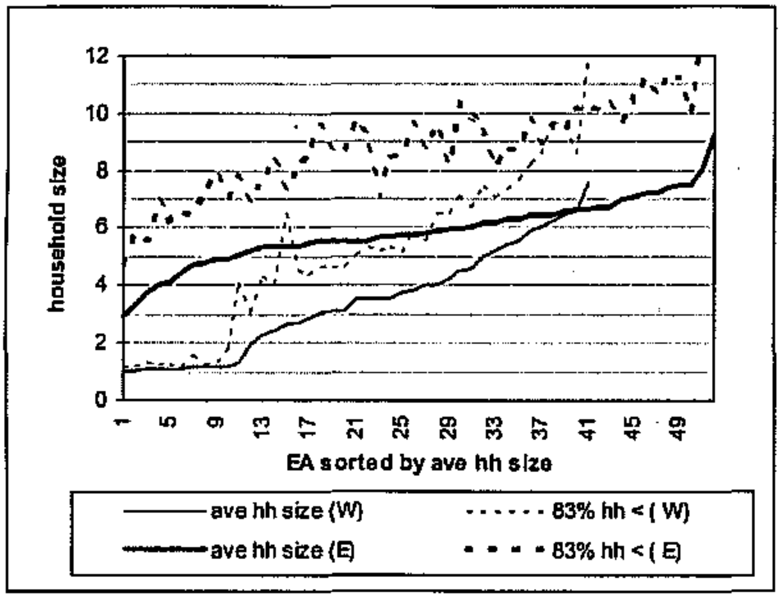

Figure 37: Household size distribution by enumerator area (Grahamstown)

5. **Choosing the geographic unit.** On the basis of an examination of the above two data sets for the specific supply area, the WSP manager must decide whether to calculate uniform kl/CU switch-points for the whole supply area, or to calculate them separately for each (or groups of) enumerator area. This decision will depend on the uniformity of the distribution across enumerator areas and the administrative ease with which differentiated kl/CU figures can be applied by area.

6. **Translating the 50 lcd switch-point into kl/CU.** *The principle for this calculation is that it should be as inclusive as possible, that is, large households should be able to receive a target-basic water "allocation" which is adequate to ensure a consumption of 50 lcd even if this means that smaller households receive more than this.* For example, the data for Grahamstown suggests that the target-basic household consumption should be calculated on the basis of a household size of 10 in Grahamstown East and 8 in Grahamstown West. Thus the switch-points would be 15 and 12 kl per month per consumer unit respectively.

7. **Translating the 200 lcd switch-point to kl/CU.** This calculation can be based on average household size for the supply area. The reason for this is that beyond basic use (50 lcd), one may expect economies of scale in water use as the household size increases. For example, outdoor water use is largely unrelated to household size. An average household size of 5 would translate into a switch-point of 30 kl per month per consumer unit. In this case, even if the actual household size was 10, then the per capital consumption at the switch-point would be 100 lcd, which is still quite adequate for normal domestic use. *In general, and unless the household size distribution is quite different to the normal pattern, a luxury-use switch-point of 30 kl per month per consumer unit seems to be sensible.* This confirms that recommended in the National Water Supply Regulations.

10. Implications for South Africa

The implications for South Africa of following the recommended pricing policies and proposed pricing methodology are outlined in this section. It should be pointed at the many of the pricing outcomes will largely be determined at the local level and will differ depending on local circumstances. Hence it is not possible to draw definitive conclusions as to the likely general impact of the proposed pricing reform. Nevertheless, it is possible to suggest in broad outline what some of the likely impacts might be.

10.1 Implications of first tier pricing reform

Quantifying the impacts of first tier pricing reform was not within the scope of this project. Nevertheless, it is possible to make some general Comments about the impact of first tier pricing reform.

Reduction of subsidies to irrigators. The price of water to irrigators will increase over the next five or so years from their current levels to levels which will cover the full cost of the service. This will place financial pressure on irrigators who will now have greater incentives to use water more efficiently. In some cases prices may actually increase five-fold.

Catchment management fees. Catchment management fees will be introduced at the river basin level. The likely magnitude of these fees have not been quantified (research on this is currently underway) and hence it is not possible to speculate on the impact of the introduction of these fees.

The ecological reserve. An ecological reserve will be determined and set aside in each river system. Work on the determination of the ecological reserve is ongoing. The absolute quantity of the ecological reserve is likely to increase from that which exists by default at present (many rivers systems are over exploited). Increasing the ecological reserve in an already fully exploited river system will have two effects. First, it will increase the financial cost of the available water in direct proportion to the reduction in the allocable portion. That is, a 10% reduction is allocable water will increase the unit cost of water supplied from that system by an average of 10% (if all allocable water is in fact allocated to start with). Second, it will increase the scarcity value of water in the catchment. This will affect the economic resource charge (see below).

Economic resource charge. In the medium term, an economic resource charge may be levied which reflects the scarcity value of the water. This is a price of the water itself (net of any infrastructure costs). The more scarce water is in a given catchment, the higher the resource price will be. There is disagreement at present over how the resource charge should be calculated and to what extent water allocation should be based on markets principles. Hence it is not possible to quantify the overall effects of implementing a resource charge at this stage.

Free basic needs water. The policy is that first tier water that is ultimately used for basic needs (calculated at 25 lcd) should be made free of charge to the second tier. As already discussed, while this may be a fine principle, its effect in practice is likely to be small. The quantity is approximately 10 kl per annum per person which totals

420 million m³ which is about 2% of total water use in South Africa. It is not clear whether the cost of this water should be borne by the other water uses or whether it is a direct subsidy from national government. If it is the former, then there seems little point in implementing the policy. If it is the latter, it may make a difference in some catchments where basic needs consumption is a significant share of total consumption, though this is likely to be the exception rather than the rule.

Reporting marginal resource development costs. The marginal cost of developing additional water resources in each catchment or water system to meet increasing demand should be calculated using a nationally defined methodology and reported annually. This cost will inform retail pricing decisions (see below).

Overall impacts. The overall impact of these reforms over time will be to move water use away from lower value use to higher value use. Therefore, it may be expected that, in contrast to conventional expectation, water use for irrigation as a proportion of total water use will decline with time as shown in Figure 38. Increases in the first tier water prices will be passed down to the second and third tiers. However, current first tier prices are already based on full costs for urban supplies, hence the impact of first tier water price reform on urban water prices is likely to be small in the short term and only moderate in the medium term. This is because raw water costs are only a small fraction of total water costs at the retail level. However, in the longer term, water resource development costs are likely to rise steeply which will impact significantly on third tier urban water prices.

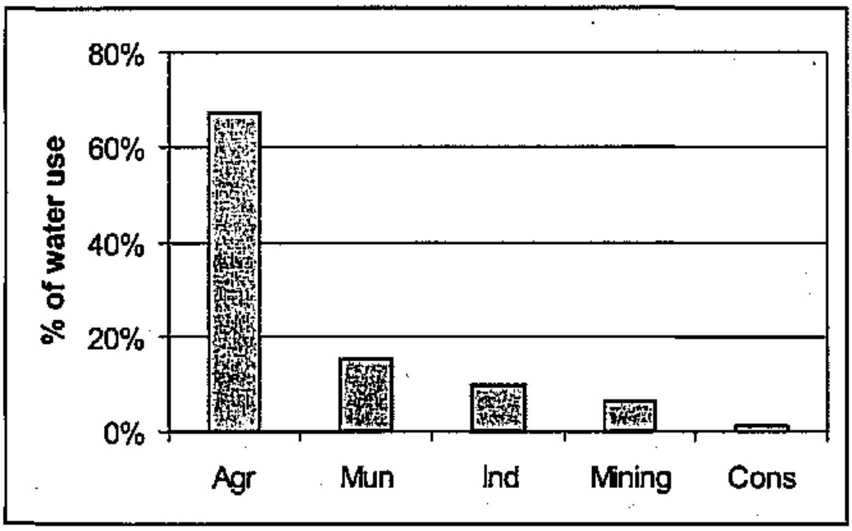

Figure 38: A reduction in the proportion of agricultural water use is likely over time

10.2 Implications of second tier pricing reform

A "clean" second tier role for second tier has been recommended. This implies that the second tier wholesale function is run as a commercial operation which raises private capital at the lowest possible cost, sets tariffs to fully recover costs (but no more) and operates the wholesale function as a distinct business entity (ring-fenced) if the WSP is engaged in any other activities. It is also recommended that tariffs reflect differences in supply costs between wholesale customers where there are significant cost differentials. These policies have a number of implications.

Urban-rural cross subsidies. It is not appropriate that these take place at a regional level. It is more equitable that rural subsidies should be made available from the national budget.

Differential wholesale prices. The principle of "common pool" wholesale water pricing appears to have been taken too far in South Africa. The result is that some wholesale customers with high costs of supply pay much lower average system costs and hence are subsidised by other wholesale customers. Defining separate "supply cost centres" where appropriate and setting prices to reflect costs will result in much higher water prices for some consumers and a lowering of prices for the remaining customers in the common pool system.

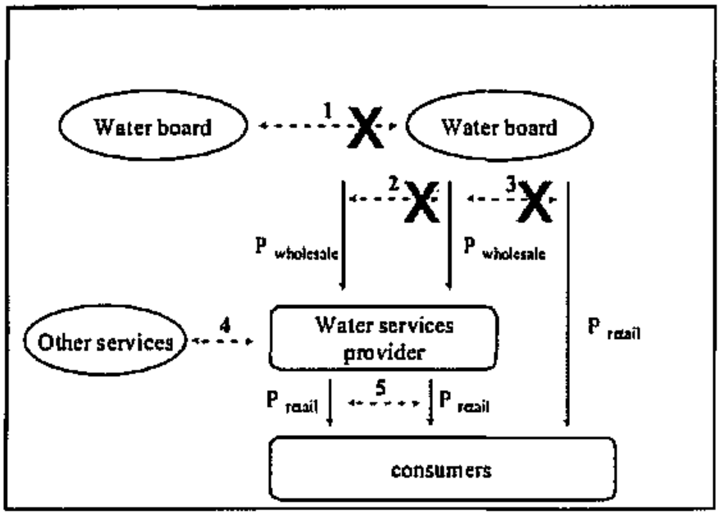

Figure 39: Cross-subsidies at the 2nd tier are not recommended

Institutional support costs. To the extent that Water Boards and other wholesale WSPs carry out institutional support functions to assist retail WSPs, these costs should be accounted for separately. If possible, these costs should be funded from the national budget (though not from the equitable share). Alternatively they can be funded by adding a surcharge onto bulk treated water sales.

Conservation pricing. Wholesale WSPs should not try to effect conservation pricing. Conservation is taken care of at the first tier level (through resource charges, the ecological reserve allocation and catchment management fees) and at the retail level (where consumer decisions are taken).

Capital subsidies. Implementation of capital subsidies at the second tier level have the effect of lowering costs for all consumers and benefit large consumers much more than small consumers. Such subsidies are not targeted, neither are they equitable and are therefore not recommended.

Reporting marginal capacity expansion cost. The marginal cost of expanding the second tier network to meet increasing demand should be calculated using a nationally defined methodology and reported annually. This cost will inform retail prices (see below).

Overall impact. There is not likely to be any significant *overall* impact on water demand arising from second tier pricing reform because existing prices at this level are already cost based. Increased first tier water prices will be passed onto the third tier. In some instances there may be significant adjustments because of the implementation of cost-based differential wholesale pricing and the elimination of second tier cross-subsidies.

10.3 Implications of third tier pricing reform

As indicated above, the impact of pricing reform at the retail level will be dependent on local circumstances to a very large extent. Not only will the tariff design be influenced by local factors such as costs, demographics and the pattern of water demand, but the starting point of price reform will be different in each case. Nevertheless, it is possible to illustrate the possible implication of retail price reform in broad terms and to describe the factors that will determine the feasibility of cross-subsidies. This is done in the next two sub-sections. The approach adopted by Durban and conclusions arising from the Grahamstown case study are briefly summarised in the last two sections. The Durban approach is advocated as an example to follow. The Grahamstown case study emphasises the necessity of a context specific analysis and cautions against universal policy prescriptions.

10.3.1 Broad implications of domestic price reform

Improving access to water services. The primary goal of the pricing policies advocated here is to improve access to water services. The implementation of these policies should help to facilitate a significant improvement in access to water in South Africa.

Preference for on-site water supplies. There should be a strong preference for on-site water supplies, particularly in the urban areas of South Africa. The pricing policies put forward support this preference.

Restricted on-site supplies as an intermediate option. The provision of restricted on-site supplies provides an intermediate option between off-site supplies such as communal standpipes (where consumption of water is generally inadequate) and unrestricted on-site access (which may be prohibitively expensive). This option has been explored successfully in the Durban metropolitan area.

Making basic use affordable. The policies seek to ensure that households not only have access to adequate water services, but can *afford* to consume a target of 50 lcd.

Reducing the disparities in domestic consumption. The pricing policies and methodologies recommended here have the twin goals of encouraging domestic water use where this is less than 50 lcd and discouraging water use where this is in excess of 200 lcd. The overall effect of this is to reduce the disparities in existing domestic water use arising from apartheid policies (see Figure 40). The specific effect that these policies will have on overall water use in any specific urban area will depend on the distribution of consumption in that area and the strength of the subsidies, pricing signals and other policy tools. All of these are locally determined.

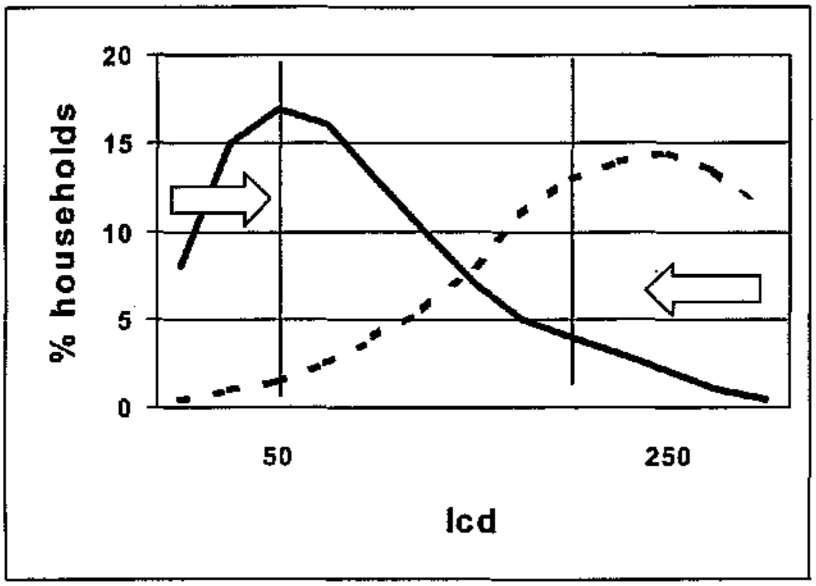

Figure 40: Reducing disparities in domestic water use

Promoting water-use efficiency. Setting higher tariffs for luxury water use (water use in excess of 200 lcd) will have the impact of improving water-use efficiencies through investments in water saving devices and reducing wasteful water use. Thus water conservation will be promoted.

Non-residential tariffs. Cost-based tariffs will help to ensure financial sustainability.

10.3.2 Financial sustainability and cross-subsidies

The key premise in the analysis presented here (and indeed in the *guidelines*) is that the WSP must be financially sustainable, that is, that revenue must be sufficient to cover full costs (operating and maintenance as well as capital replacement and expansion costs) over the long run. The extent of subsidies that are sustainable and the leeway that WSAs or WSPs have to incorporate cross-subsidies into urban water tariff design will depend principally on the following factors: (1) the capital subsidies made available to the water sector from higher tiers of government, (2) the total equitable share subsidy (SS_{ES}) made available to the WSA from higher tiers of government, (3) the share of the SS_{ES} made available to the retail water sector by the WSA, (4) regional and local cost factors which determine the cost of supply, (5) the total wealth of the supply area, (6) the proportion of water consumed by the non-residential compared to the residential sector, (7) the income distribution within the supply area, (8) the consumption distribution in the supply area and (9) the political feasibility of introducing cross-subsidies. Many of these factors are locally specific. Hence it is not possible to quantify the impacts of retail price reform at the national level. The guidelines presented in the previous sector were design to assist WSP water managers to assess the implications of tariff reform for their locally specific conditions. Two examples of tariff reform in South African cities are briefly discussed below.

10.3.3 Durban - setting an example

Durban has developed (and begun implementing) a strategic plan to achieve universal access to water services within a defined time-frame and in an equitable and financially sustainable manner. In doing this, Durban has been a both a leader and innovator. The approach and methodology embodied in the strategic plan are briefly summarised here.[149]

Premises. The economic premises of the plan are fourfold (Macleod, 1997: 17). First, few households will pay more than two percent of their disposable income for water. Second, customers whose household incomes are less that R1500 per month have extreme difficulty in affording the cost of an unrestricted (full pressure) water supply. Third, customers are generally unwilling to pay for water from a public standpipe if they have to walk more than 200 m. Fourth, payment for water services is dependent on three main factors: a fair and affordable tariff structure, the provision of a level of service that is acceptable to customers and an acceptance by all customers that payment is essential for the continued provision of services and for the expansion of services to the households without services.

Data. The strategic plan required that relatively accurate data was obtained on existing services and on the number and distribution of households within the Durban Metropolitan Area. This huge task (population more than 3 million) was achieved through the use of aerial photography together with selected household surveys to determine occupancy rates by structure type and area.

Financial modelling. Three levels of service were modelled: a "basic" service (public standpipe within 200m, an "intermediate" service (restricted on-site access) and a "full" service (unrestricted on-site access). The overall financial constraint imposed on the investment programme was an annual real tariff increase of less than 5% in order to break even. A ten-year investment programme was designed which aimed to provide universal access with a mixture of service levels (basic, intermediate and full). The investment analysis showed that over a 20 year period it would be possible to provide higher levels of service (30% intermediate and 70% full) in a financially sustainable way. The total investment over 20 years was estimated to be R1.4 billion (1997 Rands). In the modelling is was assumed that much of the capital expenditure would be financed by loans obtained by Durban Water and Waste (who are part of the Metropolitan Council though operate in a financially autonomous way) and that all income would be derived from the sale of water and direct charges to water consumers (that is, no income from property taxes).

Technical options. A unique feature of the strategic plan in Durban was the development of intermediate water supply options which allowed lower cost restricted flow on-site access. The key principle underlying these options is that the reduction in peak consumption greatly reduces system capacity requirements and hence costs. The two intermediate options are a low-pressure ground tank system and a semi-pressure roof-tank system.

Tariffs. The Metropolitan Council accepted the principle that tariffs should be linked to the levels of service provided. They also accepted a three-part rising block tariff for residential consumers, fully subsidised service for restricted on-site connections (low-pressure system only) and a zero tariff for the first 6 kl per month. The 1998 tariffs are summarised in Table 33.

[149] This section draws heavily on Macleod (1997) as well as various personal communications with Macleod (pers comm., 1998 and earlier). The author developed the financial models used in the development of the strategic plan for service provision in the Durban Metropolitan area (PDG, 1994e).

Table 33: Tariffs by service level in Durban metropolitan area (1998)

	Domestic			Other
	Restricted		Unrestricted	Unrestricted
	low pressure	semi-pressure	full pressure	full pressure
fixed charge	nil	nil	18	18 to 1800[2]
0 - 6 kl	nil	nil	nil	253
6 to 30 kl	nil	176	253	253
> 30 kl	nil	506	506	253

NOTE: 1. Tariffs exclude VAT. 2. Depends on diameter of connection.

Consumer choice. Within the defined service options and tariff options, new customers are free to choose their own level of service. Community workshops are held in poorer communities. Use is made of audio-visual media and visits to existing water supply installations are arranged.

Consumer information. Durban Water and Waste have embarked on a "creative billing" programme which seeks to significantly improve the level of communication between the WSP and the customer. Basic information on the bills is provided in a simplified and clearer manner. Additional information is provided such as comparative consumption data and hints on water saving.

Tariff enforcement. Within this framework, payment for services is strictly enforced. Failure to pay results in the water being disconnected. In the case of very poor communities, the water is not disconnected but is restricted to a flow of approximately 200 litres per day. The constitutionality of these actions (in terms of the Bill of Rights) has been tested in the courts with a favourable outcome (Macleod, pers comm., 1998). The consequence of this strict enforcement is that Durban Water and Waste have bad debts of approximately 0.1% of total revenue. This very low level of bad debt is unprecedented in South Africa.

Beyond Durban. The strategic plan for water services supply, management and pricing adopted by Durban Metropolitan Council offers a good example of an approach which ensures universal access to on-site water while maintaining financial sustainability, targeting subsidies to those most in need, ensuring affordability of services and encouraging conservation amongst large domestic consumers. The approach should be used as a model by other WSAs in South Africa.

10.3.4 Grahamstown - dealing with difficult legacies

Introduction. An analysis of water pricing in Grahamstown was undertaken as part of this project. This is reported in Working Paper 5. The pricing policy conclusions arising from this analysis are replicated here. They highlight the need for a context-specific approach and caution against universal policy prescriptions.

Context specific. The existing water pricing policy in Grahamstown is grounded in the particular historical institutional and political-economy context. This must be the starting point of the analysis of water price reform.

Revenue neutrality. The water trading account generates a significant surplus. Whilst this is not an unusual phenomenon in South Africa, it is hard to justify this policy in a context where water prices are high (both in absolute terms and in relation to surrounding towns) and where so many households are consuming so little water. It is difficult to both maintain this surplus *and* implement a more progressive increasing block tariff which has a life-line component and reasonable marginal tariffs for higher levels of consumption. The decision to move to strict revenue neutrality within the water trading account will have an important impact of revenue raising requirements for the general rates fund. This is clearly a political decision which needs to be made by the council is the light of an analysis of the distributional impacts of such a change.

Fixed charges. The distributional impacts of reducing the revenue requirements in the water sector (by as much as 40%) will depend on how revenue reduction policies are implemented. One possibility is to reduce the annual fixed charges. However, the current system of fixed charges is very progressive because it targets property owners in Grahamstown west only. Given the highly skewed income distribution, this method of raising finance for water is very progressive. An alternatively possibility of reducing revenues is to implement a life-line tariff. A free or very low-cost life-line tariff for at least the first 5 kl of consumption per connection is *highly* desirable as increased consumption needs to be *encouraged* amongst the many households in Grahamstown who are using very little water. On the other hand, existing revenues could be retained within the water account and used to improve the distributional impact of water prices.

Progressive block pricing. The implementation of a steep inclining block tariff (for example, high tariffs for consumption exceeding 30 kl per month) in Grahamstown may not be equitable. The primary reason for this is the existence of many large households reliant on a single water connection. This needs more careful examination. Further, the implementation of a very steep inclining block tariff is likely to meet with significant resistance from a small but politically and economically powerful minority. Lastly, meter reading in Grahamstown is unreliable and inaccurate. Unless this is improved, the implementation of a steep rising block tariff structure is likely to cause many problems arising from false or inaccurate meter readings which may inflate water bills significantly. It is unlikely that the Grahamstown municipality will have the institutional capacity to address this aspect adequately.

Marginal costs. The definition of the appropriate marginal cost is a complex issue in Grahamstown. The marginal cost (capital and operating) of the Waainek system is very low and arguably is fully sufficient to meet Grahamstown's water needs in the near future. The investment in the James Kleynhans system has *already occurred*; because significant excess capacity exists, the marginal *capital* cost of this water is also zero. Because of past investments in water infrastructure (and the premises upon which these were based) there is effectively no water resource scarcity in Grahamstown and hence *calculating an average incremental cost for future water supplies and using this as a bench mark for pricing policy is inappropriate*.

Historic costs. Grahamstown is burdened by significant debt related to the James Kleynhans scheme and must make annual payments to the DWAF. These interest and redemption charges are fixed and are not related to the amount of water consumed (even though this goes against the new national water policy). Thus, there is no incentive for Grahamstown to conserve water, rather it is in Grahamstown's interests in encourage the use of this water so as to ease the burden on the repayments. (The greater the volume of water sold, the lower the unit cost of the water.)[150]

Creating the right mix of incentives. The major objectives of the water price policy reform in Grahamstown should include the following. First, the encouragement of residential water use up to at least 50 lcd for *all* households in Grahamstown. Second, encouraging wise investment in water saving technologies by households, institutions and businesses. In the case of households, this will require the subsidisation of low levels of consumption. The encouragement of wise investment in water saving practices and equipment amongst households is most important for those households using large amounts of water (greater than 30 kl per month). A two-pronged approach should be adopted. First, the marginal cost for water in excess of 30 kl per month should be significant (but not excessive, for the reasons previously identified). Second, consideration should be given to the subsidisation of targeted water saving appliances. (Non-residential water pricing is addressed below.)

Residential pricing. The above discussion suggests that the following five component residential tariff structure is appropriate. (1) Zero connection fees for low-income households, otherwise cost-based. (2) Fixed charges related to property value with a 100% rebate given to targeted low income households. (The rebate could be related to a threshold property value or area based, that is, areas within which the majority of households are low-income).(3) A life-line tariff which encourages consumption of at least 50 lcd amongst *all* households. (4) a historic cost based tariff for 'normal consumption', that is, up to between 20 or 30 kl per month per household, and (5) a significantly but not excessively higher tariff for consumption in excess of 30 kl per month.

Non-residential pricing. In the light of the discussion on marginal costs above, pricing water at cost appears to be the most sensible approach to pricing non-residential water. Higher prices may jeopardise the already fragile economic and institutional base in Grahamstown. Similarly, there is little justification for subsidising water supplied to non-residential consumers. The most appropriate form of the tariff is likely to be a two-part tariff with fixed charges related to fixed costs and a uniform volumetric charge related to variable costs. It is hard to justify a increasing block tariff for non-residential consumers. New connections charges should be equal to the actual cost of connecting.

Decision making. The final decision concerning the tariff structures and levels should be made by the democratically elected council. This decision should be fully informed by the kind of analysis undertaken in Working Paper 5.

[150] More detailed information pertaining to this issue is in the researchers possession but has not been incorporated into the main text of this report. Discussion between Grahamstown and DWAF in relation to this issue are ongoing.

11. Summary of recommendations

This section provides a summary of the recommendations as they relate to policy, methodology, institutions and further research needs. In some cases, the recommendations are not repeated here but only cross-referenced directly to the main text. There are two reasons for this. First, where the recommendations within the main text are clear and succinct, they are not repeated here. Second, where it is important that the recommendations are not isolated from their context, the relevant section in the text is cross-referenced.

11.1 Policy recommendations

The policy recommendations have been presented in a succinct form in Section 7. and are thus not repeated here.

11.2 Methodological recommendations

The recommendations made with respect to the methodology of pricing and price reform are summarised here.

No mechanistic method. A generalised method which can be applied in order to determine the appropriate price structures and tariffs in any specific urban area does not exist and is not desirable.

Political-economy context. The development of an appropriate pricing policy must be informed by both the national *and locally specific* historical, socio-economic and political-economic contexts.

What is, is. Pricing reform must start with the existing situation. Existing conditions have arisen for particular reasons which need to be understood. It is not possible to impose a uniform blueprint.

Decision making. The appropriate pricing policy for a particular context cannot be decided on by an "impartial expert". The very real political-economy trade-offs integral to price reform must be made with reference to local political decision making processes.

Process. The following pricing process is recommended: (see Figure 41) (1) develop an understanding of the political-economy context at the country and city level; (2) develop consensus on equity, sustainability and efficiency frameworks that address the political-economic realities; (3) develop consensus on an appropriate and practical *set* of indicators for equity, sustainability and resource efficiency, in particular, water use efficiency; (4) develop explicit pricing objectives linked with measurable goals; (5) determine the price structure and set the price levels so as to achieve the defined objectives; (6) evaluate the impacts; and (7) refine the price structure and level. This approach emphasises the iterative nature of the pricing process whereby improvements are made so that the objectives are more fully achieved. The availability of practical measures whereby the extent of attainment of the specified objectives can be assessed greatly assists this incremental reform process.

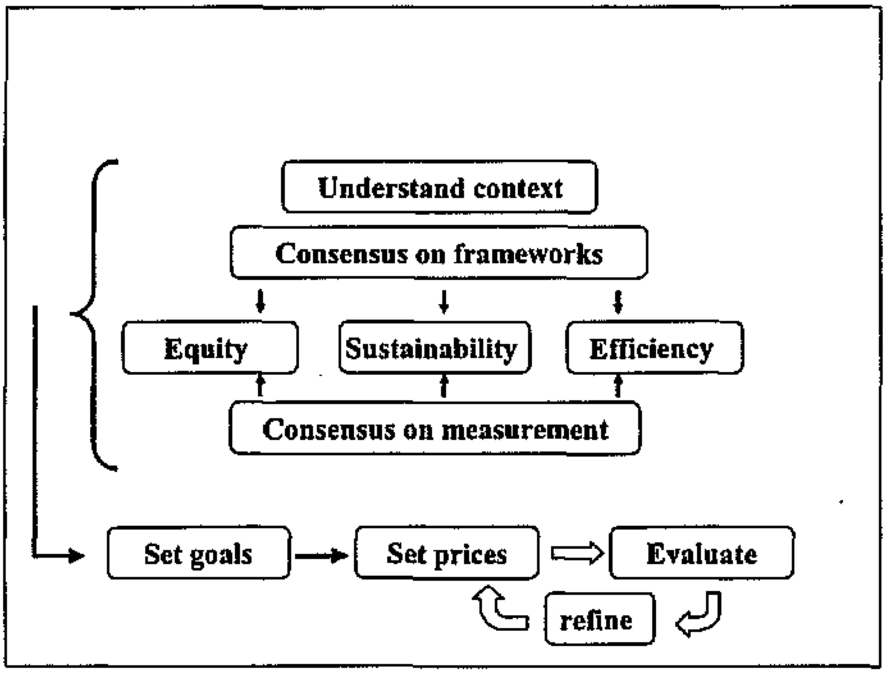

Figure 41: Recommended pricing process

Best practice principles. A set of best practice principles are proposed and their practical application discussed (see Section 8.4).

Data requirements. Specific data sets which are necessary and/or desirable for use in the tariff reform process are proposed (see Section 8.2). These data sets take the likely data limitations into account.

Practical performance indicators. A number of practical performance indicators are proposed (see Section 8.3). These indicators will allow the tariff reform process to be more transparent and enable progress to be more easily assessed.

Measurable goals. A set of measurable pricing and performance goals are proposed (see Section 8.3).

Estimation techniques. The use of sophisticated econometric estimation techniques is highly unlikely to yield meaningful results and is therefore not recommended for general application. On the other had, descriptive techniques for analysing data of likely to be useful. Histograms and nonparametric density functions are likely to be useful tools. These do not impose theory on data form, allowing the "data to speak for themselves", and are particularly useful for examining issues related to distribution and inequality. This has been demonstrated in the text and in Working Paper 5.

Financial modelling. Spreadsheet based financial models are extremely useful for evaluating the impacts of alternative tariff structures and levels. The use of the *WSSM* is recommended (PDG, 1998f). It may be useful to supplement the analysis provided in this model with smaller custom designed models to test particular aspects of the proposed tariff reform.

Tariff design. Practical guidelines for setting tariffs are given in the text (see Section 9.). These are largely complementary to the existing *guidelines*. However some important amendments are proposed which have been highlighted in the text (see Section 9.).

Subsidy design. An explicit process for quantifying, prioritising and applying subsidies is proposed (see Section 9.).

11.3 Institutional recommendations

Governance. The governance structure for wholesale and retail water supply advocated in the Water Service Act of 1997 is endorsed in this report as an appropriate model for the South African context.

Ring-fencing the wholesale WSP function. The wholesale function undertaken by WSPs should be ring fenced and a separate cost-centre established.

Separation of wholesale supply systems. Separate cost centres should be established for different wholesale supply systems.

Institutional support for third tier water management. Water Boards have been encouraged by DWAF to provide institutional development support to third tier WSPs. This is a pragmatic policy in the light of the severe capacity constraints that exist at the third tier level. However, two potential problems exist. First, not all third tier WSPs are served by Water Boards, hence heavy reliance on Water Boards to provide this support may mean that many third tier WSPs receive no support at all. Second, the water retail business is quite different from the wholesale business and hence Water Boards may not have the appropriate experience or expertise required to assist in institutional development at the third tier. In the light of these problems, it has been previously recommended that consideration be given to the establishment of a small specialised "retail support agency" whose task would be to assist with institutional reform and provide specialist technical, economic and financial services to third tier WSPs (PDG, 1994f). This recommendation is endorsed here. Such an agency could facilitate greatly improved water resources management amongst retail WSPs through a strategic approach.

Amendment of the tariff guidelines for WSP managers. The existing guidelines should be amended to take into account the recommendations from this research project (to the extent that these are agreed upon by policy makers).

Learning by example. More emphasis should be placed on institutional learning through the communication of successes and failures in water management at the retail level. Successful examples of water pricing reform such as that achieved by Durban Water and Waste should be actively promoted.

Informative billing. Informative billing should be more actively promoted in addition to other important improvements to customer support, namely language capability, more accessible payment points and improved communication with consumers.

11.4 Areas for further research

Performance benchmarks for wholesale WSPs. Best practise performance indicators and standards are needed to enable the comparison of wholesale WSPs and to encourage greater efficiencies in wholesale WSPs.

Restricted on-site access. The options for (and technical, institutional, financial and social implications of) providing an intermediate water supply option between off-site access and unrestricted on-site access should be *more fully* explored. The innovations in this area undertaken by Durban Water and Waste, and their preliminary experiences of using this technology, suggest that such an intermediate option has significant potential to fill an existing gap in the demand for water services.

Intermediate grey water technologies. Increasing access to on-site water (from say 20 lcd to 50 lcd) may result in increased costs of grey water disposal (moving from on-site disposal to a networked collection system).[151] The potential for creative intermediate solutions needs to be explored.

Water-use efficiencies and technology. There is scope for dramatic improvements in technical water-use efficiencies in all water using sectors in South Africa which will have significant social benefits. Public investment of funds into research and development in this area is therefore warranted.

Industrial water use efficiencies. Little work has been undertaken on industrial water use efficiencies and research into locally appropriate best practice standards for specific water use, specific effluent production and recycle ratios is needed. Available evidence suggests there is significant scope for improvement (see Figure 42).

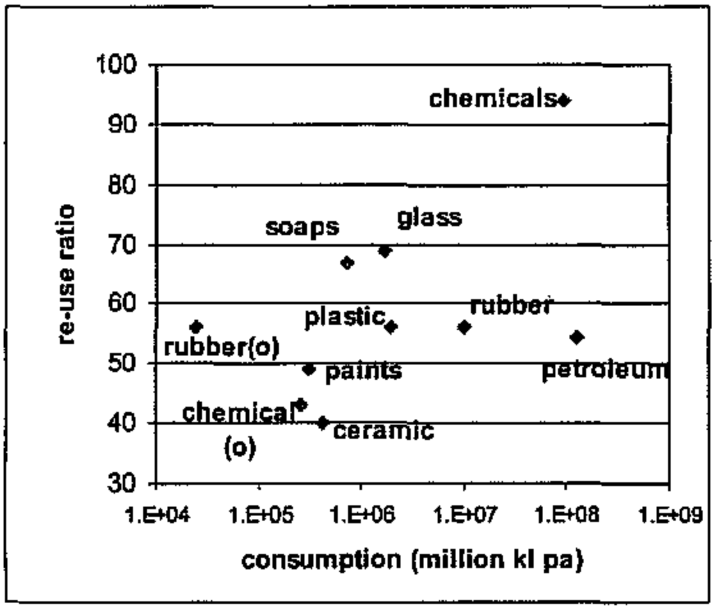

Figure 42: Recycle ratios in selected industrial sub-sectors

System efficiency. Further investigation should be undertaken into the implications of water management reform on overall system efficiency. In terms of the concept of integrated water resource systems (IWRS) it is important to distinguish a range of technical efficiency measures that vary from household-efficiency, sector efficiency, up to total system (or primary catchment) efficiency. Depending on the objectives of demand management, the relevance of the different efficiency measures changes. For example, savings in water use at the household level may result in reduced return flows. Because downstream users depend on this return flow, the increase of total system efficiency may be less that the increase in household efficiency. Hence total

[151] The experience of Durban suggests that approximately 200 l/day of grey water can be disposed on a 90 m^2 site without resort of off-site disposal. Obviously the exact amount will depend on local conditions.

system efficiency may be a more appropriate level for the evaluation of efficiency in certain contexts.

Focus on major industrial water users. A few industrial sectors use a very large share of total manufacturing water use (see

Figure 43). A specific focus on water use efficiencies and pricing in these sectors is therefore warranted.

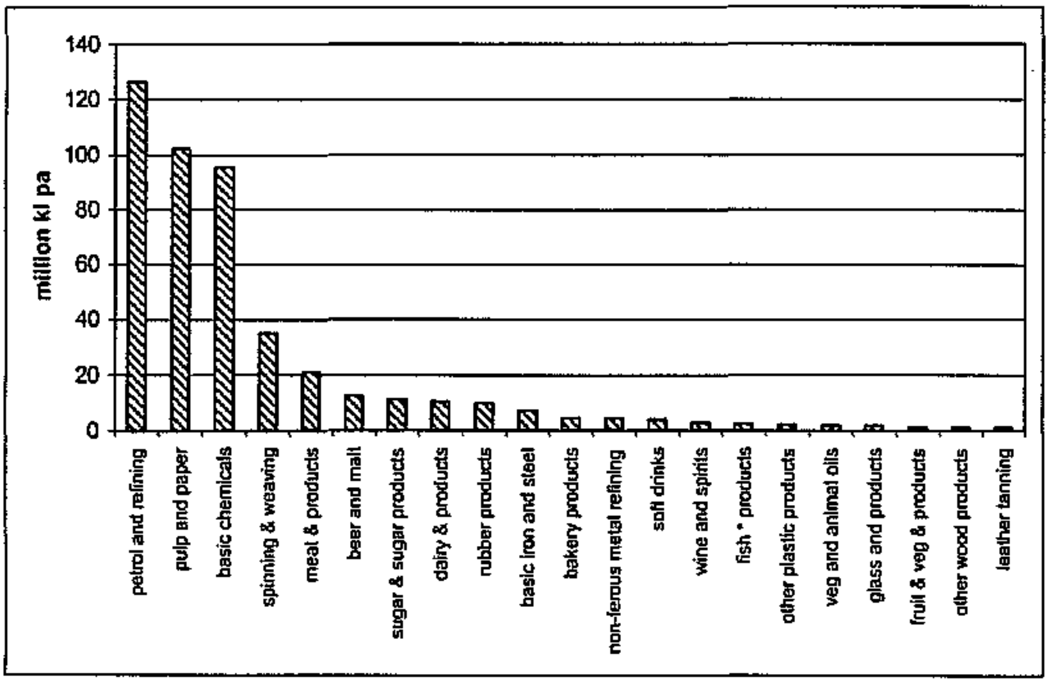

Figure 43: Water use by manufacturing sector

Industrial effluent pricing policy. Research into effluent pricing policy is needed. The strong relationship between water intake and effluent production in manufacturing industries suggests that one consideration should be adding at least a portion of the effluent charge directly onto the price of water. An effective effluent pricing policy has the potential to reduce effluent volumes (and hence the costs of treatment), increase water recycling and reduce water consumption.

Location of new water using industry. The location decisions for new water using industry should be based on the costs of securing addition water supplies in the area and not on the existing average historic costs of water supply. This is particularly important where the marginal costs of extending supply capacity are high relative to historic costs. Although this policy was stated in DWAF (1986), as far as is known, this policy has not been implemented. Practical and effective methods of implementing such a policy need to be investigated.

Pricing in times of drought and plenty. This project has not addressed the question of pricing in times of drought and plenty in any detail. However, this issue was prominent in the Los Angeles case study. It is recommended that the Los Angeles pricing methodology be investigated further to ascertain its applicability to the South African context.

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APPENDIX 1
Financial modelling of water services

Source: PDG (1998f)

Origin of financial models

The Water Research Commission (WRC) appointed Palmer Development Group (PDG) to undertake an institutional and financial review of water supply and sanitation services in the urban areas of South Africa (PDG, 1994). The overall objective of this project was to present information and analysis that could help relevant community leaders and decision-makers to guide and promote the extension of services, to enable all people living in the (urban) areas of South Africa to have adequate and appropriate water supply and sanitation. The project also aimed to facilitate the related processes of financial, institutional and policy changes that the adoption and implementation of relevant strategies would require.

During this project, an investment-tariff model was developed. The purpose of this model was to assist the agencies responsible for water supply in urban areas in the development and evaluation of investment scenarios and tariff policy. This was to be done in the context of the overall goals of eradicating service backlogs as rapidly as possible, whilst maintaining the financial viability of the service.

Model testing and extension

Subsequent to its initial development, Durban Water and Waste expressed interest in using the model and were involved in the testing, further development and extension of the model to include the modelling of sanitation as well as water supply. The revised model was tested and used by a number of water service providers including Durban Water and Waste, Rand Water, Port Elizabeth, Pietermaritzburg and Estcourt.

The water and sanitation model was applied to twenty towns in South Africa during a study commissioned by the Development Bank of Southern Africa (DBSA) to assess the financial viability nationally of alternative residential infrastructure investment programmes (DBSA, 1995a). Similar models for electricity, roads and stormwater and solid waste were developed and used. A consolidated model of all these services was also developed for application on a national scale (DBSA, 1995b). These studies informed the first draft of the Municipal Infrastructure Investment Framework (RSA, 1995).

The Water Supply Services Model

The Water Supply Services Model was developed in 1997 as an updated and extended version of the original investment-tariff water model, incorporating additional variables, allowing for inflation and making full use of the experience gained in the development and application of the Combined Services Model. The model has to date been applied in the Winterveld, King William's Town, Harrismith and the (Johannesburg) Southern Metropolitan Substructure.

APPENDIX 2
Glossary

allocative efficiency	The neo-classical economics definition of efficiency, referring to the static Pareto optimal allocation of resources (as would be allocated in a perfectly competitive market). See Pareto-efficiency.
Asset specificity	Durable investments undertaken in support of specific transactions which have much lower values in alternative uses. The identity of the parties to the transaction matter and the continuity of the relationship matters. Asset specificity may relate to physical assets, human capital, location or dedicated assets. (Williamson, 1985)
asymmetrical information	When different information is available to the buyer and seller. For example, it is often the case that the seller possesses information that the buyer does not, placing the buyer at a disadvantage. A classic example is the used car market. In the water sector, asymmetrical information is a particular problem in the case of franchise bidding for the right to supply water. The incumbent typically has information that the regulator and other potential bidders do not.
average incremental cost (AIC)	The average cost of future water supply projects. The average incremental costs can be calculated by dividing the discounted value of future supply costs by the (similarly discounted) amount of additional water to be produced. See Working Paper 1 for details.
basic water supply	This is defined either as a minimum basic water supply or as a target basic water supply depending on the context.
capital indivisibility	Investments can only take place in relatively large fixed amounts. For example, an investment in a water supply dam.
DCD	Department of Constitutional Development
DOF	Department of Finance
DWAF	Department of Water Affairs and Forestry.
efficiency	This term is used in three senses in this report: allocative efficiency, technical efficiency or optimal beneficial use.
externalities	Costs and/or benefits not included in the price.
first fundamental theorem of welfare	Competitive equilibrium allocations are Pareto-efficient.

economics

first tier water / price — The extraction of water from the water resource, including both ground and surface water and arising from both the direct and indirect use of water. Examples of indirect first tier water use include the reduced run-off arising from forests and plantations (such as sugar cane). First tier water includes all water supplied by DWAF owned raw water schemes (including water for agriculture).

IMTA — Institute of Municipal Treasurers and Accountants (South Africa)

Kaldor-Hicks compensation principle — If an economic policy has the consequence of making one set of people better off and another worse off, a potential Pareto-improvement can be said to have occurred if the gainers could compensate the losers and still benefit from the change.

kl — 1 000 litres = 1 cubic meter.

lcd — Litres per capita per day.

long-run marginal cost — The cost of providing the last or next unit "in the long-run", that is, when investments in supply capacity are not fixed. For example, the cost of supplying the next unit of water when new investment in pipelines, pump stations and dams must be made to increase capacity.

m^3 — Cubic meter = 1000 litres = 1 kl

marginal cost pricing — Setting the unit price of all goods equal to the cost of producing and supplying the next or last unit.

MIIF — Municipal Infrastructure Investment Framework. A policy framework developed by DCD to meet basic infrastructure needs.

minimum basic water supply — Access to, and consumption of, at least 25 lcd; potable, that is drinkable without adverse health impacts; available at least on a daily basis and at known times. reasonably proximate (within a short walk) to the household (within 200 m).

NIIF — National Infrastructure Investment Framework. A national financial framework for investment in infrastructure. Prepared for the RDP Office.

optimal beneficial use — The best possible (that is, optimal) use of a resource in the public interest. This concept combines the social, economic and environmental values of water use, and requires a consideration of both intra- and inter-generation concerns. The definition of efficiency in terms of optimal beneficial use thus recognises the *social* value of water and the fact that it is inappropriate to value water solely in

	terms of value placed on the resource by the "highest bidder". Social choice is implicit within this definition of efficiency
Pareto-efficiency	A Pareto-efficient allocation of resources is said to exist when it is not possible to increase overall welfare without causing some individuals in society to become poorer.
Pareto-improvement	A change in which some individuals are better-off but no individuals are worse-off.
Pareto-superior	A state which more closely approximates a Pareto-efficient state than another.
PCE	Per capital expenditure: total expenditure on goods and services in a household divided by household size.
price elasticity of demand	The percentage change in demand for a one percent change in price.
price elastic	The percentage change in demand is greater than equal to one for a one percent change in price.
price inelastic	The percentage change in demand is less than one for a one percent change in price.
RDP	Reconstruction and Development Programme.
second fundamental theorem of welfare economics	Any Pareto-efficient allocation can be achieved as a competitive equilibrium if appropriate lump-sum transfers are made.
second tier water / price	The wholesale of treated water, typically by water boards.
short-run marginal cost	The cost of providing the last or next unit while keeping the level of fixed investment constant. For example, the cost of supplying the next unit of water for a given set of investments in pipelines, pump stations and dams.
sunk investment	An investment in an asset which is not readily marketable or an expense which is irrecoverable. For example, once money has been expended on a dam, it is not possible to use that same money for another purpose.
target basic water supply	Access to, and consumption of, at least 50 lcd; potable, that is drinkable without adverse health impacts; available at least on a daily basis and at known times. Proximate to the homestead (within 50 m).
technical efficiency	The achievement of a specific objective with the use of the minimum possible resources.
third tier water / price	The retail of treated (typically potable) water to individual consumers, typically by municipalities.
Transaction costs	The cost of transacting, that is, the costs associated with making a sale or purchase or entering into and enforcing a

	contract. Transaction costs jeopardise perfect competition and have been used to explain the distortion or absence of markets and the existence or form of institutions.
UAW	Unaccounted-for water. This is broadly defined as all water that is not metered and hence "unaccounted for". The term is more precisely defined in the text.
water demand	The economic demand for water, that is, the quantity of water demanded for a given price or set of prices. See also water use.
water resource	The water itself. It usually refers to the "raw" water in the river or in the ground, but also may refer to all water in the hydrological cycle, including water abstracted and used for any purpose.
water resource development	The infrastructure required to "extract" water from the environment. For example, dams for the storage of water.
water resources management	Management of the water resource. Usually an emphasis is placed on the management of water within its natural environment and a management of human activities which impact on this.
WSA	A water services authority.
WSP	A water services provider.
water services	The distribution of treated water for industrial, commercial, institutional and domestic use (as defined in the Water Services Act of 1997).
water services authority	The political entity responsible for water services within its area of jurisdiction, that is, local government (as defined in the Water Services Act of 1997).
water services institutions	Public and private institutions engaged in the distribution of treated water for industrial, commercial, institutional and domestic use (as defined in the Water Services Act of 1997).
water services provider	A water services institution (as defined in the Water Services Act of 1997).
Water use	Actual (or projected) water use. This is different to water demand.
welfare economics	The branch of economics that examines the welfare of individuals and society.
welfare maximisation	The overall "welfare" of society as a whole is maximised. Although this concept is used a lot in economics, forming the rationale for much of economics, there is little consensus on the meaning of "welfare". For convenience, the measure of welfare is usually reduced to monetary

	terms.
WSSM	Water services supply model. A financial model of retail water supply developed in South Africa. See PDG (1998f).
x-efficiency	See technical efficiency.

APPENDIX 3
Notation for tariff guidelines

Symbol	Name	Relationship	Description / Comment
+	includes access costs of target access (finance charges on capital loans)		
++	includes access and recurrent costs of target access		
AS	**ACCESS SUBSIDIES**		
AS_{RET}	reticulation		additional annual cost to WSP of reaching target access
AS_{CON}	connection		ditto
C	**COSTS**		
C_F	Fixed costs		
C_v	Variable costs		
C_{TOTAL}	Total costs	$= C_F + C_V$ $= C_{RES} + C_{NRES}$	
C_{RES}	Residential costs		Costs allocated to residential
C_{NRES}	Non-residential costs		Costs allocated to non-residential
$C_{V\text{-}RES}$	Variable residential		
$C_{V\text{-}NRES}$	Variable non-residential		
$C_{F\text{-}RES}$	Fixed residential		
$C_{F\text{-}NRES}$	Fixed non-residential		
CS	**CROSS-SUBSIDIES**		
CS_{BURDEN}	cross-subsidy burden	$RS_{NET} / (R_{RES} - RS_{NET})$	calculated for residential consumers, can be extended to include all consumers
Q	**QUANTITIES**		
Q_{TOTAL}	total purchased	$Q_{SOLD} + Q_{UAW}$	or supplied (if own supply)
Q_{SOLD}	total sold	$Q_{RES} + Q_{NRES}$	metered water
Q_{UAW}	unaccounted-for water	$Q_{NR} + Q_{LOSSES}$	
Q_{NR}	non-revenue water	$Q_{CST}+Q_{ON\text{-}R}+Q_{OTHER}$	unmetered water
Q_{LOSSES}	water losses		leaks etc.
Q_{RES}	residential sold		metered water
Q_{NRES}	non-residential sold	$Q_{IND} + Q_{COM} + Q_{INS}$	metered water
Q_{IND}	industrial sold		metered water
Q_{COM}	commercial sold		metered water
Q_{INS}	institutional sold		metered water
Q_{CST}	communal standpipes		estimate of that supplied
$Q_{ON\text{-}R}$	on-site restricted		estimate of that supplied
$Q_{ON\text{-}U}$	on-site unrestricted	$= Q_{RES}$	
Q_{OTHER}	other water supplied		other non-revenue water
Q_{NEW}	additional residential consumption arising from access target		
	NON-PAYMENT		
NPAF	non-payment adjustment factor	100 / (100 - NP%)	
NP%	% non-payment	$(R_{BILLED} - R_{ACTUAL}) / R_{BILLED} \times 100$	

Symbol	Name	Relationship	Description / Comment
R	**REVENUE**		
R_{TOTAL}	total revenue requirement	$R_{FF} + R_{WS}$	excludes external subsidies
R_{FF}	from fixed fees	$R_{PTAX} + R_{CHARGES}$	
R_{WS}	from water sales		from volume related tariff
R_{PTAX}	from property taxes		
$R_{CHARGES}$	from direct charges		billed directly to water consumer
$R_{WS\text{-}MIN}$	minimum benchmark		
$R_{FF\text{-}MAX}$	maximum benchmark		
R_{BILLED}	revenue billed		
R_{ACTUAL}	actual revenue received		
R_{RES}	residential revenue		from water sales and fixed fees
R_{NRES}	non-residential revenue		from water sales and fixed fees
RS	**RECURRENT SUBSIDIES**		
RS_{OFF}	to off-site consumers		residential
$RS_{ON\text{-}R}$	to on-site restricted		residential
$RS_{ON\text{-}U}$	to on-site unrestricted		residential
RS_{NET}	net RS requirement	$RS_{TOTAL} - SS_{ESW}$	net recurrent subsidy requirement
RS_{TOTAL}	total RS requirement	$RS_{OFF} + RS_{ON\text{-}R} + RS_{ON\text{-}U}$; $= RS_{ESW} + RS_{CS}$	total recurrent subsidy requirement
RS_{CS}	cross-subsidy requirement	$R_{CS} = RS_{NET}$	
S	**SUBSIDIES**		
AS	access subsidies		see separate **AS** section
CS	cross subsidies		see separate **CS** section
RS	recurrent subsidies		see separate **RS** section
SS	subsidy sources		see separate **SS** section
SS	**SUBSIDY SOURCES**		
SS_{CS}	cross-subsidies	$RS_{TOTAL} - RS_{ESW}$	cross-subsidy requirement
SS_{ES}	equitable share (ES)		equitable share subsidy - inter-government recurrent subsidy
SS_{ESW}	ES allocated to water	$SS_{EWS} < SS_{ES}$	the share of ES allocated to water
T	**TARIFFS**		
T_{MIN}	benchmark minimum		
T_{LL}	life-line tariff		
$T_{LL\text{-}MAX}$	maximum life-line tariff		
T_{MAX}	benchmark maximum		
T_{MC}	marginal cost		average incremental cost of capacity expansion and operation of bulk supply and city level infrastructure