GUIDELINES FOR SETTING WATER TARIFFS

WITH A FOCUS ON INDUSTRIAL, COMMERCIAL AND OTHER NON-RESIDENTIAL CONSUMERS

Palmer Development Group

WRC Report No. 992/1/00

Water Research Commission

GUIDELINES FOR SETTING WATER TARIFFS

With a Focus on Industrial, Commercial and other Non-Residential Consumers

Report to the
Water Research Commission

by

Palmer Development Group

WRC Report No: 992/1/00
ISBN No: 1 86845 682 X

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Printed by Sikowa Printers: 012 804 7565

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Preface

The Water Research Commission's *Management guidelines for water service providers* contains a module on setting water tariffs. The module concentrates mainly on water tariffs for residential consumers, explaining this scope as follows:

> The focus of the guidelines is on residential tariff structures, reflecting the emphasis of the recent national policy initiatives of DWAF. Little detailed policy and research work has been undertaken in South Africa in recent years on the determination of appropriate tariff structures and levels for non-residential customers. Hence only preliminary comments pertaining to these are made is this guideline. (Palmer Development Group, 1998d: 4-1)

Yet commercial and industrial consumers represent a major grouping of water consumers in most local authorities, consuming up to 50% of the water supplied in larger municipalities. These enterprises also have significant impacts on the local economy, society and the environment. Furthermore, municipal tariff surveys have revealed inconsistent and random approaches to setting tariffs for these consumers.

Recognising this gap, the Development Bank of Southern Africa and Durban Metro Water and Waste took initiatives which lead to the establishment of this Water Research Commission project in 1998 entitled *Guidelines for water supply tariffs for industrial and commercial consumers.*

The overall aim of this project is to provide local authorities with information to assist them in setting water supply tariffs for their industrial and commercial consumers, taking equity, economic development and conservation objectives into consideration. More specifically, the aims were:

1. To review the literature and current South African experience with regard to industrial and commercial water supply tariffs.
2. To gain specific insight into the industrial and commercial water supply arrangements in three local authority case studies.
3. To assess the water use circumstances in selected commercial enterprises and industries.
4. To review the principles relating to tariff setting which emanate from current WRC projects.
5. Based on the above inputs, to draft a set of guidelines for use by local authorities in establishing water supply tariff structures and setting tariffs.
6. To modify the Water Supply Services Model (WSSM) to incorporate the proposed tariff structures and provide a tool for the setting of tariffs.

A particular issue which the study set out to address was the potential for using rising block tariffs with commercial and industrial consumers.

These guidelines contain the distilled lessons and insights from past work undertaken by Palmer Development Group, international literature reviews and local case studies. The Water Supply Services Model remains an appropriate tool to use in implementing this guideline.

Acknowledgements

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Case Studies

Various individuals in the following organisations assisted with interviews and materials:

- Durban Metro Water Services
- City of Cape Town: Water Department
- West Coast Peninsula Municipality
- Hermanus Municipality
- Richards Bay Municipality
- Paarl Municipality
- Gabriel Shock Absorbers
- AECI
- Sasol
- Mondi
- DWAF
- Water Conservation Campaign
- SACOB
- Business South Africa
- Whale Carwash and Valet
- Zoete Inval Backpackers
- Walker Bay Nursery
- Washtub Laundry
- Marine Hotel
- Optima Brick Products
- Ocean Basket Fish Restaurant

Document preparation

These guidelines were prepared by Rolfe Eberhard and Mark Pickering.

Glossary

AIC	Average Incremental Cost
Average Incremental Cost	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 Palmer Development Group (1999b).
Block tariff	The unit volumetric tariff varies as a function of the amount of water consumed. Block tariffs are also called stepped tariffs. Bock tariffs could be increasing block tariffs (unit tariffs increase for higher consumption levels) or decreasing block tariffs (unit tariffs decrease for higher consumption levels). The number of blocks can vary from 2 to many. The unit tariff within any block is constant. The block boundaries define the lower and upper consumption boundaries to which the block tariff is applied.
consumption related charge	The price charged per unit of water sold, typically in c/kl. Also called a volumetric tariff or consumption tariff
consumption tariff	The price charged per unit of water sold, typically in c/kl. Also called a volumetric tariff or consumption related charge
cost centre	A responsibility centre, where the managers are responsible for controlling costs to budget, but have no responsibility for income
CMA	Catchment Management Agency
DCD	Department of Constitutional Development
DOF	Department of Finance
DWAF	Department of Water Affairs and Forestry
GAAP	Generally Accepted Accounting Practices
GAMAP	Generally Accepted Municipal Accounting Practices
IMFO	Institute of Municipal Financial Officers (South Africa)
kl	1 000 litres = 1 cubic meter.
investment centre	A responsibility centre, where managers are evaluated on the basis of the returns obtained from investments (return on capital or assets).
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.
NDC	new development charge
price elasticity of demand	The percentage change in demand divided by the percentage 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.
profit centre	A responsibility centre, where managers are responsible for both income and expenditure, that is, they have final accountability for net income but not for returns on investment.
retail	The supply of water to the end-user (consumer)
Retail WSP	A WSP which undertakes only retail functions
RMI	Rocky Mountain Institute, Colorado, USA
short-run marginal cost	The cost of providing the last or next unit "in the short-run", that is, when investments in supply capacity are fixed.
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.
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.
volumetric tariff	The price charged per unit of water sold, typically in c/kl. Also called a consumption related charge or consumption tariff
vertically integrated WSP	A WSP which undertakes both wholesale and retail functions
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	The infrastructure required to "extract" water from the

development	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.
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 agency that is constitutionally responsible for the provision of water services within its area of jurisdiction. In South Africa, this refers to local government.
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	The agency that physically carries out tasks related to the provision of water and waste water services. Typically a WSP is a public agency, though it may also be a private agency. In South Africa, WSPs are generally Water Boards (whose primary function is to supply wholesale treated water to other WSPs) and local governments (that is, municipalities or district councils) who typically carry out the function of the distribution and retail of water service to end consumers. That is, in many instances the WSP is the same as the WSA.
wholesale	The functions of treatment and bulk supply
WSA	Water Services Authority
WSP	Water Services Provider

Guidelines for setting water tariffs

With a Focus on Industrial, Commercial and Other Non-residential Consumers

Executive Summary

Commerce and industry represent a major grouping of water consumers in most local authorities, consuming up to 50% of the water supplied in larger municipalities. These enterprises also have significant impacts on the local economy, society and the environment. Yet surveys have revealed significant inconsistencies in the manner in which municipalities set tariffs for these consumers.

The Water Research Commission has already established a guideline on setting water tariffs, in the form of a module in the *Management guidelines for water service providers*. However, this module concentrates mainly on water tariffs for residential consumers. These guidelines have therefore been developed to assist Water Managers in setting tariffs for non-residential water use, focusing specifically on commercial and industrial water tariffs.

The guidelines have been written for water managers in Water Services Authorities (WSAs) and Water Services Providers (WSPs) who are involved in setting retail water prices, that is, water prices to the end-user. They propose the following tariff reform process:

1. **Understand the national context**. The roles of various institutions involved in water supply are described, together with the relevant national water pricing policies.
2. **Understand the local context**. A broad range of factors are outlined which tariff reformers may wish to consider to better understand their local context. These include the local institutional, historic, economic and water resources context, the consumer market, the costs of supply, revenues and current tariffs. Given the political nature of tariff-setting practitioners are strongly advised to undertake a stakeholder analysis.
3. **Set pricing goals, establishing principles and develop performance indicators**. Practitioners are advised to define pricing goals and to prioritise or weigh these as far as possible. A basic set of principles are proposed for good tariff practice. Various practical indicators are proposed with which to measure organisational performance.

4. **Make some preliminary choices**. The possible components of the water tariff are described, including development charges, connection charges, fixed fees and volumetric tariffs. Two approaches are described for determining tariff levels: the revenue requirements approach and the marginal costs approach. The user is advised to consider the impact of future supply costs and climate and to examine the scope for cost reductions when determining revenue requirements. A set of guidelines are provided to assist with these choices, covering universal cases and specific conditions.

5. **Define the tariff structure and set tariff levels**. Users are advised to establish a tariff policy framework on the basis of the selected goals, and to use this for further consultation.

6. **Undertake consultation and evaluation exercises**. The likely impacts of tariff reform should be evaluated before approval is sought. Depending on the outcome of the stakeholder analysis, and the extent of the proposed tariff reform, it may be necessary to consult stakeholders prior to seeking political approval. Long term evaluation procedures should be set up to establish whether the tariff reforms are achieving the desired pricing goals.

7. **Refine tariffs**. Users are advised to undertake incremental reforms to tariff structures and levels until they achieve desired goals and adhere to best practice principles.

A key conclusion of the research is that there is no practical system to implement inclining block water tariffs for non-residential consumers.

The guidelines also describe some tariff refinements for special cases, such as the use of new development charges; seasonal pricing; drought pricing and commodity price-linked tariffs.

Finally, the guidelines review a number of international and local case studies as a means of offering insights into the circumstances of other local authorities. Source documentation for these case studies is available at Palmer Development Group.

1. Introduction

1.1 Who are the guidelines are intended for?

These guidelines are intended for Water Managers in Water Services Authorities[1] (WSAs) or Water Services Providers (WSPs) who are involved in setting retail water tariffs, that is, water tariffs to the end-user.[2]

1.2 Scope

These guidelines will assist Water Managers with setting tariffs for non-residential water use, but focus specifically on commercial and industrial tariffs.

1.3 Institutional and policy context

Retail water tariffs are affected by the cost of wholesale water (the supply of bulk treated water), which in turn is affected by the cost of the water resource itself, water abstraction and water management. These different functions of water supply are typically (though not necessarily) carried out by different institutions. Although these guidelines focus on retail tariffs, it is important to understand both the institutional and policy context within which these tariffs are set. These are described below.

1.3.1 Organisations involved in water supply

The typical institutional arrangements for water supply in South Africa are shown in Table 1 in terms of the six main functional components of water supply.

Table 1: Organisational arrangements by water supply function

Agency / Water supply function	DWAF as regulator	DWAF as operator	CMA	Wholesale WSP	Integrated WSP	Retail WSP
Regulation	■					
Water management		■	■			
Resource pricing		■	■			
Abstraction		■		■	■	
Treatment & transmission		■		■	■	
Distribution and retail		■		■	■	*focus of guidelines*

Key: Dark grey = dominant arrangements; light grey = alternative arrangements
DWAF – Department of Water Affairs & Forestry
CMA – Catchment Management Agency
WSP – Water Service Provider

1 Underlined words and phrases terms are described in the glossary.

2 The terminology used for water institutions is specific to South Africa and follows the definitions set out in the Water Services Act of 1997. These terms (and all underlined terms) are described at the end of this report in the Glossary.

The key features of the institutional arrangements are described below:

- **Regulation**. DWAF is the principal regulator of the water sector in South Africa. National water policy is set out in a series of White Papers, especially the White Paper on National Water Policy (DWAF, 1997), and in national water legislation, principally, the National Water Act of 1998 and the Water Services Act of 1997.
- **Water management and resource pricing**. These activities refer to all aspects related to the management of the water resource (including planning, allocation and monitoring) and to the pricing of the water resource itself (the economic value of the water itself independent *as against* the cost of supplying water). The National Water Act makes provision for Catchment Management Agencies (CMAs) to play the lead role in water management and resource pricing in the future, although at present these functions are carried out by DWAF.
- **Abstraction**. Abstraction generally refers to the infrastructure (and related management) necessary to make raw water available for abstraction, such as raw water storage dams. Abstraction is managed by DWAF for most of the large urban schemes. For example, in the case of water supplied to Gauteng from the Vaal River, DWAF manages the Vaal Dam and the major inter-basin transfer schemes supplying water into the Vaal River. Abstraction may also be managed by Wholesale WSPs (typically Water Boards). For example, some of the dams supplying Durban with water are managed by Umgeni Water. For many smaller urban areas, abstraction is managed by a Vertically Integrated WSP. For example, the Stellenbosch WSP manages its own dams in addition to purchasing water from another Integrated WSP (the Cape Town Metropolitan Council).
- **Treatment and transmission (wholesale)**: This refers to the bulk supply of treated water, typically including transmission to treated water storage reservoirs located in or near urban areas. This function is typically managed by Wholesale WSPs (Water Boards) but may also be undertaken by Integrated WSPs (typically local authorities) which manage both the wholesale and retail functions.
- **Distribution and sale to the end-user (retail)**: This function is generally managed by a Retail WSP (typically a Local Authority) though it may also be managed by an Integrated WSP. Wholesale WSPs may also supply retail services, though this is typically a peripheral activity as their core function is wholesale.

The focus of this guideline is on retail services provided by retail and integrated WSPs.

1.3.2 National raw water pricing policies

The South Africa government released a raw water pricing strategy in 1998. This policy deals with the pricing of:

- **Water abstraction**, that is, the activities involved in abstracting water from the water resource, including the infrastructure costs. The policy limits itself to government owned infrastructure.
- **Water management**, that is, the activities related to the management of water, including water allocation, planning and monitoring.

- **The resource itself,** that is, the water itself. The rational for this is that the water itself has economic value independently of the costs associated with managing the resource and supplying water to consumers.

The document is titled "National Water Act, 1998 - A pricing strategy for raw water use charges. A strategy document" (DWAF, 1998). This strategy was developed in relation to the Water Policy White Paper (DWAF, 1997) and the National Water Act (RSA, 1998). Key elements of these policies and the raw water pricing strategy are outlined in Appendix A.

1.3.3 Wholesale water pricing policies

The pricing of bulk treated water provided by wholesale WSPs is governed by the Water Services Act of 1997. The key elements of this policy are outlined below:

- **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.
- **Cost-based pricing**. The wholesale tariff should be set as a sum of the cost of the raw water (determined by the national raw water pricing policy) and the costs entailed in the wholesale function (typically treatment, conveyance and storage).[3]
- **Infrastructure financing**. Finance for infrastructure investments should be sourced from a mix of internal revenue sources and private capital markets at the lowest possible cost. The wholesale function should be financially autonomous and not be dependent on government subsidies.

1.3.4 Retail water tariff policies

The Water Services Act (Act 108 of 1997) provides for the development of norms and standards for the determination of tariffs for water services. The relevant section of the Act is replicated below.

> **Norms and standards for tariffs**
>
> **10.** (1) The Minister may, with the concurrence of the Minister of Finance, from time to time prescribe norms and standards in respect of tariffs for water services.
>
> (2) These norms and standards may-
> (a) differentiate on an equitable basis between-
> (i) different users of water services;
> (ii) different types of water services; and
> (iii) different geographic areas, taking into account, among other factors, the socio-economic and physical attributes of each area;
> (b) place limitations on surplus or profit;
> (c) place limitations on the use of income generated by the recovery of charges; and
> (d) provide for tariffs to be used to promote or achieve water conservation.
>
> (3) In prescribing the norms and standards, the Minister must consider, among other factors-
> (a) any national standards prescribed by him or her;
> (b) social equity;

3 Where raw water is provided by a government owned water scheme, the raw water tariff 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.

(c) the financial sustainability of the water services in the geographic area in question;
(d) the recovery of costs reasonably associated with providing the water services;
(e) the redemption period of any loans for the provision of water services;
(f) the need for a return on capital invested for the provision of water services; and
(g) the need to provide for drought and excess water availability.

(4) No water services institution may use a tariff which is substantially different from any prescribed norms and standards.

A draft set of Norms and Standards were developed in December 1998. Key elements of these Norms and Standards applicable to non-residential water tariff setting are replicated below.

- A WSP must take into account recovery of overhead, operational and maintenance costs, the cost of capital and depreciation when determining its revenue requirements.
- A WSP must differentiate at least between residential, industrial and other (non-residential and non-industrial) consumers.
- Tariffs for water supplied to non-residential users must be based on the volume of water provided and recover at least the capital costs, operating costs and maintenance costs associated with that supply.

1.4 Complementary guidelines

The Water Research Commission's *Management guidelines for water service providers* contains a module on setting water tariffs (Palmer Development Group, 1998d). The module concentrates mainly on water tariffs for residential consumers, explaining this scope as follows:

> The focus of the guidelines is on residential tariff structures, reflecting the emphasis of the recent national policy initiatives of DWAF. Little detailed policy and research work has been undertaken in South Africa in recent years on the determination of appropriate tariff structures and levels for non-residential customers. Hence only preliminary comments pertaining to these are made is this guideline. (Palmer Development Group, 1998d: 4-1)

The intention of this guideline, focussing on commercial and industrial tariffs, is to complement the existing guidelines and they should be read in conjunction with these guidelines.

1.5 WSP size and level of tariff reform effort

The size of the WSP, in terms of the number of customers served and the total volume or water sales will influence the approach to setting tariffs. In particular it will influence the feasible level of effort (and hence expenditure) that is warranted and determine the level of detail (and complexity) that is appropriate. Rough approximations of these factors are given in Table 2. These are not prescriptive in any way.

Table 2: WSP size and indicative expenditure of effort on tariff setting

	Small Town	Large Town	Major City
Indicative size categories			
Population in service area	Less than 50 000	Between 50 000 and 1 million	More than 1 million
No. of customers	10 000	10 000 to 200 000	More than 200 000
Indicative annual revenue [1]	Up to R5 million	R5 million to R100 million	More than R100 million
Indicative level of effort			
Indicative expenditure [2]	R25 000	R25 000 to R500 000	More than R500 000
Indicative time-frame	Weeks	Months	Continual
Indicative level of detail			
Level of complexity	Formula driven	Moderate adaptation	Advanced adaptation
Level of detail	Engineering estimates	Moderately detailed	Very detailed

Notes:

1. Based on a consumption of 90 lcd and average water tariff of R3/kl

2. Based on 0.5% of annual revenue.

1.6 Learning from international experience

There is much to be learned from the experiences of water tariffing in other countries. A review of the literature on this subject was recently undertaken (Palmer Development Group, 1999g). The lessons from this review are incorporated into these guidelines and specific case studies are presented in Appendix C.

1.7 The tariff reform process

The guidelines set out in this document are based on the following tariff reform process:[4]

1. **Understand the national context**. Develop an understanding of the national policy and institutional context (Section 1.3 and Appendix A).

2. **Understand the local context**. Understand the local institutional, historic, economic and water resources context; understand the market (consumers and water use), the costs of supply, revenues and current tariffs; and undertake a stakeholder analysis (Section 2).

3. **Set tariffing goals, establishing principles and developing performance indicators**. Define and reach consensus on tariffing goals, and in particular, on the

[4] Adapted from Palmer Development Group (1999g).

prioritisation and weighting of these goals; reach consensus on a basic set of principles; and develop an appropriate set of practical indicators for the measurement of performance against defined targets (Section 3).

4. **Make some preliminary choices**. Understand the different components of the water tariff (development charges, connection charges, fixed fees and volumetric tariffs); decide on the basis for determining tariff levels (revenue requirements, marginal costs); understand the impact of future supply costs and climate on the tariff structure; and examine the scope for cost reductions when determining the revenue requirements (Section 4).

5. **Define the tariff structure and set tariff levels**. Develop the tariff structure and determine the tariff levels with reference to the guidelines presented in Section 5.

6. **Undertake consultation and evaluation exercises**. Evaluate the likely impacts of tariff reform prior to approval and implementation; consult with stakeholders and obtain political approval for tariff reform; and evaluate the impacts of the tariff reform after implementation (Section 6).

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

This structure suggests an iterative approach to tariff reform, whereby annual improvements lead to objectives being achieved over time. The establishment of practical indicators to measure the extent to which specified objectives are being attained will greatly assist with this process of incremental reform.

2. Understanding the context

The following contextual information is required to inform the water tariff reform process: Existing policies and legislation, governance structure, economic profile, water resources context, consumer and consumption data, and financial data.

National policies and legislation have been discussed in Section 1.3. More detail pertaining to the other contextual factors is presented below. It should be borne in mind that the appropriate level of detail will be determined by the size of the WSP and local circumstances, as described in Section 1.5.

2.1 Institutional context

2.1.1 Governance

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. Institutional arrangements in South Africa have been briefly reviewed in Section 1.3.1. 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.

2.1.2 Type of WSP

The type of WSP will affect the approach to financial management and accounting policies. There are three principal types of WSPs: (it is also possible to get hybrids of these types through public-private partnerships)

- A privately owned company
- A publicly owned company
- A (local) government department

Financial and accounting policies are discussed in relation to these WSP types in the following two sections.

2.1.3 Financial policies

Financial plans. The function of *financial planning* or *financial management* is to inform (or take) decisions on future investments and budgets, so as to achieve the overall financial goals of the organisation. Significant areas of concern for financial planners are the capital structure of the organisation, and the measurement (or estimate) of whether investment decisions will add to, or subtract from, the net value of the organisation, and if so by how much. In general, financial planners take a long-term (multi-year) view on these issues, since capital investments typically involve

large cash out-flows, which are (hopefully) followed by cash-inflows over a number of future years. Hence it is necessary to consider the time value of money and to discount expected cash-flows to some suitable common base.

Since financial planning is an organisation-specific exercise there are no set rules as to how to perform this function. However, there are generally accepted practices, involving the use of financial indicators such as Net Present Value (NPV), Cost-Benefit Ratios (C/B) and the Internal Rate of Return (IRR). Lending institutions will examine the WSPs financial plan before agreeing to loan funds to the organisation.

Impact of WSP type. The nature of a WSP's financial plan, and the level of detail in it, will vary between organisations. Private sector organisations may be more concerned with debt-equity ratios than public sector organisations, since they are more reliant on private lenders. Private sector organisations are also more likely to measure rates of return, and to require higher rates of return, than public sector organisations. In the public sector, the required rate of return is generally taken to be equal to the cost of capital. In some cases the required financial rate of return may be even negative if the expenditure is deemed to be warranted from a social policy point of view. Some of these differences are highlighted in below in Table 3.

Table 3: Implications of WSP type for financial policies and tariffs

	Private company WSP	Public utility WSP	Local Authority WSP
Financial planning objectives	Profit driven. Interested in overall rate of return on investment and the financial health of the company.	Similar to Private Sector WSP, but probably not as much focus on rate of return. May accept internal cross subsidies more readily. Service-driven within constraints of financial autonomy.	Focus on balancing the total budget with a 'basket' of services, some 'economic' others not. Often facing severe spending cap restrictions from the Department of Finance. Probably focussed on the short-term (annual budget cycle). Little sense of capital structuring. Unlikely to measure rates of return. Unlikely to undertake project-level financial evaluations. Driven by social policy rather than financial considerations.
Responsibility centre type	Investment centre	Investment or profit centre	Profit centre at LA level, Cost centre at WSP department level
Key financial indicators	Rate of Return on Assets and/or Investments. Debt:equity ratios for the institution. NPV or IRR for individual projects.	Rate of Return on Assets and Investments. Debt:equity ratios for the institution. If less emphasis is placed on investment returns then more focus on operating margins. Likely to be less emphasis on NPV, IRR for individual projects than in the case of a private sector WSP.	The level of surplus arising from the trading account at LA level. Expenditure to budget at departmental level. May focus on cash-flow indicators, such as payment levels, debtor days, etc. Probably no focus on project level financial indicators.
Who is responsible	Financial director, together with the marketing department. Overseen by the WSA, within the context of national policy frameworks and regulations.	Financial director. Marketing department if one exists. Overseen by Board, possibly with a dedicated finance and tariffing committee at board level.	Treasurer for local authority level revenue requirement decisions - which lead to tariff *level* decisions. Engineer for tariff *structure* proposals and budget control. Overseen by appropriate Council sub-committees.
Implications for tariff setting	Should start from financial policy, taking into account market information (such as consumer willingness and ability to pay), regulatory regime, and any other policy goals the company may have.	Similar to Private sector WSP. More likely to be influenced by social policy goals, i.e. less emphasis on financial objectives.	Frequently lack market insight. Economic distortions may be introduced through a lack of ring-fencing and limited financial planning.

Implications for this guideline. The key issue here is not a prescriptive point, but an observation that financial policy is diverse and depends on institutional factors such as ownership, governance, and the regulatory regime. This guideline is *not* about how to set financial policy for a WSP, but it is important to note that financial policies can have an important impact on tariff setting.

Tariff reform must take the organisation's financial policies into account. In some cases the tariff reform process may even lead to improved financial policies.

2.1.4 Accounting conventions

Accounting policies determine how the organisation's finances are organised and reported on, as a basis for planning and control.

Tariff reformers need to be aware of the accounting policies and practices which apply within their organisation. There are various approaches to accounting, two of which are relevant to South African WSPs.

The fund accounting approach. Fund-based accounting is widely used by local governments and government-owned utilities. However, fund accounting is not consistent with international conventions, as outlined by the Generally Accepted Accounting Practices (GAAP).

Generally Accepted Municipal Accounting Practices (GAMAP). Because of the difficulties that fund accounting systems pose for banks, councillors and lenders, the Department of Finance has developed a new set of accounting policies which comply with GAAP principles (Department of Finance, 1999).

A key difference between these two conventions relates to the approach taken to capital accounting. In the fund accounting system fixed assets are recorded in the accounts at the purchase tariff. Such assets can be financed by either external loans, internal loans, revenue contributions, donations or grants and subsidies. As a result there are different cost implications arising from these different funding sources. This is incorrect from a GAAP point of view as the cost of the fixed asset consumed in rendering services should be recognised as an expense, regardless of the financing of that fixed asset. This cost, relating to the consumption of the fixed asset, is known as depreciation. Charges for depreciation are calculated on the basis of the estimated useful life of the fixed asset and in GAAP systems are reflected on the organisation's annual financial statements.

Thus, under the GAMAP system the annual costs of an asset will not be related to the financing system utilised to purchase the asset. As a result, GAMAP income statements will not reflect capital repayments to internal and external loans or revenue contributions to capital, but will reflect interest charges.

Approaches found in practice

- **Local Authorities** have traditionally used the fund accounting approach. With the advent of the GAMAP conventions all local authorities will be expected to change their accounting policies with effect from the 2000/2001 fiscal year.
- **Water Boards** have traditionally used the fund accounting approach. This is also in the process of change and most Water Boards are likely to follow a GAAP approach in future.
- The **private sector** already follows GAAP conventions.

Tariff reform should take changing accounting policies into account.

2.2 Historical context

It is important that there is knowledge and understanding of the historical development of water supplies and water tariffing 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. Knowledge and understanding concerning previous water shortages (and the reasons for and responses to these), any special tariff arrangements made in the past, etc. is also important.

The status quo may be an important constraint on the tariff reform process and the impact of past decisions should be taken into account. Past decisions, even if they may have been well motivated, may have had unintended consequences. This may constrain the ability of the WSP to reform tariffs in the future.

This information will help to inform the tariff reform process. In particular, the knowledge will help to identify key stakeholders who need to be included in the consultative process prior to obtaining political approval for tariff reforms (see Section 2.10).

2.3 Economic context

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. See Palmer Development Group (1998cd).

The following information should be sought:

- Economic growth rate for the region and/or local area (historical and predictions).
- Information on industrial activity, for example, industry establishment and closure rates (both historical and predicted).
- Information on large "wet" industries[5]. A database comprising industries using large amounts of water (for example, the 20% of industries that are responsible for 80% of the total industrial water use) should be compiled. These industries should be surveyed to learn about current water use (including peak demand patterns), their development and investment plans, the likely impacts of this on water use, and so on.

2.4 Water resources context

It is important that local decision makers have an understanding 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):

5 There is no absolute definition as to what constitutes a "wet" industry. This is a relative concept, which should be defined for a particular local context.

Table 4: Water resource data for urban area Y (data is illustrative)

Data for 19*xx*	**Assurance of supply** %	**Yield** million kl pa	**Cost** c/kl	**Comment**
Current water supply	98%	3.2	150	Schemes ***a***, ***b*** and ***c***.
	80%	5.1	94	
Next water supply	98%	1.5	300	Scheme ***d*** to come on stream in the year 20*xx*.
	80%	2.3	196	
		Water used		
Current water use		2.6		Below average use.
Future water use		3.5		In year 2003

Likely data sources: Wholesale WSP, CMA 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 Palmer Development Group (1998bf).

2.5 Consumer categories

2.5.1 Rationale for different consumer categories

The are two basic rationales for segmenting the market (water consumers) into different categories:

- **To learn about the market** so as to better inform the WSP about water use and demand characteristics, and to improve water demand forecasts. Market segmentation can take place along many lines: consumer age, consumer supply capacity, consumption levels, the purpose for which the water is used, the geographic area, etc. All of these can be tracked in a consumer database. The extent to which this is desirable will depend on the size of the WSP, the consumer mix and the WSP's information management capacity.
- **To apply different tariffs** to differentiate between consumer categories.

This discussion concentrates on the latter rationale.

Generally speaking two arguments are raised for the application of different tariffs to different consumer types:[6]

6 There are, of course, other kinds of rationale that may be used, for example, tariff discrimination can be on the basis of location or willingness to pay.

- **Differences in costs**. There is an argument that tariffs should be different for different consumer categories because the costs of supply differ systematically between consumer categories; and
- **Differences in affordability and willingness to pay**. This argument is based on equity principles and starts from the point of view that poor residential consumers should pay less for water than other consumer groups, since water is also a social good and is essential for the maintenance of life. As a result, residential consumers (as a whole) should be distinguished from, and pay different tariffs to, non-residential consumers.

2.5.2 Consumer categories found in practice

The following consumer categories are commonly found in practice (these "major" consumer categories are often sub-divided into numerous sub-categories):

- **Residential consumers**. These may be subdivided into metered and unmetered on-site connections, public standpipes (and related arrangements like kiosks), other forms of intermediate supply such as distributed storage and/or low pressure systems.
- **Non-residential consumers**. These may also be subdivided into various categories, such as the following:
  - **Commercial and "dry" industry consumers**. Businesses who do not use water as part of a manufacturing process.
  - **"Wet" industrial consumers**. Industries using a large amount of water, typically as part of a manufacturing process.
  - **Institutional consumers**. Government, non-government (not-for profit) agencies, schools etc.
  - **"Other" consumer categories**. Consumer groups with "special" needs or characteristics such as sports-clubs, golf courses, caravan parks, etc.

It is not uncommon for WSPs to have numerous consumer categories with specific tariffs applied to each category. As a result additional data has to be kept and managed relating to these consumers, adding to the complexity and cost of administering tariffs. It is not always clear that the benefits of this differentiation exceed the costs.

2.5.3 Costs by consumer category

The costs of supply differ between consumer categories in two essential ways[7]:

- The cost of making a service connection.
- The capacity cost related to the peak demand pattern of the consumer group.

In reality, these two costs differ by individual consumer (and not just by consumer category). However, it is often cost-effective to standardise fees based on typical

[7] Ongoing customer support and maintenance costs typically do not differ that much between consumers, and even if they do, form a small component of overall costs; hence they can be ignored for the purposes of this discussion.

average costs for consumer categories, rather than working out a separate cost for each individual consumer.

The *cost of a service connection* is relatively easy to determine and is uncontroversial. Typically, standardised costs are used for small consumers, and custom-specific costs for large consumers. There may also be standard variations, such as a cost per meter of additional pipe-length required if a consumer is further than a threshold distance from the existing reticulation line.

Allocating the *capacity cost* between consumers is difficult. This allocation is somewhat arbitrary for three reasons:[8]

- **Agreement on methodology**. First, there are different methods for allocating capacity costs, with no general preference amongst practitioners for any one of these methods. Three of these methods are the *average cost, equal percentage of marginal cost* and *embedded cost* approaches. The average cost approach averages total costs across all consumer classes to come up with a uniform unit tariff applicable across all customer classes. The equal percentage of marginal costs approach calculates costs on the basis of the estimated contribution to marginal costs of each customer class. The embedded cost method seeks to allocate historic costs on the basis of estimated contributions to these costs on the part of each customer class.

- **Availability and cost of information**. Undertaking a cost allocation exercise requires detailed information by consumer category. This is often not available, even in developed countries. Furthermore, the information may be costly to obtain and the gains of undertaking a cost allocation exercise may not exceed the benefits. For example, a cost allocation study done for Los Angeles concluded that the average cost method was most appropriate as differences in costs between consumer categories were not large and the resulting benefit would not justify the added complexity.[9]

- **Subjectivity**. The allocation of capacity costs between consumers must rely on a number of subjective judgements.

For these reasons it is recommended that, as a general rule, detailed capacity allocation studies should *not* be undertaken by WSPs in South Africa.[10] An effect of this approach will be to favour residential consumers slightly since residential water demand is more "peaky" than non-residential water demand and contributes disproportionately to peak capacity costs. This is a favourable equity outcome in the South African context.

2.5.4 Defining consumer categories: An appeal for simplicity

On the basis of the preceding discussion, it is recommended that consumer categories are kept to as few in number as possible with clear definitions. This will minimise the

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8 For a detailed discussion of cost allocation approaches, see Beecher *et al* (1991).

9 See Palmer Development Group (1999g).

10 This approach has already been adopted by some large WSPs in South Africa, for example, Durban Water and Waste.

administrative burden (managing the different consumers categories) and the potential for inter-category "arbitrage" (where consumers seek to gain advantage by moving from one category to another).[11] A generic set of consumer categories is recommended in Table 5.

Table 5: Recommended consumer categories

Major category	Sub-category	Comment
Residential	Full-service (metered)	Households with a "conventional" connection which is not restricted
	Full-service (unmetered)	It should be the aim of the WSP to have all full-service residential consumers metered as soon as is practicable. Hence, in time this category should be phased out altogether.
	Limited-service	Households with some form of limited service. There may be one or two choices in this category, each with its own tariff structure.
	Communal service	Households who must walk to fetch water. There may be different kinds of communal supply each with a unique tariff structure.
Non-residential		All consumers who are not defined as residential or special
Special		Consumers for whom specific arrangements are made, for social, historical, boundary or other reasons.

The suggested approach is to:

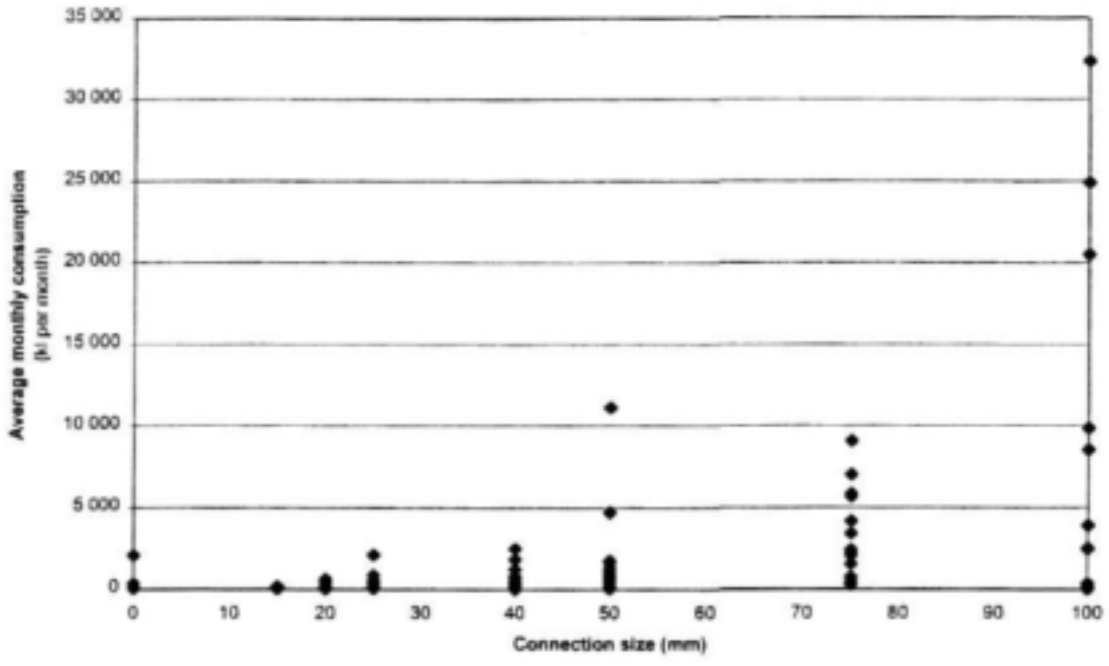
- Keep to as few consumer categories as possible and make the definitions as clear as possible.
- Avoid differentiating between institutional, commercial and "dry" industrial consumers, since this just opens up scope for confusion, arbitrage and corruption.
- Avoid special consumer categories as far as possible, for the same reasons.

It is important to note, however, that this should be a local decision which must take into account existing capacity constraints.

Where historical data is available it may be useful to plot average monthly consumption figures against connection sizes, in order to get a sense of the distribution of consumers.

11 A further motivation, beyond arbitrage, is the potential that is created for the corruption of officials if there are many consumer categories with differential tariffs.

Figure 1 : Sample consumer data



(Source: Paarl Municipality, 1998)

Note that some customer data is clearly incorrect in the above example, since it is not possible to have a 0 mm connection.

2.6 Consumer data

Information on Consumer data is reported in the Water Services Development Plan and annual progress reports. The following information is relevant to tariff setting:

- **Connections.** The number of consumers connected to the piped water network by consumer category (active versus disconnected).
- **Metering.** The status of metering (metered or unmetered).
- **Illegal connections.** The estimated number of unauthorised connections, by consumer category.
- **Off-network supplies.** A description of non-residential consumers, especially large industries, who obtain water from other sources than the piped water network. This may influence the price elasticity of demand as it may impact on "switching choices" between off-network (non-WSP) and network (WSP) supplies.

2.7 Water use data

An accurate picture of current and historical water use in the water supply area is highly desirable. Water use data is reported in the Water Services Development Plan and annual progress reports. The following data is particularly relevant to tariff setting:

- **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).[12]
- **Water use by consumer type**: Total water use by consumer category (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, hence it is important to know this.
- **Unaccounted-for water**: Measurement of unaccounted-for water. A methodology for the calculation of UAW is shown in Table 6.
- **Seasonal water use**. Analysis of seasonal distribution of water consumption (by major consumer category), and the relationship between climate and water use.
- **Peak demand**. The analysis of peak demand, in particular, peak-day demand.

Table 6: Calculating and reporting unaccounted-for water (data is illustrative)

	1998		Comment
	Kl	%	
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%	

Likely data 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, such as that presented in Table 7. This data is useful to determine the revenue impact and efficiency impacts of alternative tariff structures.

Table 7: 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
Total water use													
monthly total water use	kl	105	98	90	80	75	70	68	70	75	85	95	105
Non-domestic water use													
monthly water use	kl	75	68	59	50	41	35	31	33	37	48	62	75
% total water use	%	71	69	66	63	55	50	46	47	49	56	65	71

Likely data sources: Rainfall from local weather station. Water use data from WSP.

The above data could be illustrated as follows:

12 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.

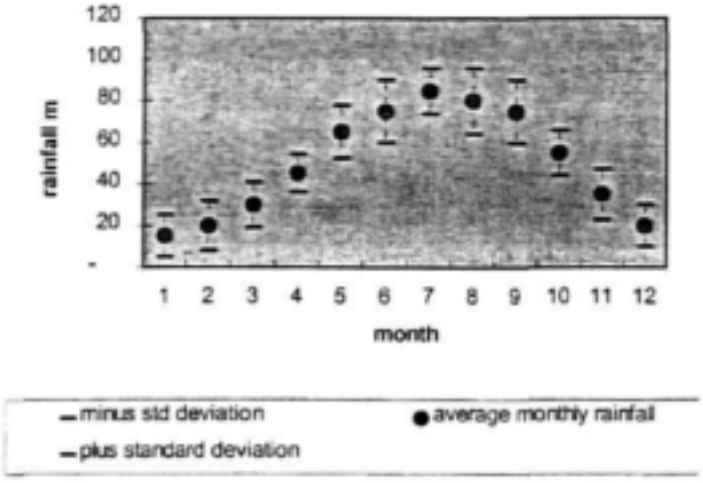


Figure 2 : Seasonal rainfall pattern (illustrative)

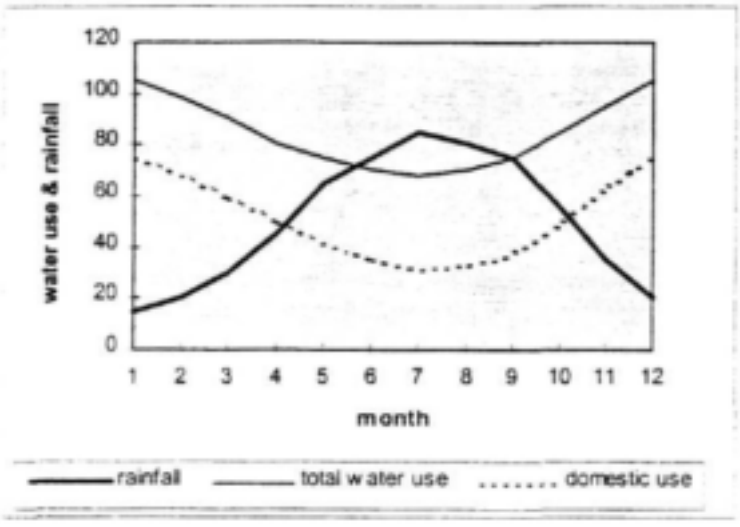


Figure 3: Seasonal water use pattern (illustrative)

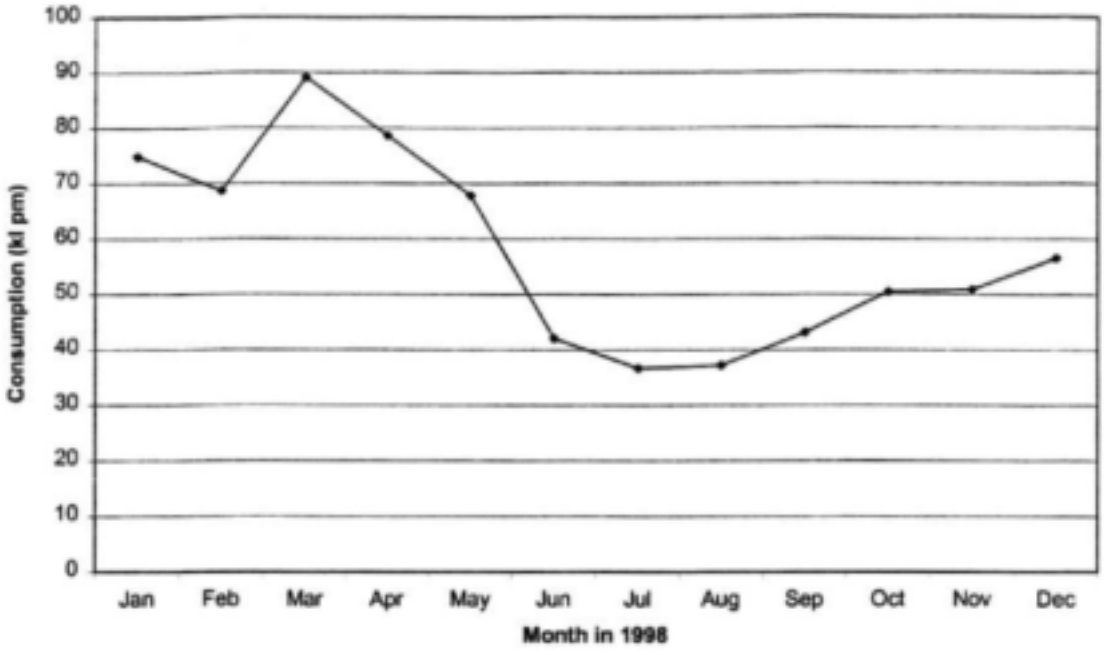


Figure 4: Seasonal water use pattern (actual - Paarl Municipality)

Note that actual data is likely to display some irregularities, such as in the above figure where meter reading routines lead to an under-read in February and an over-read in March.

Consumption distribution data is summarised in Table 8. The decile format has the advantage that it is not reliant on the definition of consumption categories and hence allows for better data comparability.

Table 8: Consumption distribution

Consumers ranked by consumption	first 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	next 10%	last 10%
Ave. consumption (kl/month)	5	12	15	19	23	27	33	41	55	346
Share of consumption (%)	1%	2%	3%	3%	4%	5%	6%	7%	10%	60%
Cum. share of consumption (%)	1%	3%	6%	9%	13%	18%	23%	30%	40%	100%

Data source: Paarl consumer data, 1998.

2.8 The costs of service provision

Knowledge about the structure of the costs of service provision will influence the choice of approach to tariff setting. There may be a distinction between the actual cost structures and what is known about the cost structures. In some cases, it may be important to improve the knowledge base about costs.

2.8.1 Calculation of unit costs

It is useful to estimate the unit costs of supply, as these can be used as the basis for setting tariffs. Unit costs can be calculated either on a volume or connection basis. The choice depends on the cost driver, that is, the factor that most influences costs.

Hence it is important to understand the cost structure of water supply and the factors that influence these costs. These are discussed in this section.

It should be noted that fund accounting approaches treat capital-related costs differently from GAAP-based accounting approaches. Since many WSPs are in the process of changing their accounting procedures it follows that some costs may change (See 2.1.4).

2.8.2 System components and the basic cost structure

In order to understand the cost structure of water supply, it is useful to analyse water supply system costs in terms of their constituent parts. For example, the cost structure could be conceptualised in a format such as that presented in Table 9 with reference to **Figure 5** (source: Palmer Development Group, 1998d).[13]

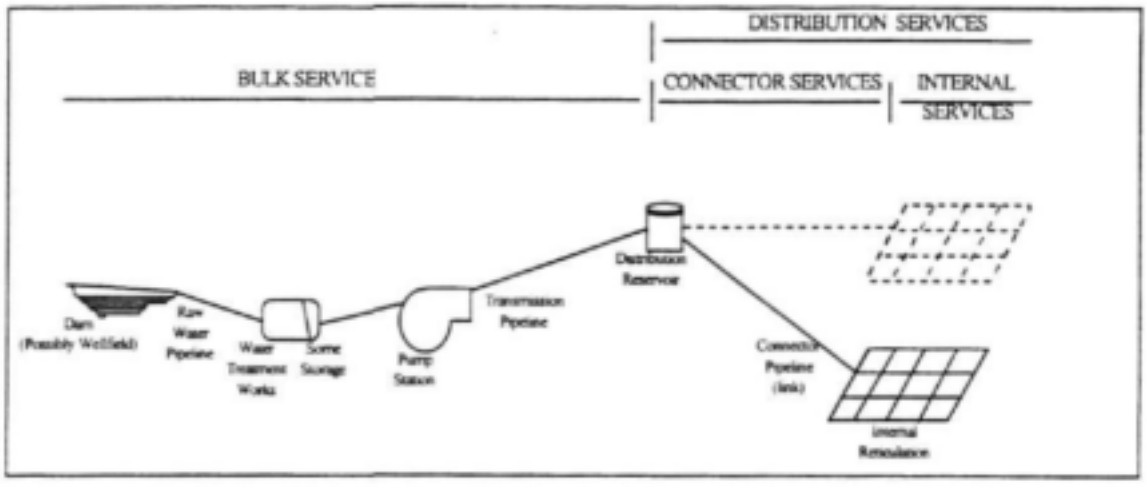


Figure 5: Components of a water supply system

The diagram assumes that treated water is provided by 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.[14]

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 local political representatives to understand the factors influencing water costs in the local area.

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13 This cost scheme and the discussion that follows is taken from Palmer Development Group (1999a).

14 An example of how this is done where a municipality manages it's own bulk water supply is shown in Palmer Development Group (1999f).

Table 9: Proposed schema to analyse the water supply cost structure

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 a 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)
Depreciation [9]		f(asset value)	f(asset value)
Interest 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: *either on a cash flow basis (excluding depreciation, including interest and repayments of principal) or on income statement basis (including interest and depreciation, excluding capital flows such as repayments of principle)*			
Unit	**c/kl**	**c/kl**	**R / connection / year**
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 to Table 9:

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 IMFO guidelines. See Palmer Development Group (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.
9. *Depreciation*. If a fund accounting approach is used then the depreciation item is replaced with Repayment of principle and related items.

This cost structure is illustrative and Water Managers should develop a cost structure which most suits their own particular water supply and management system.

An alternative, simpler break down is presented in Table 10 in terms of fixed and variable costs for the WSP as a whole.

Table 10: Fixed and variable costs - illustrative major components

Component	Description	Comment
Fixed costs		
Staffing related costs	Staffing levels are related to the number of consumers, the functions performed by the WSP and overall size of the operation (economies of scale)	Affects income statement and cash flow.
Interest payments	Related to past investments, financing policies, interest rates and cash flow	Affects income statement and cash flow
Depreciation [1]	Function of accounting policies, specific approach taken to depreciation, and the value of assets	Affects income statement and balance sheet

Component	Description	Comment
Variable costs		
Bulk treated water purchases	Directly related to the amount of water purchased	

Note: [1] If fund accounting is used then the depreciation item is replaced with repayment of principle and other capital expenditures funded directly from revenue.

Either of these cost breakdowns can provide a basis for allocating the revenue requirements from a tariff between a volume related tariff and fixed fees. They are also important tools to assist Water Managers in understanding (and hence managing) the costs of water supply incurred by the WSP.

2.8.3 Cost breakdown for a vertically integrated WSP

The above cost schema has assumed that the WSP is a Retail WSP which purchases water from a Wholesale WSP, that is, that the bulk water supply cost is "fixed" as the unit purchase tariff for bulk water. Where a WSP manages all (or a portion) of its bulk supply, it is generally a good idea to establish a separate cost centre for the bulk function. This should not be hard to do as the activities and cost of bulk supply are normally quite distinct from the retail operation, comprising:

- **Capital costs** of bulk infrastructure, translated to a depreciation expense and interest charges.[15]
- **Operating costs** consisting of treatment, pumping and maintenance of the bulk supply system.
- **Dedicated staff costs** for activities directly related to the bulk supply system such as operation of the treatment works, pumping stations etc.
- **Common costs allocation**: an allocation of head-office and other shared (common) costs to the bulk supply function.

Once the above costs have been established, the unit cost of the bulk water supply service may be calculated by dividing the total annual cost by the total water produced each year.[16]

2.8.4 Cost breakdown for a multi-service WSP

A horizontally integrated WSP provides multiple services, typically water and wastewater services. In this case, a number of costs are common and must be allocated between services.

Ideally, it would be desirable to have a separate cost centre established for each service so that the costs of each service are clearly identifiable. This approach is likely

15 If fund accounting is used, then the cost is represented as repayments of principle as well as interest charges on outstanding loans.

16 This straight forward approach will yield high unit costs in the early years of a scheme when there are high fixed costs and a low level of sales (relative to production capacity), with a declining unit cost of time as water production increases in line with demand. There may be reasons for applying an average tariff over the life of the scheme with a "lower than cost" tariff in the early years of the scheme and a "higher than cost" tariff in the later years of the scheme.

to be feasible only for larger WSPs. In smaller WSPs, common costs must be allocated between services using estimates. There are a number of ways of doing this. No particular approach is necessarily better than the others. The choice of approach will also depend on the availability of information. It is therefore difficult to development a generic set of recommended approaches

2.8.5 Cost efficiencies

It is important to assess the extent to which the water supply function is being carried out efficiently. This can be undertaken in two ways:

- Compare efficiency indicators with other similar WSPs.
- Compare efficiency indicators for the same WSP over time, net of inflation.

Some indicators that may be used for this purpose are presented in 3.5.

It is not fair to expect consumers to pay for operational inefficiencies and the WSP has an obligation to manage the water supply operation in an efficient and cost effective manner.

2.8.6 Past versus future costs

In order to set water tariffs to encourage efficient use it is useful to compare past, current and likely future costs.

The future cost of water supply may differ from the current costs. This situation could arise for various reasons:

- Future costs may be lower than current costs if efficiencies are improving through, for example, greater economies of scale.
- Future costs may be greater than current costs if operational efficiencies are decreasing, or if new more expensive sources of water are required due to increasing water demand.

Typically both decreasing and increasing tendencies will be in effect at the same time. This is illustrated in Figure 6. (Sourced from Baumann *et al*, 1998: 147).

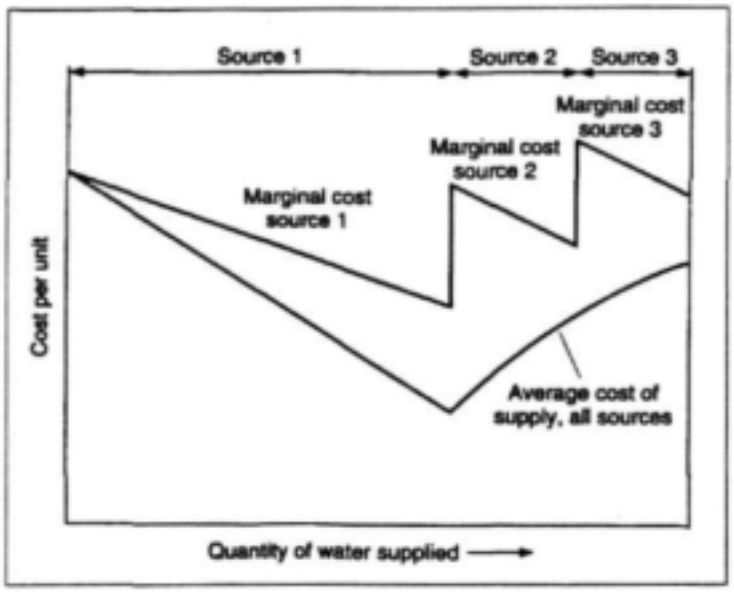

Figure 6: Water supply cost stucture over time

The cost effects shown in Figure 6 will take place over a number of years and are likely to be largely driven by bulk water supply costs.

It is to be expected that in most situations future costs will be greater than past (historic) costs. In order to provide the right incentives to use water wisely it is a good idea to provide pricing signals which are not only based on historic costs, but also reflect what future costs will be.

Hence it is important to know what the short-run and long-run marginal costs are.[17] These costs should be estimated for the whole system, and not just the retail component (distribution infrastructure).

A retail WSP should try to find out from its wholesale provider (typically the wholesale WSP or Water Board) the short-run and long-run marginal costs of bulk water supply. Estimates of the short-run and long-run marginal cost of the distribution (retail) function should be added to these bulk marginal costs to get marginal cost estimates for the whole system.

An integrated WSP which manages its own bulk supply should estimate the short-run and long-run marginal costs of supply itself.

2.8.7 The influence of time-frame on costs

Water demand may impact on costs (incurred by WSPs) in a number of contradictory ways:

- In the **short-run**, increasing water consumption can *decrease* unit costs because fixed costs remain constant.

17 The short-run marginal cost is the variable cost of supply for a given supply capacity. The long-run marginal cost of supply is more complicated to estimate. It is probably best to use the Average Incremental Cost method of calculating long-run marginal costs. This method is explained in Appendix B.

- In the **long-run**, increasing water consumption can *increase* unit costs because new, more costly, water supply infrastructure must be built.

It is important to try to understand the relative influence of these two effects of water demand on water costs. Water supply is a capital intensive industry and it will typically be the case that the long-run consumption influences on water costs will be much more significant than the short-run variable cost influence.[18] Although the retail or distribution function is less capital intensive, it is important to understand the cost structure of the whole water supply system, as increased demand for water by consumers at the retail level translates to increased capital expenditure "upstream" (on bulk supply).

The extent of the difference between historical and future costs of supply, and the amount of surplus capacity that exists as present, will determine whether the short-run or long run-factors are most important.

It is for these reasons that it is important to determine both the historic and the likely future cost structure of water supply.

2.8.8 The influence of demand characteristics on costs

In addition to time-frame (short-run versus long-run), the characteristics of demand have an important influence on cost. In particular, water costs are sensitive to two kinds of peak demand:

- Peak-hour demand (maximum demand during the day)
- Peak-day demand (maximum daily demand)

The load factor of a system is the ratio of average demand to peak demand. The load factor is defined with reference to the type of peak demand being measured, typically maximum-hour or maximum-day demand. Formulas are presented in Table 11.

The capacity utilisation factor is closely related to the load factor. It refers to the average system demand as a percentage of the design capacity (see Table 11). Since most water systems maintain some reserve capacity beyond that necessary to meet peak demands, the difference between the load factor and the capacity utilisation factor for a specific water system is determined by the amount of reserve capacity (Beecher et al, 1991).

Higher load factors and capacity utilisation factors will tend to result in lower unit costs.

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18 Beecher *et al* (1991) note that the water supply industry is "possibly the most capital intensive of all utility sectors" and requires of the order of 5 to 19 units of asset value for every unit of revenue.

Table 11: Load factors and capacity utilisation

	Formula	Comment
Load factor		
Peak-hour demand	Average hourly demand / peak-hour demand	Affects design of reticulation system. This factor is not calculated by WSPs on a routine basis.
Peak-day demand	Average daily demand / peak-day demand	Affects capacity requirements for treatment and storage.
Capacity utilisation		
Treatment	Average daily demand / design capacity	
Raw water storage	Annual demand / storage capacity	In South Africa, storage capacity is typically multi-year due to the lack of reliable rainfall in many areas.

Local water reticulation systems (internal services) are typically designed to meet maximum-hour demand, or maximum-day demand plus fire protection flow requirements, whichever is the greater.

Treatment capacity and other connection infrastructure is designed to meet maximum-day demand.

Bulk raw water storage capacity is designed in relation to average annual demand.

Outdoor residential use is typically the most important factor affecting peak demand (both peak-hour and maximum-day demand). Income, plot sizes, climate, landscaping preferences and water tariffs all affect outdoor residential use and hence peak load and system costs.

2.8.9 The influence of tariffs on water costs

There is a circular feedback between system demand, system costs and water tariffs. In other words, system demand impact on costs, costs are used to determine tariffs, and tariffs impact on consumer demand. It is therefore useful to have an understanding of the influence that tariffs have on the quantity of water demanded.

Unfortunately, two factors hinder this understanding. Firstly, it is not easy to apply economic theory to the empirical measurement of the price elasticity of demand for water.[19] Secondly, few empirical studies have been undertaken specifically on the price-elasticity of non-residential water, whilst those that have show a very wide range of results. Some of these results are reported below.[20]

The results confirm the expectations that the characteristics of water demand differ significantly between industrial sectors, and that sector 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

19 The reasons for this are discussed in Palmer Development Group (1999g).

20 The discussion is borrowed from Palmer Development Group (1999g).

demands are predicted to be the most sensitive to changes in water tariffs. 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*" (1992: 401, own emphasis).

Notwithstanding the difficulties with measurement described in the previous section, some empirical estimates of the price elasticity of water demand are summarised below.

Table 12: Price elasticities - the empirical evidence

Source	Price-elasticity	Comment
Commercial & institutional		
Williams and Suh (1986)	-.14 to -.36	USA; 1976; mixed; water utility and state census data
Boland (1991)	-.2 to -1.8	Individual categories
Yepes *et al* (1995)	-.17 to - .33	Individual categories
Yepes *et al* (1995)	-.23 to -.92	Aggregate categories, short and long run
Industrial		
Renzetti (1988)	-.12 to -.54	British Columbia, Canada; 1981; firm level observations, elasticities quoted by industrial sector
Renzetti (1992)	-.15 to -.59	Canada; 1985; mixed; firms (2000), survey; elasticities quoted by industrial sector
Williams and Suh (1986)	-.44 to -.74	USA manufacturing; 1976; mixed
Winpenny (1994)	-.3 to -6.7	Individual categories
Winpenny (1994)	-.5 to -.8	Aggregate categories
Yepes *et al* (1995)	-.43 to -1.32	Aggregate categories

Source: Palmer Development Group (1999g)

The following should be borne in mind with respect to the empirical data presented in Table 12:

- The results vary widely within and between studies.
- The results vary widely between and within industrial sectors.
- The results are likely to have low levels of confidence.
- The results are not comparable between studies.
- The results are not translatable to new policy contexts.

Furthermore, it should be noted that industrial and commercial water use may either be consumptive or non-consumptive. In most cases industrial water use has a large non-consumptive component. This means that a significant portion of water that is

purchased is eventually discharged back to the water environment. In many cases the quality of the water may be significantly affected.[21]

Renzetti's results showed (for his Canadian data set) that water intake and re-circulation were substitutes. This is a significant finding because it means that *an increase in water traiffs will lead to a reduction in water intake and greater recycling*. Similarly, he found that, discharge and re-circulation are substitutes. This also has important implications because it means that *an increase in discharge fees will result in greater re-circulation and hence also a reduction in water intake* (1992).

Effluent tariffing policy may thereof be a very important complementary policy instrument which may be used to increase the efficiency of water use and to reduce downstream environmental damage.

These results have the following practical implications:

- **Input cost - margin approach**. A preliminary indication of the likely changes in water demand in response to changes in the water tariffs may be obtained by examining the cost structure of the industry and the input cost of water as a proportion of total input costs and the operating margin respectively.[22] Where water costs are a small proportion of both total input costs and operating margin, water demand is unlikely to be price elastic. Where operating margins are small, water demand is likely to be more sensitive to changes in the price of water compared to the case where margins are large. When doing this analysis, it is important to be aware that the margin is not static and may vary over time due to commodity price or input cost cycles (arising from changing macro-economic conditions).

- **Examining substitutability**. Price elasticity will also be dependant on the degree to which existing water use is "substitutable". In some cases it may be relatively easy to reduce water consumption, whereas in other cases major capital investment may be required. For example, in the case of electricity generation, once an investment in cooling technology (dry versus wet) has been made for a particular power station, the scope for further reduction in water use per unit of electricity generated is limited. *In this case, the price signal at the time of the initial investment is crucial*. On the other hand, improved operating procedures may save significant amounts of water in some cases. This partly explains why there is such a large range in empirical estimates of the price elasticity of industrial water demand.

- **Short-term versus long-term effects**. It is likely that price-elasticities are higher in the long-run compared to the short-run. This is because of the issue of substitutability discussed above.

- **Observation**. Rather than undertake price elasticity studies to determine what price elasticities were in the past (based on the historical record), it may be more practical to closely observe actual consumption responses to tariff changes as they occur. This is because price elasticity studies based on the historical record are not

21 This includes heat pollution in the case of cooling water.

22 The operating margin is the difference between revenue and operating expenses.

helpful in making predictions about how demand will respond to future tariff changes, under conditions not experienced in the past.[23]

- **Linking supply and effluent tariffing policies**. Effluent tariffing policy is a key to providing industries with incentives to reduce effluent (and hence water consumption) and to improve effluent water quality. It is therefore crucial that water supply policies are linked with effluent tarifing policies.

2.8.10 Real versus nominal price levels

All costs and prices should be recorded at constant prices so that *real* changes in costs and prices can be identified. Past year's costs should be inflated into Rand values for the current year, using the Consumer Price Index as an inflation factor.

2.9 Revenues and tariffs

The nature and source of existing revenues, and how these have changed over time, need to be understood.

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 Palmer Development Group, 1998d)

- The nature and level of *capital development charges*.
- The nature and level of *connection fees*.
- The nature and level of *fixed charges*..
- The nature and level of *volume related* charges.
- The *differentiation of these charges* by consumer category, connection type, consumer characteristic, area, season etc. as applicable.
- The *frequency* with which these fees and tariffs are levied.

2.10 Stakeholder analysis

Retail tariffs in South Africa need to be approved by the WSA. Thus stakeholder analysis and participation of the key stakeholders in the tariff reform process is crucial to the success of tariff reform.

Key stakeholders need to be identified. The following interest groups are likely to have an interest in non-residential tariff reforms:

- Large industries
- The local Chamber of Commerce
- Trade unions

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23 This is called the "Lucas critique". See Palmer Development Group (1999g) for a discussion of this.

- Consumer protection agencies
- Special interest groups, such as developers, sports clubs, charities etc.

3. Goals, principles and performance indicators

3.1 Introduction

Tariffs can be implemented to accomplish a number of goals. It is desirable to be explicit about which goals are being prioritised and targeted. The prioritisation of goals depends on the political context, discussed in Section 3.2. Suggested goals are presented in Section 3.3, taking national pricing policy into account. Principles are useful as general guidelines for action. Suggested principles, based on the identified tariff goals, are presented in 3.4. In order for the goals and principles to be put into practice, it is desirable that measurable performance indicators are implemented. Suggested performance indicators are presented in Section 3.5.

3.2 Reconciling goals, principles and interests

The fact that potential trade-offs exist between the different goals and principles of water tariffing policy means that *context and politics matter*.[24] These factors influence 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." Hence the political context influences the *process* of setting water tariffs as it will influence the relative weight placed on the primary goals of water tariffing as shown in Figure 7.

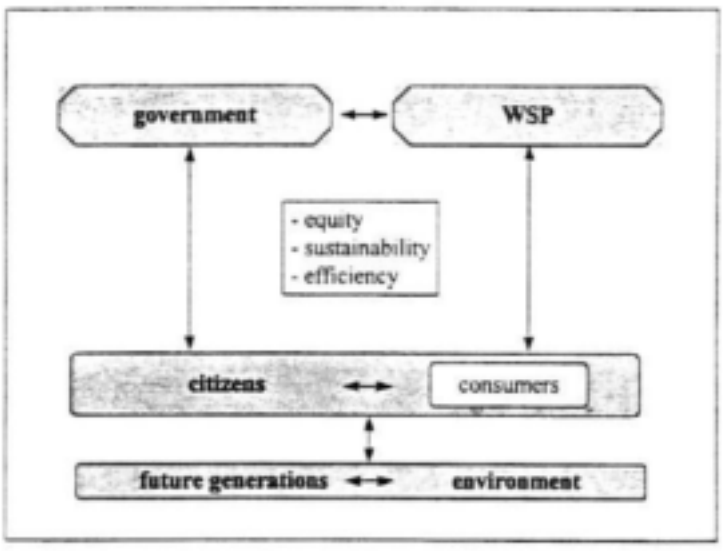

Figure 7: Political-economy affects weighting of goals

The key actors (or "interest groups") are the consumers (or customers), citizens, government and the water services provider (WSP). Important indirect "interest

[24] This section is adapted from Palmer Development Group (1999a). For a more detailed discussion on this topic, see Palmer Development Group (1999c). The case of water supply to Los Angeles is a classic case study of the importance and influence of politics. See, for example, Ostrom (1953) and Reisner (1993).

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 tariff outcomes.

In the context of commercial and industrial tariffs some key conflicts of interest are the following:

- Local authorities may wish to induce new industries to locate within their area by offering discounted water tariffs.
- Local authorities may wish to increase water tariffs to established industries, commercial consumers and other non-residential consumers in order to subsidise the cost of water for residential consumers.
- Businesses need low input costs to compete, and may threaten not to locate within the area (or to relocate out of it) unless they are given "special deals" for water tariffs. Businesses are also likely to object to 'taxes' for the purposes of cross-subsidising other consumers. Large water consuming businesses are likely to be more vocal and persuasive than small businesses.
- Residential consumers may wish to have lower tariffs than non-residential consumers and, by implication, some form of cross-subsidy from non-residential consumers.
- Residential consumers generally have a vote in local government elections, whilst non-residential consumers typically do not.

These conflicts of interest need to be resolved at the political level. In these guidelines, the recommendations are based largely (but not exclusively) on economic considerations.

3.3 The goals of tariff setting

3.3.1 National pricing goals

Broad water pricing goals have been established by national government. Although these goals are primarily directed at the pricing of *raw* water, they form an important context for the establishment of retail tariffing goals and are therefore discussed here.

Four primary national water pricing goals are clearly identified in the National Water Act of 1998: improving social equity, ensuring ecological sustainability, ensuring financial sustainability and improving efficiency.[25]

Improving *social equity* is important because the South African Bill of Rights establishes the right to equality as a fundamental human right. It is evident from the constitution that South Africa is committed to improving equality and that this informs government policy.[26] This is because equality of opportunity will not address

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25 This summary discussion of national water pricing goals is taken from Palmer Development Group (1999a).

26 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).

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).

3.3.2 Goals for third tier non-residential tariffing

It is the role and responsibility of WSPs, in conjunction with WSAs, to establish specific goals for retail tariffs within their area of supply. These goals must be compatible with the national goals described above and conform with the national policies and legislative requirements presented in Section 1.3.

As a starting point for deliberations, the following normative guidelines are proposed:

- **Unequal status**. For *non-residential* water services, the four goals identified above are not of equal importance for third tier tariffs.
- **Financial sustainability and efficiency priorities**. The two goals which are most important with respect to the tariffing of non-residential water services are:
  - **financial sustainability** through ensuring that tariffs recover the full costs of water supply to non-residential consumers; and
  - **efficiency** through ensuring that tariffs provide the correct incentives to non-residential water users to use water effectively, efficiently and non-wastefully.
- **Ecological sustainability** is best achieved through first tier pricing policies (the ecological reserve, inclusion of environmental externalities), pollution charges linked to effluent discharges and legislation governing permissible discharges.[27]

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[27] 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

- **Equity** is best achieved through residential water tariffing policies (through ensuring that households can afford a minimum amount of potable water).
- **Subsidies and cross subsidies**. Non-residential tariffing policies impact on equity goals through cross-subsidies. Subsidising non-residential consumers is not equitable because it will negatively impact on the affordability of water for residential water use. Excessive cross-subsidies from non-residential users to residential users also may be inequitable if they adversely affect economic activity in the region. In general it is preferable that consumers are aware of the true cost of water, and that any subsidies are transparent.

3.4 Principles for setting tariffs

Broad principles are proposed in this section to promote the attainment of the tariff setting goals suggested above.

3.4.1 Efficiency principles

The following principles promote efficiency in water use:

1. Tariffs should be based on "efficient costs" (that is, the costs to run the water service provider in a cost-effective and efficient manner).
2. Where practical and cost-effective, payment should be in proportion to the amount of water consumed. This will promote the more efficient use of water, compared to tariffs which have a large fixed cost component.
3. Tariffs should promote the development of competitive businesses. Hence business tariffs should not be loaded with excessive taxes or cross-subsidy requirements.

3.4.2 Financial sustainability principles

The following principles should facilitate the development (and maintenance) of a financially sound WSP:

1. Tariffs should recover the full costs of water supply.
2. Tariffs should ensure a positive and sustainable cash flow over time, taking into account past, current and future financing needs.

3.4.3 Principles of good practice

Over and above the principles presented above a number of "good practice" principles are proposed which relate to the management of tariffs.

The following principles of good practice are proposed:

1. **Fairness**. Tariffs should be fair in that they should treat all consumers in the same circumstances in a consistent manner. Because the notion of fairness is inherently subjective, the fairness of tariff reform can only be tested within a democratic political realm. This emphasises the need for retail tariff reform to be subject to the democratic political process. (See Sections 3.2 and 6.2.)

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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*

2. **Non-complex**. Tariffs and subsidies should be clear and easily understood, that is, there should be a general preference for simple (non-complex) tariff structures.
3. **Consistency**. Tariff enforcement should be fair and consistent. This implies that tariff reforms must be subject to due political process. Equally, the WSP must have the *capability* and *willingness* to enforce revenue collection.
4. **Cost-effective**. The benefits derived from implementing tariff reform should exceed the cost of implementation, that is, they should be cost-effective.
5. **Stable revenue**. Tariffs should seek to generate revenue that is reasonably stable and predictable. 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 conservation 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 tariff changes implies that, in general, a *cautious and incremental approach to tariff reform should be adopted*. There may, however, be circumstances where significant and relatively rapid changes in tariff structures and levels may be desirable.
6. **Transparency**. Tariff determination should be transparent. That is, consumers should have access to information relevant to the determination of their tariffs. 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. Firstly, the *consumer relations* capability of the WSP should match the customer base (both existing and potential). For example, consumers should have ready *telephonic access* to the WSP to relay complaints, feedback and queries related to their service, in the language of their choice. Secondly, monthly water bills 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.
7. **80/20 approach**. In view of capacity limitations, WSPs should generally adopt what is known as the "80/20 approach"[28]. This approach entails focussing on the 20% of the possible implementation strategies that will achieve 80% of the desired outcomes. For instance, in the case of a WSP with a priority policy goal of water conservation, the 80/20 approach would suggest an initial focus on the largest water consumers in the area. Such a focus could examine water tariffs, industrial waste-water tariffs, billing information, and the promotion of water conservation measures.

3.5 Developing performance indicators

Performance indicators enable Water Managers to measure performance over time so as assess the extent to which specific goals or targets have been met. The performance indicators chosen by a WSP will depend on a number of factors: the type of WSP, the

28 Also known as the Pareto approach.

financial policies of the WSP, the accounting practices of the WSP and the size of the WSP, to name a few.

Possible indicators are presented below. It is suggested that the Water Manager select a few of the most appropriate indicators as a starting point. These indicators should be such that managers have some control over outcomes relevant to the indicators. Over time, more indicators can be added as appropriate.

No comparative database of such indicators for South African WSPs exists at present. Inter-WSP comparisons are also fraught with difficulties as conditions differ in so many respects between WSPs. Hence it may be misleading to rely on simple indicators for inter-WSP comparisons. It may be much more useful to review indicator trends within the WSP over time. The maintenance of historical data records is important for this reason. Ideally, five years of historical data should be used, although three years of data would also be useful.

The following indicators may be used for the measurement of financial sustainability:

- **Working ratio**: Operating costs (less depreciation and interest) over income. (Target: <1)
- **Operating ratio**: Operating costs (including depreciation and interest) over income. (Target: <1)
- **Financial dependence**: The ratio of external revenue to total revenue.
- **Debt to revenue ratio**: Debt service over income.

The following indicators may be used for the measurement of efficiency:

- **Billing efficiency**: Percentage of water supplied that is billed. (100 - UAW) (Target: 85%).
- **Collection efficiency**: Percentage of sales (billing) that is collected. (Target: >90%)
- **Meter coverage**: The percentage of individual connections metered. The extent of district metering (for water management and water loss detection purposes.) (Target: 100%)
- **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.[29]
- **Unit operating costs**. Unit costs excluding depreciation, interest and bulk water purchases.
- **Metering reading, billing and collection costs per meter read**.

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[29] Investments in water saving are only cost-effective if the present value 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.

- **Number of meters read per meter-reader per month**.
- **Number of staff per thousand connections**.

The following indicators may be used to measure the efficiency of water use by consumers:[30]

- **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 taps and showerheads, banning automatic flushing urinals etc. This is particularly important in relation to new investments that may be influenced through *building codes*. 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.[31]
- **Industrial water use efficiencies**. Industrial water use efficiencies can be calculated in a number of ways. These are shown in Table 13 with reference to Figure 8. 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 could be applied in cases where water is used wastefully.

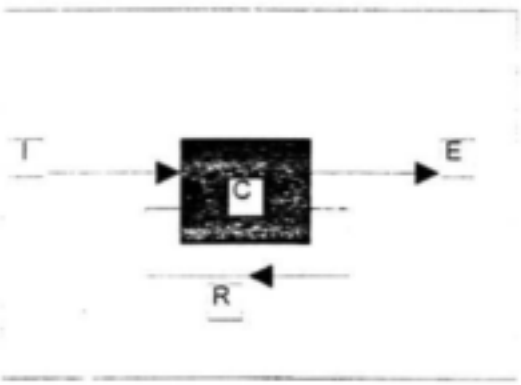

Figure 8: Calculating industrial water use efficiency

Intake	I
Effluent	E
Consumption	C = I - E
Recycle	R
Gross use	I + R
Output	O

30 These indicators are not in the direct control of the WSP, nevertheless WSP policies can create incentives for consumer water use efficiencies to be improved.

31 See RMI (1993, 1994a&b).

Table 13: 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.

4. Setting tariffs - preliminaries

4.1 Introduction

Before actually designing the tariff structure and setting the tariff level, it is necessary to understand the typical component parts of the tariff (Section 4.2), decide on the basis for setting the tariff level (Section 4.3) and understand the impact of future supply costs and climate on the tariff structure (Sections 4.4 and 4.5).

4.2 Tariff components and structures

There are typically four major components of the water tariff: development charges, connection charges, fixed fees and consumption charges. Each is discussed in turn.

4.2.1 Development charges

Development charges are levied to recover the capital costs of any combination of the different components of a water supply system (bulk services, connector services and local reticulation).

Development costs could be recovered in a variety of ways, some of which are listed below:

- a separately identified capital development charge,
- incorporation into the purchase price of a property,
- a connection charge,
- an annuitised fixed fee,
- a consumption related tariff and/or
- a government grant

The choice depends on preferences as to how the water supply system should be funded and the constraints imposed by existing legislation.

Development charges for local reticulation. In South Africa, it is quite common that development charges are restricted to the local reticulation (internal services) component of the water supply infrastructure, with the costs of bulk and connector services being funded through the consumption tariff. This is especially the case for retail WSPs because the responsibility for the investment in bulk supply capacity rests with another WSP (typically the wholesale WSP). In practice, a wide variety of mechanisms are used to recover the cost of reticulation infrastructure in South Africa and a full discussion of these is beyond the scope of this guideline.

Development charges for bulk water infrastructure. It is not common for development charges to be implemented for bulk water infrastructure in South Africa as these costs are normally recovered through a consumption related tariff. Nevertheless, there is an argument for requiring new consumers to pay development charges (often called "New Development Charges") where the marginal costs of bulk capacity expansion are greater than historical costs.

4.2.2 Connection charges

Connection charges are used for one or both of the following two purposes:

- To recover the cost of the physical connection to the existing local reticulation system. This is the most typical use.
- To recover (fully or partially) the system capital development cost. In this case, it is typical for the connection charge to be related to the connection diameter as this is related to the maximum demand that the new connection can place on the water supply system.

4.2.3 Fixed fees

Fixed fees can be used to recover any combination of operating and capital costs. They are typically levied on a monthly basis, although they could also be levied less frequently.

4.2.4 Consumption charges

Consumption related charges can be used to:

- Recover operating costs not recovered through the other charges indicated above.
- Recover capital costs not recovered through the other charges indicated above.
- Signal future water supply costs.

4.2.5 Other charges

In addition to these four major components, there are other non-routine charges. These include disconnection fees, reconnection fees, meter checking fees and various others. Guidelines for these non-routine tariffs are not presented here. The reader is referred to AWWA (1996) for a discussion of these charges. In general such charges should follow the principle of being cost reflective.

4.2.6 Combining the tariff elements

It is obvious from the above discussion that there is considerable flexibility in the way in which the four different tariff elements can be used. Each can be justified on the basis of economic principles and tariff goals. The choice and use of the tariff elements depend on the relative weight of the tariff goals and on judgements as to which combination would best meet these needs in the specific context. A recommended approach is presented in Section 5.

4.3 The basis for determining tariff levels

There are essentially two approaches to determining the overall tariff level.

4.3.1 The revenue requirements approach

The basic aim of this approach is to set a tariff to meet a defined revenue objective. Typically, this revenue objective will be derived from an analysis of operating and capital costs and the required surplus. The scale of the surplus (or loss) will depend in turn on the prevailing regulations and financial policies (see Section 2.1.3).

4.3.2 The marginal costing approach

This is a forward looking approach in which the tariff is based on estimates of marginal (future) costs rather than historic costs. The economic argument which underlies this approach is that efficiency is maximised when the price is set equal to the marginal cost of providing the next unit of supply.[32]

In the case of water supply, investment often takes place in large increments (such as when a new treatment works is built) and hence the marginal cost of supplying water varies considerably over time (see Figure 6). A strict form of marginal cost pricing (short-run marginal cost pricing) is therefore impractical. Economists typically recommend an approximation of the marginal cost by calculating the Average Incremental Cost of additional capacity (see Appendix B for details).

The review of the international literature did not find one instance where long-run marginal cost pricing (based on Average Incremental Costs) is practised in a fully implemented form (that is, where all units of water are priced at the long-run marginal cost).[33] However, it is increasingly common for the marginal cost price to inform some aspect of setting water tariffs.[34] This approach has advantages because it is possible to meet policy constrained revenue requirements at the same time as providing consumers with signals about the future cost of water if long-run marginal cost pricing is judiciously implemented. Ways to do this are discussed in Sections 4.4 and 5.

4.3.3 Choosing the appropriate approach

There is no one correct approach to determining the appropriate overall tariff level. The choice of approach must take into account the type of WSP, the WSP's financial objectives, the regulatory environment and other factors such as future supply costs. Of these, the regulatory environment is likely to be the most important.

Irrespective of which approach is adopted, it is important that costs are understood to be efficient costs (in the least-cost sense).

4.4 The impact of future supply costs

The relative difference between current and future water supply costs will influence the tariff setting approach. For example, where supply costs are increasing, it is important to adopt an approach which incorporates price signals which tell consumers that water is becoming more expensive. A basic outline of the influence of future supply costs on the tariffing approach is given in Table 14.

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32 For a full discussion of marginal cost pricing in the water sector, see Palmer Development Group (1999b).

33 See Palmer Development Group (1999a&g).

34 See Palmer Development Group (1999g).

Table 14: The impact of future costs on tariffing approach

Future costs	Impact on approach to tariff setting
Much higher than current costs	• Signalling marginal supply costs very important • Price signals at time of investment important • Recover all costs through volumetric tariff
Moderately higher than current costs	• Signalling marginal supply costs important • Investment price signal focused on large water users • Recover most costs through volumetric tariff
About the same	• Historic average cost approach appropriate • Recover fixed cost components through fixed fees and variable cost components through variable (volumetric) charges
Lower than current costs	• Use historic average costs • Recover most costs though fixed fees • Lower the consumption related tariff

4.5 The impact of climate

The climate, in particular the seasonal rainfall pattern, will influence the overall approach to tariff setting. This is likely to be more important for residential water use than non-residential use. However, there is a justifiable argument to impose seasonal tariffs on all water users as all consumers using water during the peak period contribute to the peak-demand.

The regularity and reliability of rainfall is also important. Where rainfall is irregular, or "regularly fails", some form of drought tariffing may be appropriate as a permanent feature of the tariff (rather than only as an emergency provision).

The likely importance of seasonal and drought tariffing for different areas in South Africa is given in Table 15. The information is indicative only and decisions for a particular WSP will depend on local circumstances with respect to climate, demand and supply.

Table 15: Impact of climate on tariffing approach - some broad guidelines

Climatic zone	Indicative areas	Seasonal tariffing	Drought tariffing
Summer rainfall, cold dry winters	Highveld	Maybe	Yes
Summer rainfall, mild dry winters	Lowveld	Maybe	Maybe
Winter rainfall, hot dry summers	Western Cape	Summer peak-tariffs	As emergency measure only
Year round rainfall, temperate	Eastern Cape	No	Maybe
Year round rainfall, sub-tropical	Natal coastal	No	As emergency measure only
Semi-arid	Karoo	No	Yes

Seasonal tariffing is discussed in 7.1 and drought tariffing in Section 7.3.

5. Setting tariffs - guidelines

Recommended guidelines for establishing the tariff structure and setting the levels for each of the tariff components are presented here in three parts:

- Starting premises
- General guidelines, likely to be applicable to most WSPs
- Guidelines likely to applicable in specific contexts.

5.1 Starting premises

The following premises are followed in presenting guidelines for non-residential water tariffs:

- **Tariff discrimination**. There is a sound basis for discrimination between residential and non-residential tariffs on the grounds of equity. This argument is accepted and endorsed by national water policy in South Africa.[35]
- **Marginal cost tariffing**. The full implementation of marginal cost tariffing is neither feasible nor desirable.[36] The primary reasons for this are as follows: marginal cost tariffing is likely to lead to excessive profits in the context of increasing marginal supply costs;[37] and marginal cost tariffing has unfavourable equity outcomes.[38] It should be noted that marginal cost tariffing has not been fully implemented anywhere in the world.[39] This is not to say that the implementation of aspects of marginal cost tariffing is not desirable nor feasible in certain contexts.
- **Revenue or profit constraint**. WSPs in South Africa will generally have to operate under defined revenue or profit constraints. As a result tariffs will have to set at levels which meet appropriate revenue targets. This fact alone precludes the full implementation of marginal cost tariffing.
- **Cost based tariffing**. Non-residential water tariffs should be based on the costs of supply and should not be subsidised nor excessively taxed. (See Section 3.4.)
- **Uniform tariff for non-residential consumers**. There is no sound rationale for a differential in the standard consumption-related tariff between business, industrial and other non-residential consumers.[40]

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35 Guidelines for residential water tariffing in South Africa are presented in Palmer Development Group (1998d) and Palmer Development Group (1999a).

36 "Full implementation" is defined here as pricing *all* units of water at the marginal cost of supply.

37 If long-run marginal cost pricing is implemented. Large deficits would arise if short-run marginal cost pricing were implemented.

38 See Palmer Development Group (1999ab).

39 See Palmer Development Group (1999g).

40 The differential treatment of residential consumers is based on equity arguments which are not applicable to non-residential consumers. For a full discussion of retail residential tariffing, see Palmer Development Group (1999g).

- **Consumption related tariff**. It is recommended that one uniform volumetric tariff be applied to all non-residential consumers.[41] There is no sound rationale for a block tariff (or a quota type tariff) for non-residential consumers and hence this is not recommended. There is, in fact, a clear rationale for *not* having a block-based tariff where water is used for *productive* purposes rather than *consumptive* purposes, as in the case of residential users. The key reason for this is that the WSA/WSP will wish to encourage *efficiency* in the case of productive usage. Since efficiency is a ratio there is no point focussing on the inputs (water use) unless you are certain you can also measure the outputs in an equally reliable fashion. Since production outputs are difficult to measure, and virtually impossible to compare, it is not practical to implement block tariffs for productive water use. If, however, the policy goal for non-residential water use if not efficiency but simple demand reduction - at all costs and in an indiscriminate fashion - then perhaps it could be argued that an inclining block-based tariff may be an effective tool. Generally though, except perhaps under drought conditions, this would not generally be an acceptable policy goal[42].

5.2 General guidelines for non-residential consumers

The following general guidelines are recommended:[43]

- **Capital development charges - local reticulation**. In general, non-residential consumers should pay for their full share of the capital costs of local reticulation (internal services). The way in which this charge is implemented by WSAs and WSPs in South Africa will vary and the details of this are not the concern of this guideline.
- **Connection charges**. Connection charges should cover, at least, the physical cost of making the connection. There should be standard charges for connections within a reasonable distance from the existing pipe network, followed by a distance-based charge.
- **Fixed fees**. The determination of fixed fees is likely to be different in specific contexts and hence no universal guideline is presented here. It should be noted, though, that monthly fixed fees are the best mechanism to address the issue of *connection capacity* as this is linked to the diameter of the connection. This is dealt with in the specific guidelines that follow.
- **Volume discounts**. There is no rational to provide volume discounts to industrial consumers. Tariffs should be based on cost.[44]

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41 Both "soft" (social) and "hard" (economic) rationales are likely to be put forward in defence of tariff discrimination. The soft rationale for price discrimination is not defensible, given the principle that there should be no hidden subsidies. The hard rationale for price discrimination is not defensible in most instances because cost differences are unlikely to be significant. In fact, the marginal costs of implementing more complex pricing systems than simple average costs are likely to outweigh the marginal benefits.

42 See also Palmer Development Group (1999g) and the case studies in Appendix C: Benchmarking industrial water use in South Africa; A quota-based tariff system - Paarl; and Block tariffs - the case of Hermanus.

43 These guidelines are universal in the sense that they are likely to be applicable to all or more WSPs in South Africa.

44 See Palmer Development Group (1999g).

5.3 Guidelines where bulk water supply costs are increasing

These guidelines are relevant to water supply areas where future bulk supply costs are expected to be moderately or much higher than current costs. (See Section 4.4.)

In this context, two sets of incentives are important:

- Businesses, and particularly larger water using industries, who are considering making new investments which would result in an increase in water use, should be given the correct signal about the marginal cost of increasing supply capacity. This signal needs to be given at the time that the investment decision is made or executed. In effect, this is a signal to new consumers.
- Existing consumers should be given incentives to use water efficiently and hence make best use of the existing capacity. This may be accomplished in a revenue neutral way by raising the consumption related tariff and reducing fixed fees.

The following approach for implementing these signals is recommended:

- **New development charges**. New development charges, which reflect the cost of new supply capacity development (for the whole system and not just the distribution infrastructure) should be implemented. The charge should be based on the diameter of the connection (which is a good proxy for maximum demand on the system) and implemented at the time of connection. A more detailed discussion of these charges is given in Section 7.1.
- **Volumetric tariff**. All remaining costs from non-residential consumers (or as much as is practicable) should be recovered through a volumetric tariff as this will maximise the incentive to use water wisely.

5.4 Guidelines where bulk water supply costs are constant

Where future water supply costs are estimated to be the same as current costs, the issue of new development charges is not so important. The following two guidelines are proposed:

- **Fixed fees**. These should be related in magnitude to the fixed costs for the WSP. In the case of a retail WSP, this would exclude the bulk water purchase costs which can be regarded as a variable cost.
- **Volumetric tariff**. These should be related in magnitude to the variable costs of the WSP. In other words, the revenue derived from the volumetric tariff should cover the WSPs variable costs. In the case of a retail WSP, these would include the purchase of bulk treated water from the wholesale provider.

5.5 Guidelines where bulk water supply costs are decreasing

Where future water supply costs are estimated to be the lower than current costs, the issue of new development charges is not important. The following guidelines are proposed:

- **Increasing fixed fees and reducing the volumetric tariff**. The WSP could give consideration to deriving a higher proportion of revenue from fixed fees and a

lower proportion from the volumetric tariff (compared to the case in Section 5.4). This will have the effect of lowering the unit volumetric tariff.

- **Connection fees**. The WSP could give consideration to reducing connection fees to below cost.

6. Consultation and evaluation

6.1 Evaluation of impacts before approval and implementation

Once the tariff structure and tariff levels have been decided upon, it is important to evaluate the likely impact of any tariff reforms. The following impacts should be examined:

- Likely changes in water use.
- Likely changes in revenue.
- Likely changes in monthly bills for a range of consumers.
- Likely impacts of capacity utilisation, load factors and other relevant performance measures defined in Sections 2.8.8 and 3.5.

In the light of this evaluation, refinements to the tariff reform proposal should be made. A good example of such an analysis is provided by the Los Angeles tariff reform process (City of Los Angeles, 1992).

6.2 Getting political approval

The following factors need to be considered during the tariff approval process:

- **Formal approval process**. Statutory (or more likely provincial ordinance) requirements have to be followed. These differ from place to place and should be identified as part of the context. Usually they involve the WSA approving the tariffs, publishing them for comment in a recognised local newspaper, with a notice period (usually 30 days) for people to comment or object, followed by final implementation.
- **Informal consultation**. Beyond the formal steps, there is obviously a need for a more informal process of interaction between officials and politicians. The politicians have to defend the tariff reform. The better informed they are the more confident they will be in 'selling' the tariff reforms. The better the interaction between officials and politicians (time and quality), the better the chance of winning political approval for tariff reform.
- **Internal coherence**. A key element in winning acceptance for tariff reform proposals is the level of internal communication within the organisation. That is, getting the Finance, Engineering, and Marketing (Communications and Community Relations) groups to talk to each other and agree on process and strategy.
- **Stakeholder consultation**. The stakeholder analysis conducted during the context phase will enable the tariff reformer to identify key stakeholders. The impact of the proposed tariff reforms on individual stakeholder interests should be considered and stakeholder management strategies should be developed. For instance, in cases where impacts are likely to be adverse meetings could be held with stakeholders to inform them of the logic underlying the proposed changes

and their possible courses of action. A key factor which will influence consumer resistance is the scale of change. Consumers are only likely to respond vigorously if there are major changes. By identifying the interests of key stakeholders (and their power bases) the tariff reformer should be able to develop strategies to accommodate or counteract these interests, and thereby maximise the chance of successful tariff reform.

6.3 After implementation

Once the tariff has been approved (see Section 6.2) and implemented, it is sensible to evaluate actual performance against predicted performance. Given this information tariffs can be refined to better achieve the defined goals. It should be borne in mind that some impacts of tariff reform are only likely to be felt in the longer term (see Section 2.8.9). A good example of an analysis of tariff reform impacts over a longer period of time is presented in Martin *et al* (1984). Although a longer term view is important, this does not negate the validity and importance of examining shorter term impacts (say, over a period of six months to a year).

6.4 Things to watch out for

The following points highlight circumstances where tariff reformers should take particular care:

- **The dangers of radical tariff changes**. Radical tariff changes are much more likely to lead to consumer resistance than gradual changes. See, for example, Martin *et al* (1984). Phased increases over a number of years may be much more politically win-able than
- **Dealing with special constituencies**. Where tariff reforms will result in large changes for certain constituencies special care should be taken to accommodate or counteract any potential resistance. (See Section 6.2.)
- **Cross-subsidies and their pitfalls**. It is tempting to make extensive use of cross-subsidies. Small cross-subsidies can easily give rise to larger ones over time with consequent negative equity and incentive impacts. Tariff reformers should take care to quantify cross-subsidy effects and make these transparent during the decision-making process.
- **Increasing complexity as a result of special cases**. It is easy for "special cases" to multiply, adding to administrative complexity and cost. (See Section 2.5.4.)
- **Effluent tariffing**. Effluent tariffing should not be neglected. Many of the principles are the same and the review of water tariffs presents a good opportunity to review effluent tariffs at the same time.

7. Some tariff refinements

7.1 New development charges

This discussion is based on the Case Study presented in Appendix C.

Rationale. The motivation of implementing new development charges (NDCs) is to signal the marginal cost of developing new water supply capacity.

Applicability. New development charges make sense in a context where urban water demand is increasing and the costs of constructing additional bulk water supply capacity is much greater than historical costs.

Calculation. New development charges could be calculated as follows:

- Determine the base water demand from which the increase in demand will be measured.
- Estimate the increase in demand over the period of analysis (say 20 years).
- Identify and estimate the costs of the (least cost combination of) projects required to meet the increase in demand (= "new project costs").
- Calculate the new demand charge which is equal to the present value of the "new project costs" (R million) divided by the total projected quantity of *new* demand at the end of the period of analysis (million kl per annum) multiplied by 100. The present value of the "new project costs" should be adjusted by subtracting the present value of the future contribution to capacity expansion made through the normal tariff (though debt repayments, pay-as-you-go or depreciation). This avoids double payment for capacity expansion.[45] The new demand charge is therefore a charge based on the additional annual capacity required by the new demand, that is, cents per kl per annum of addition capacity required. Thus the actual charge in a specific application may be calculated by multiplying the NCD charge (c/kl per annum) by the new demand (kl per annum) divided by 100 to get Rands per annum.

Application. New development charges can be applied in a number of different ways:

- **A. Surcharge on wholesale tariff**. Wholesale WSPs can levy NDCs on Retail WSPs as a surcharge on top of the wholesale water tariff. Typically the charge will be as a c/kl charge on all "new demand", that is, demand in excess of some defined baseline demand. In this case the NDC is calculated and applied by the Wholesale WSP.
- **B. New consumer connection charge**. The NDC can be levied on new consumers at the time they connect to the system. In this case, the charge will be based on the estimated additional annual demand that will result from the new connection. This could be based on connection diameter. For example, the agency could assume that each additional standard commercial 18mm connection adds an annual usage

[45] An example of such an adjustment is provided in MWD (1996).

of (say) 360 kl per annum. Hence if the new development charge is (say) 600 c/kl, then the new development charge applied to each new connection would be R2 160. In the case of an industry, if the new demand was (say), 36 000 kl per annum, then the new development charge would be R216 000. This is a once-off charge which pays for the costs of the capacity expansion necessary to meet the new demand. Ongoing costs of supplying the water are recouped through the normal tariff.

- **C. Surcharge on retail tariff for new demand**. This application is similar to the surcharge on the wholesale tariff, except it is implemented at the retail level. The charge is levied on all existing consumers and applied only to the increase in demand over some defined baseline.

Equity and the incidence of the payment burden. The distribution of the burden of payment for new capacity costs has important implications for equity and income distribution. This is particularly the case in South Africa. If much of the new demand for water arises from "RDP-type" programmes which extend access to water resources to poor households, then shifting the burden of new capacity expansion costs onto these households reverses the initial redistribution in favour of these households.[46]

A case for selectivity. A strong case has been made for dealing with equity and efficiency issues related to domestic water tariffing at the retail level (see Palmer Development Group, 1999b). This argument is premised on the very large inequalities in water access and consumption between households in South Africa. In this context, there is a strong argument for a *selective application* of the concept of new development charges to commerce and industries *at the retail level* (that is, options B and C and not A). There are strong efficiency arguments which would support the implementation of new development charges to increased commercial and industrial water use arising from new consumers connecting to the system (B), or existing consumers increasing their demand (C).

Dangers and limitations. Implementing new demand charges like this does have pitfalls, as evidence by the Californian experience (presented in the Case Study in Appendix C). Institutional capacity limitations may make it difficult for WSPs to implement such a dual tariffing strategy effectively, especially amongst existing consumers. (It is reasonably easy to apply a new development charge to new connections.) Furthermore, WSPs may be reluctant to apply these charges to commerce and industry if they fear that businesses might relocate or that these charges create disincentives for new investment.

7.2 Seasonal tariffs

Rationale. To signal to those users who contribute to seasonal peaks the costs of the additional capacity requirements resulting from peak seasonal demands.

Applicability. Where demand is distinctly seasonal and where this impacts on system capacity and hence costs of supply.

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46 This initial redistribution occurs through subsidies for the water distribution infrastructure.

Calculation. Based on the marginal cost of bulk water supply development (peak seasonal demand) and the extra capacity costs for the transmission infrastructure (treatment capacity, pumping and pipelines) associated with peak-day demand.

Period of application. Applied over period of high demand.

Nature of seasonal tariff. Usually a volumetric tariff. Can be applied either to all units of demand in the peak season, or to the additional demand (compared to some defined off-peak baseline demand).[47]

Examples. Case studies of seasonal tariffing in the cities of Los Angeles, Phoenix and Tucson (all in the United States of America) are presented in Appendix C.

7.3 Drought tariffs

Rationale. To signal water shortages to consumers and to create incentives for consumers to conserve water in proportion of the extent of the water shortage.

Applicability. During declared water shortages. The tariff could be a permanent feature, but only become operational when a water shortage is declared.

Calculation. The degree of water shortage should be declared (for example, 10%, 20% etc.). The increase in the tariff is proportional to the declared water shortage and calculated so that the monthly payment for water remains the same if the desired water conservation target is achieved. (Thus the tariff is based on an estimate of the price elasticity of demand.)

Application. To all consumers during the period of declared water shortage. The tariff could be applied to (1) all units of consumption in all seasons; (2) to all units of consumption during the peak season period; or (3) to the additional demand during the peak period only. There is an equity argument for differential application of drought tariffing to residential consumption below a specified consumption threshold.[48]

Example. An example of drought tariffing is presented in Appendix C.

7.4 Commodity price-linked tariffs

Rationale. Cases where large, water-intensive industries face significant commodity price cycles and wish to reduce the risk of insolvency during cyclical lows by linking their revenue stream to their input costs.

Applicability. Commodity price-linked tariffs may be desired by industries which export into global markets, such as the pulp and paper industry. Such deals are invariably customer-specific, and would only be warranted in cases where water forms a substantial component of input costs.

Calculation. Commodity price cycles are typically of the order of 10 years in length, and hence these deals should take a long term view (such as 20 years). Such a deal would generally be based on the movement of a well recognised commodity price

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47 There is no consensus in the economics literature as to which is most appropriate. See Palmer Development Group (1999b).

48 See Palmer Development Group (1999a).

index related to the customer's product. The anticipated average tariff level over the period of the deal should be similar to the expected average tariff level for all consumers. Since these deals effectively entail the transfer of risk from the industry to the WSP it may be appropriate for the WSP to earn some return for bearing this risk. The establishment of such deals is a very complex exercise, requiring teams of financial experts, and is well beyond the scope of this guideline.

Application. Commodity price-linked deals have been pioneered by the electricity supply industry. This project has found no evidence of such deals within the water sector, either locally or internationally. This may be due to the fact that electricity typically forms a much larger proportion of industry input costs than water, and hence there are lower incentives to structure such deals within the water sector.

8. Concluding remarks

In many cases the existing tariffs may be quite different from the desired tariffs. Hence, it is important that the *process* of tariff reform is given adequate attention. Some cautionary points are made below in relation to this process.

Start with the status quo. Tariff reform must start by understanding the nature and origin of existing tariff structures and levels. It is generally not possible nor desirable to wipe the slate clean and start afresh. It is for this reason that this guideline has placed so much emphasis on "understanding the context" and on establishing the goals of tariffing reform in relation to practical indicators of existing performance.

Incremental reform is more likely to succeed. In general it is recommended that WSAs and WSPs follow an incremental approach to tariff reform. Where large changes in the tariff structure or level are required it is recommended that these be implemented over a number of years. However, there may be exceptional instances where a more radical approach to tariff reform is both politically feasible and desirable.

Follow an iterative process. The tariff reform process advocated in this guideline is an iterative approach. That is, as incremental reforms are implemented they should be assessed against the performance goals that were set in previous cycles. This enables progress to be measured and estimates to be adjusted, such as price elasticities. Any unexpected results which show up in evaluations should be examined in greater detail.

Improve input data. Existing data may not provide an adequate basis for tariff reform. Ongoing improvements to the reliability and accuracy of available data should be undertaken to enhance future tariff reform processes.

Use spreadsheet models for scenario and sensitivity analysis. Spreadsheets provide a useful tool for scenario analysis. For example, where significant changes in tariff levels are planned over a period of time, different price-elasticity assumptions can be used to test the sensitivity of revenue projections to consumer demand responses. Tariff reformers may either develop their own models or utilise existing models such as the Water Research Commission's Water Supply Services Model (WSSM) which has been specifically designed for this purpose (Palmer Development Group, 1998f).

Take institutional constraints into consideration. Tariff reformers should always think through the practical implications of policy proposals and check to ensure that they are implementable.

Link tariff reforms to other measures. It must be borne in mind that tariffs are only *one* policy measure amongst many which may be implemented to achieve the WSA/WSP's goals. Experience has shown that by linking the implementation of tariff reforms to other programmes, such as informative billing or consumer education programmes, far greater impacts can be achieved.

Focus on efficiency of use, rather than level of use. Lastly, it should always be recognised that industrial and commercial consumers generally do not consume water as an end goal in itself, but for the purpose of producing products and services to meet the demands of their own customers. Consequently there are factors to take into

account which are beyond the control of either the WSP or the industrial or commercial consumer. WSPs should therefore focus on the *efficiency* with which industrial and commercial consumers utilise water, rather than the absolute level of use, by establishing appropriate tariffs and by complementing these with appropriate education programmes.

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Appendix A

National Raw Water Pricing Policies and Practice

This summary of the national raw water pricing policies and practice in South Africa is extracted from Palmer Development Group (1999g).

Water use rights

A key principle underlying South Africa's water law, as embodied in the new water act (National Water Act of 1998) is that there shall be no private ownership of water, but only a (proscribed) right to use.[49] The principle motivation underlying this approach is the desire to improve and safeguard equity in access to water (DWAF, 1997a).

This marks a fundamental shift from past policy is two respects. First, water rights have been separated from land ownership. Second, a water right is limited to a "use right" (water is deemed a common property resource owned by the people of South Africa as a whole and managed by the national government, acting as public trustee).[50]

Both of these changes have profound implications for the management of water resources in South Africa. The decision to alienate water rights from land rights is a sound one. The "common pool" approach to water is more controversial. Agencies such as the World Bank strongly favour the privatisation of water rights (that is, outright ownership of the rights to water by private parties), however, the literature on this issue is far from unanimous. It may be argued that where inequalities are significant and politically important (which is certainly the case in South Africa), then a pure market approach to water is inappropriate. This is not to say that "market forces" should not play a role in the allocation of water. The South African government has taken the view that privatised water rights will not adequately protect and enhance the public interest. This is an entirely legitimate view which is upheld by many countries including Israel, Canada, France and other OECD countries.

This approach has important implications for industrial (and commercial) water use. Industries do not have the right to purchase water rights in perpetuity. Furthermore, the rights that industries have to water use remain subject to social evaluation and are not predicated solely on the ability (or willingness) to pay for these rights.

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49 Principle 3 of the Fundamental principles and objectives for a new water law for South Africa (DWAF, 1997a).

50 Previously, South Africa's water law was based on (an uncomfortable and complex combination of) the principle of riparian rights and the doctrine of prior appropriation ("first in use, first in rights").

Allocation priorities and the concept of "the reserve"

Three further principles were of fundamental importance in the development of the new water law. These principles have to do with the priority of water allocation for two specific purposes: basic water needs and ecological sustainability. The principles are stated as follows:

- The water required to ensure that all people have access to sufficient water shall be reserved.[51]
- 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.[52]
- The water for basic needs and the environment (as defined above) shall be identified as "the Reserve" and shall enjoy priority of use.[53]

The motivations underlying these three principles are two fold: a desire for equity (primarily in the form of protecting poor people and their right to have access to an affordable basic amount of water), and a recognition of the need for ecological sustainability.

The philosophical assumption here is that these two uses should not be subject to economic or market evaluation.

The impact of this policy is to reduce the availability of water for other purposes.

Water allocation and the concept of "optimal beneficial use"

The policy with respect to the allocation and use of water not included in the Reserve is governed by the following three principles:

- **Equity**. Water resources shall be apportioned in such a manner as to enable all user sectors to gain equitable access to the desired quantity, quality and reliability of water.[54]
- **Demand management**. Conservation and other measures to manage demand shall be actively promoted as a preferred option to achieve these objectives.[55]
- **Optimal beneficial use**. The objective of managing the quantity, quality and reliability of the nation's water resources is to achieve optimum, long term,

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51 Principle 8 of the Fundamental principles and objectives for a new water law for South Africa (DWAF, 1997a). This is directly linked to Principle 25: "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" (DWAF, 1997a).

52 Principle 9.

53 Principle 10.

54 Principle 14.

55 Principle 14.

environmentally sustainable social and economic benefits for society from their use.[56]

The *White Paper* defines "beneficial use" as the use of water for productive purposes. Where there is competition for the same resource, then beneficial use must be optimised. The white paper defines this as "beneficial use in the public interest" or, more simply, "optimum" or "best possible use". This requires social benefits to be weighed with and against economic benefits.

According to the Act, the predominant mechanism for allocating water between uses and users will be administrative, at least in the near to medium term. This does not mean that economic factors will be unimportant in the allocation of water. For example, provision is made in the Act for the possible auctioning of water-use licences. Also, administratively levied resource charges may reflect the opportunity cost of water or provide signals as to the economic (or "scarcity") value of water in a particular catchment.

The Act requires multiple-criteria decision making with respect to the allocation of water between different uses and users. Apart from the reserve set aside for basic needs and the environment (which is prioritised and has first claim on the resource), no guidelines are given as to how water should be allocated in terms of these criteria. In practice, difficult choices between competing uses with both economic and social benefits may have to be made. It is not clear how these benefits will be weighted of how rational decision making will be facilitated. In particular, the concept of "optimal beneficial use" remains devoid of any meaningful content in an operational context.

Administration of water allocations and regulation of water use

Water use entitlements and authorisations. The Water Act specifies certain water use entitlements. These entitlements relate to non-commercial human uses of water and do not pertain to industrial and commercial water use.[57] Apart from these water entitlements, water use must be licensed or authorised. Certain constraints are imposed by the Act on water use.[58] Where existing entitlements or uses are constrained or expropriated, users are entitled to compensation.[59]

Subject to the national water resource strategy, the Director-General may determine the total quantity of water which a responsible authority may allocate under a general authorisation or licence from water resources in its water management area. In making this determination, the Director-General must take account of the water available in the resource.

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56 Principle 7.

57 Specific details pertaining to these use entitlements are set out in the National Water Act.

58 In terms of the Act, South Africa's water resources must be used, conserved and managed in accordance with the national water resource strategy. In particular, water use is constrained by the requirements of the (environmental and basic needs) Reserve, international rights and obligations, making adequate provision for projected future water needs and water use of strategic importance.

59 The principles governing compensation are set out in the act and are subject to the Constitution. Losses arising from the reduction in the original entitlement made in order to provide for the Reserve, rectify an over-allocation of water use from the resource in question, or rectify an unfair or disproportionate water use will be disregarded for the purposes of evaluating the compensation claim.

Regulation of water use. The Minister may regulate water use by restricting the purpose or extent of water use; requiring monitoring of water use and waste discharges; requiring that water uses be registered; prescribing norms and standards for waterworks; regulating activities so as to protect a water resource, prescribing standards for waste which may be discharged into a water resource; prescribing management practices to be used to treat waste discharges; prescribing procedural requirements for licence applications; and prescribing procedures for the allocation of water by means of public tender or auction.

These regulations may differentiate between different water resources (or classes of water resources) and different geographical areas. The Minister must take into account all relevant considerations, including the need to promote the economic and sustainable use of water; conserve and protect water resources, in-stream and riparian habitat, or coastal marine waters; prevent wasteful water use; facilitate the management of water use and waterworks; facilitate the monitoring of water use and water resources; and facilitate the imposition and recovery of charges.

General water use authorisations and licences. The Act specifies that all relevant factors must be taken into account, including existing lawful water uses; the need to redress the results of past racial and gender discrimination; efficient and beneficial use of water in the public interest; the socio-economic impact of the water use; any catchment management strategy applicable to the relevant water resource; the likely effect of the water use authorisation on the water resource and on other water users; the class and the resource quality objectives of the water resource; investments already made and to be made by the water user in respect of the water use in question; and the strategic importance of the water use to be authorised.

Transitional phase. Provision is made in the act for a transitional phase. An existing lawful water use, with any conditions attached, is recognised but may continue only to the extent that it is not limited by the Act. No licence is required to continue with an existing lawful water use until a responsible authority requires a person claiming such an entitlement to apply for a licence. If a licence is issued it becomes the source of authority for the water use. If a licence is not granted the use is no longer permissible.

The requirement that almost all water use be licensed places a significant burden on the agencies responsible for overseeing and managing the licensing of water use.

Raw water pricing policy and practice

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,[60] ecological sustainability, financial sustainability[61] and economic efficiency.[62] The national water

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60 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.

61 *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.

62 *Economic efficiency* is interpreted to mean pricing water so as to reflect its scarcity value and the opportunity cost of alternative uses. Economic incentives can be used to encourage water conservation and to shift water use from lower to higher value use.

pricing strategy asserts that each of these principles is of equal importance (DWAF, 1998).

The Cabinet decided in February 1996 that the tariff 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 an *economic charge* ($P_{resource}$) reflecting the scarcity value of water be introduced in water stressed areas. (This charge is the economic (or social) value attached to the "water use license" or the "water use right".) 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. Various studies are underway to determine the likely order of magnitude of this charge in different catchments in South Africa. The quantification of the value of the resource is very dependent on the determination of the reserve and the methodology employed.

It is intended that the *resource management charge* (that is, catchment management fee, P_{cm}) 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. Catchment management fees have not been implemented yet. Work is underway to ascertain the order of magnitude of these costs.

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). It is intended that the assets will be depreciated 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.[63]

For urban and industrial users it is mostly the case that the costs of infrastructure development and operation are substantially borne by the user. The qualification "substantially" is important because, although the policy was one of "full" cost recovery, in practice infrastructure costs tended to be subsidised by the national budget as a result of the interest rate policies employed and the way in which inflation

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

was accounted for.[64] Financial costs related to infrastructure are likely to increase for urban and industrial users as a result of two factors: changes in financial cost accounting practices (moving from a funding approach to a return on asset approach) and the increasing costs of new development. The timing of these changes will differ for individual schemes depending on the nature of existing agreements (see below).

Existing agreements. In many cases long-term contracts exist whereby large domestic and industrial users (such as metropolitan governments and Eskom) pay DWAF for water supplied on a basis other than unit cost tariffs. Payments under these circumstances typically include an annual capital payment, O&M payments, and payments for capital improvements as they occur. It is likely that the agreements with different users regarding payment for water will be kept in place for the next few years. In the mean time, unit costs will be calculated (as per the new cost determination policy) for each agreement until such time that the agreement is re-negotiated and a water tariff reinstated on the basis of unit costs.

Assurance of supply. In principle, it is the intention that large industrial users requiring a high assurance of supply (such as Eskom and Sasol) should pay a premium for this.

Tariff smoothing and pre-financing. The implementation of tariffs to recover infrastructure costs will done in accordance with the goal of having stable tariff increases over time. The principle of pre-financing future schemes through a levy (as has been done for the Lesotho Highlands Phase 1 scheme) is accepted.

Pollution charges have not been implemented yet. At present, water uses discharging waste into a water resource require a licence. The cost of the licence does not reflect the economic value of the damage caused by the wastewater discharge. The policy, strategy and practice related to pollution charges remains severely under-developed in South Africa. This is a critical area which requires urgent attention.

Basic needs subsidy. The basic needs subsidy consists of waiving the resource charge for the water required for basic needs (25 lcd) in each catchment, calculated on the basis of the current population in the catchment. The strategy document (DWAF, 1998) is ambiguous as to whether the first tier infrastructure costs and the catchment management fee are also waived for the water allocated to meet basic needs. It is the intention that the "economic users" of the water in the system bear the cost of the basic needs subsidy, that is, the basic needs allocation is considered to be a system cost.

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64 The following background information comes from a draft input in the DWAF tariff policy review process: "DWAF has been operating and managing a collection of 120 government water supply schemes which were historically funded by the Department of Finance through DWAF budget provisions. Although this practice has remained largely unchanged up to now, the long-term goal for DWAF is to become financially independent by raising its own financial requirements for water supply infrastructure. The financial costs of tapping new water supplies are increasing dramatically: the average cost of most new projects is expected to be two to three times that of existing investments. Government water supply schemes currently operate financially under the Trading Account of Government Water Supply Schemes. This is a departmental account consisting of a pool of revenue funds from raw water sales by DWAF and disbursements (payments) related to operations and maintenance (O&M) expenditures, upgrading, and betterments. The Trading Account includes all overheads of regional and area offices, but excludes DWAF head office costs which are covered by DWAF's treasury budget allocations. At the end of each fiscal year surpluses on the Trading Account are transferred to Treasury since the State provided funding for the capital projects on DWAF's annual budget and the State is therefore entitled to the surplus funds on the Trading Account. The Trading Account also includes cross-subsidisation of some irrigation, small domestic and industrial water supply schemes which are unable to cover their operations and maintenance expenditures."

Phased approach. The incremental approach being adopted by the national government to first tier pricing is essentially sound. The priority is to move to full financial cost recovery of infrastructure costs (including resource development planning) and to implement a catchment management fee which reflects actual resource management costs. Over time, a resource (economic) charge will be implemented to reflect the scarcity value of the water and its opportunity costs in specific catchments.

Using markets. In principle, the use of markets to determine the value of licences for "water use rights" has not been excluded. The intention is to explore the efficacy of such a route in a cautious manner. Again, this is a sound approach. Advocates of water markets, such as the World Bank, tend to underplay the complexities, high transaction costs and potential negative equity impacts of water markets. Very few countries have extensive well-functioning water markets. A cautious approach in this difficult area is fully warranted because it is much harder and more costly to move from a market system of water allocation to an administrative system compared to the other way round.

Implications for industrial water tariffs

Compared to most OECD countries, South Africa's water resource policies appear to be "ahead of the game". South Africa is in the process of implementing a rational system which seeks to balance equity, sustainability and equity objectives. The economic value of the water resource is recognised in tandem with the need to protect the environment.

A possible weakness of the approach is that it is too reliant on administrative allocations. Institutional capacity constraints may limit the efficacy of the policy. A further weakness is that the allocation criteria are not transparent (there is no clarity on exactly how allocations will be decided).

The implications of the policy for industry are three-fold. First, industries will be required to pay for the right for water use. Second, industries will have to pay towards the costs of catchment management costs. Third, infrastructure costs at the first tier level will increase as a result of the new accounting policies (revaluation of assets) and the steeply rising marginal costs of supply. Of these, the impact of increased infrastructure costs at the first tier level is likely to be most significant.

Appendix B

Calculation of Average Incremental Cost

Source: Palmer Development Group (1999b)

The Average Incremental Cost (AIC) of water supply is calculated by discounting the future incremental costs by the discounted volume (present value) of the water produced (or sold).

AIC = Present value of least-cost investment stream (PVIS) / present value of future water sales arising from the capacity increase (that is, discounted volume) (PVQ)

where

$PVIS = \sum_{t=1 \text{ to } T} [((R_{t+n} - R_t) + I_{t+n-1}) / (1 + i)^{n-1}]$

$PVQ = \sum_{t=1 \text{ to } T} [(Q_{t+n} - Q_t) / (1 + i)^{n-1}]$

R_t = operations and maintenance expenditure in year t

Q_t = water produced in year t

I_t = capital expenditure in year t

T = number of years for which water expenditures and attributable output are forecast

i = discount rate

This method can be further refined by categorising capital expenditures into those associated with water volume (such as treatment plants, service reservoirs, trunk mains and source development) and those not associated with water volume (such as distribution mains, meters and customer services). The latter capital expenditures are primarily related to customers served and should not be included in marginal capital cost calculations to be used as the basis for unit rate calculations (commodity charges).

Appendix C

Case studies: Commercial and industrial water tariffs

These case studies have been taken from Palmer Development Group (1999g).

Paying for new development costs – Southern California

Urban growth contributes significantly to increased water demand in California and the costs of constructing additional bulk water supply capacity is much greater than historical costs. In this context, the Metropolitan Water District of Southern California (MWD), which has the responsibility of providing bulk water supplies to its member agencies, commissioned a study to examine the issue of how the burden of future development costs should be shared.[65] This issue is highly pertinent to South Africa which has high capacity expansion costs relative to historic costs.[66]

The commissioned study (MWD, 1996) recommended the implementation of a "new demand charge" to be charged as a c/kl charge on new (that is, increased) water demand in the MWD's distribution system. The report states that "the charge is intended to recover the corresponding capital costs of the projects needed to provide the capacity to service new demands. Fundamentally, the charge is equal to [the MWD's] cost of meeting new demands divided by the projected regional increase in demand" (MWD, 1996: 1-3).

The new demand charge is calculated as follows:

- Determine the base water demands from which increases in demands will be measured (the higher of the either the readiness-to-service base capacity or the four-year moving average actually supplied to each member agency).[67]
- Estimate increases in regional demands based on projections of demographic and economic growth (and future water tariff increases) for each member agency.
- Identify and estimate the costs of the (least cost combination of) projects required to meet the increase in demand (= "new project costs").
- Calculate the new demand charge (c/kl) which is equal to the present value of the "new project costs" (R million) divided by the total projected quantity of new

65 The MWD acts as a wholesaler of water, supplying supplemental water to its member agencies (who own and manage the MWD) making up short-falls in their own "local" supplies. The MWD imports water from the Colorado River and the Californian State Water Project. The MWD has 26 member agencies.

66 For example, the cost of water from the Lesotho Highlands Water Project (feeding the Vaal Dam) is some five times the average historic cost of water supplied from the Vaal Dam.

67 The MWD's customers are bulk purchasers of water (not individual consumers of water), that is, they themselves are WSPs such as the Los Angeles Department of Water and Power.

demands at the end of the (25 year) period of analysis (million kl per annum) times by 100.[68] The present value of the "new project costs" is adjusted to account for the present value of the future contribution to capacity expansion made through the normal tariff (though debt repayments or pay-as-you-go). This avoids double payment for capacity expansion.[69] The new demand charge is therefore a charge based on the additional annual capacity required by the new demand, that is, cents per kl per annum of addition capacity required.

The net effect of the new demand charge is that two charges are levied by the MWD to its bulk customers:

- the normal water tariff (c/kl) x the actual water purchased each month.
- the new demand charge (c/kl) x the new demand, where new demand is the actual demand less the base demand. This charge, once incurred by a member agency, is payable over a period of 15 years.[70]

Unfortunately, the details of the calculation of the normal water tariff is not specified in the report (MWD, 1996). Presumably the average charge is calculated simply as the annual revenue requirement (less the revenue received through the new development charge) divided by the predicted water sales. (The MWD is wholly owned by its 26 member agencies and hence it is likely that the MWD is not allowed to generate a surplus.)

The calculated new demand charge was approximately four times the normal water tariff. The rationale of the new development charge is to create an incentive for member agencies to maintain their water demand at current levels or to minimise the increase in new water demand so as to avoid the payment of the new demand change.

The report suggests an approach whereby MWD's member agencies could recoup this development charge from its consumers. (The MWD also recognised that member agencies may wish to recoup the charge through an increase in the average water tariff levied on consumers.) According to this approach, the member agency estimates the average annual consumption of different connection types. For example, the agency could assume that each additional standard residential 18mm connection adds an annual usage of (say) 360 kl per annum. Hence if the new development charge is (say) 600 c/kl, then the new development charge applied to each new connection would be R2 160. In the case of an industry, if the new demand was (say), 36 000 kl per annum, then the new development charge would be R216 000. This is a once-off charge which pays for the costs of the capacity expansion necessary to meet the new demand. Ongoing costs of supplying the water are recouped through the normal tariff.

It is important to correctly attribute the increased demand between new and existing consumers. Where existing consumers increase their demand, they should carry a proportionate share of the new demand charge.

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68 MWD used a discount rate of 7% based on a five year historic average of the 30-year treasury bond rate.

69 Details of this adjustment are provided in MWD (1996).

70 This period corresponds to the average weighted life of MWD's outstanding long-term debt. The outstanding debt related to the new development charge incurs interest set at the weighted average cost of capital to MWD.

In some cases, member agencies may already implement a capacity related development charge. In this case, the MWD's new demand charge can be added to the existing charge (as it in effect represents a new capital outlay on the part of the member agency which is paid to MWD). The revenue of these charges should be balanced against the actual expenditures incurred.

Notwithstanding the clear rationale for the new development charge, the implementation of this policy has not been successful. The policy had two unintended consequences (as viewed by the MWD). First, the member agencies attempted to avoid the marginal cost fee by embarking on alternative and more costly water projects (than that which could be provided by MWD) which the MWD regards as inefficient. Second, the water infrastructure to cater for the new development is provided for anyway by the MWD, but the water sales did not materialised to pay for this infrastructure. This is also regarded as inefficient by MWD. The most compelling reason for suspending the tariff, namely the resistance to the charge expressed by property developers and the construction industry, was left unstated. As a result of these factors, the new development charge was suspended and is under review (Wodraska, pers comm., 1998).

On the basis of the outline of the implementation of a new demand charge in California given above, the following implications can be derived for South Africa:

- **Intention versus result**. Although the intention of the policy was sound, namely to provide price signals which reflected the high cost of new capacity expansion, the implementation was not successful. It appears that the primary reason for this was the failure to take into account the potential political and social ramifications of the policy prior to its implementation.

- **Equity and the incidence of the payment burden**. The distribution of the burden of payment for new capacity costs has important implications for equity and income distribution. This is particularly the case in South Africa. If much of the new demand for water arises from "RDP type" programmes which extend access to water resources to poor households, then shifting the burden of new capacity expansion costs onto these households reverses the initial redistribution in favour of these households. [71]

- **A case for selectivity?** A strong case has been made for dealing with equity and efficiency issues related to domestic water pricing at the retail level (see Palmer Development Group, 1999b). This argument is premised on the very large inequalities in water access and consumption between households in South Africa. In this context, there is a strong argument for a *selective application* of the concept of new development charges to commerce and industries. There are strong efficiency arguments which would support the implementation of new development charges (along the lines implemented by MWD) to increased commercial and industrial water use arising from new consumers connecting to the system, or existing consumers increasing their demand.

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[71] This initial redistribution occurs through subsidies for the water distribution infrastructure.

- **Dangers and limitations**. Implementing new demand charges like this does have pitfalls, as evidence by MWD's experience. Institutional capacity limitations may make it difficult for WSPs to implement such a dual pricing strategy effectively, especially amongst existing consumers. (It is reasonably easy to apply a new development charge to new connections.) Further, WSPs may be reluctant to apply these charges to commerce and industry if they fear that businesses might relocate or that these charges create disincentives for new investment.

Industrial and commercial water pricing in Los Angeles

Los Angeles has a population of 3.7 million and is situated in a water resource poor area. In the past, Los Angeles has been able to surmount its water shortage problems and make available plentiful and cheap water to its residents and industries. This legacy is coming to an end, however, and the water agencies and consumers are being forced to face the consequences of water becoming an increasingly scarce and expensive resource.[72]

In view of the fact that there are some similarities in the situation with respect to water resources in Los Angeles and some South Africa cities (especially in Gauteng), it is pertinent to examine the water pricing policies in Los Angeles as a whole, and more specifically, the particular forms that industrial and commercial water tariffs have taken.

Water is managed by the Los Angeles Department of Water and Power (LADWP).[73] The LADWP manages its own bulk water supplies (local groundwater supplies, two aqueducts from Owens Valley and an extension to Mono Lake) and purchases supplementary bulk water from the MWD.[74] The water from the MWD is more expensive than its own water sources.

In response to a significant drought in the period 1986 - 1991, a fundamental review of water tariff policy was undertaken in 1991.[75] The committee agreed to the following ten water pricing objectives: (1) water should be affordable, (2) tariffs should maximise the efficient allocation of resources, rates should be forward looking, (3) tariffs should be stable and predictable, (4) tariffs should be simple and understandable, (5) tariffs must generate adequate but not surplus revenue, (6) tariffs should not include the full cost of growth, (7) tariffs should be equitable across consumer classes, (8) tariffs should not penalise consumers for reducing consumption,

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72 For a brief overview of the history of water supply to Los Angeles, see Palmer Development Group (1999d).

73 Although the LADWP is a department within the City's local government, it is more autonomous than this would suggest and is controlled by a board which is appointed by the Mayor . The relative autonomy of the board and its considerable power and influence have arisen for historical reasons which are discussed in Palmer Development Group (1999d).

74 In good rainfall years, purchases account for less than 10% of total supply. In drought years, purchases can amount to more than 65% of supply. Recent environment related court restrictions have increased the LADWP's reliance on MWD water.

75 The committee, appointed by the Mayor, comprised 24 members and included citizens from all geographic areas and major constituencies in Los Angeles and City government representatives. The committee appointed a Technical Advisory Panel to oversee the work of the appointed consultant who assisted with the development of the proposed tariff structure.

(9) *rates should not discourage potential industrial and commercial development*, and (10) the public should understand the rate setting process. (City of Los Angeles, 1992, own emphasis)

These objectives were refined to five key principles which underpinned the development of the new rate structure in 1993: (1) marginal costs should be the basis of the new tariff structure in order to maximise efficient use, (2) customers should not be penalised for conserving water, (3) *the water tariff structure should not discourage business and industry from locating and staying in Los Angeles*, (4) apartment tenants should be eligible for low-income benefit programmes, and (5) the water tariff structure should ensure that the necessary investments in improving and equalising water quality throughout Los Angeles are made. (City of Los Angeles, 1992, own emphasis)

The LADWP was also a signatory of the 1991 Memorandum of Understanding (MOU) committing participants to the implementation of Best Management Practices for water conservation and which encourage the adoption of conservation pricing.[76]

The goals of LADWP water pricing were restated in 1995 as follows: (1*) to use price as an incentive for efficient water use*, (2) to provide basic water needs at an affordable price, (3) to provide equity among customers (4) to use price to stabilise demand during a water shortage and (5) to generate sufficient revenue for maintaining and upgrading the water system. (LADWP, 1995). These pricing goals represent the typical trade-offs between efficiency, equity and revenue generation typical of water pricing at the municipal level (see Palmer Development Group, 1999b).

The residential tariff comprised a stepped tariff which aimed to protect low-income consumers (through a direct credit system) and discourage excessive use (through a high marginal tariff for the second block. The residential tariff structure is described in detail in Palmer Development Group (1999d).

The non-residential tariff for potable water (applicable to commerce, industry and institutions/government) is shown in Table 16. Industries can also purchase reclaimed water. The price of this water is determined separately for each contract and no further information on this was available.

Table 16: Los Angeles water tariff for commerce and industry ($/kl)

Meter size	Off-peak	Peak season	
		1st tier	2nd tier
< 50 mm	0.60	0.60	1.05
> 50 mm	0.40	0.60	1.05

[76] Conservation pricing is defined as follows in the Best Management Practices: Conservation pricing provides incentives to customers to reduce average or peak use, or both. Such pricing includes: (1) rates designed to recover the cost of providing service; (2) billing for water and sewer service based on metered water use; (3) rates in which the unit rate is constant regardless of the quantity used (uniform rates) or increases as the quantity used increases (increasing block rates); (4) Seasonal rates or excess-use surcharges to reduce peak demands during summer months; (5) Rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system; and (6) Lifeline rates to protect small consumers. (California Council Best Management Practices Retail Water Agency Annual Report, Appendix C).

Source: LADWP. Tariff levels are for 1999.

Wastewater charges for commercial users are based on 90% of metered water usage. They are levied by the LADWP and the revenues are passed on to the Los Angeles Sanitation department which manages the sewer network.

The basis on which the water tariff is structured and the tariff levels calculated are explained in Table 17.

Table 17: Los Angeles – basis for determination of industrial and commercial tariff

Tariff component	Basis for determination	Calculation	Level
Definition of peak and off-peak periods			
Peak usage	Dry summer period	June through October	
Off-peak usage	Wet winter period	November through May	
Determination of first tier quantity			
Off-peak season	All water use is 1st tier		
Peak season	*f* (off-peak usage of each individual consumer)	125% of the average consumption in a sub-set of the previous off-peak season (December through March)	varies by consumer
Determination of first tier water price ($/kl)			
Meter size < 50 mm	Average historical cost of water (AHC)	Net revenue requirements divided by predicted total water usage	$0.60 /kl
meter size > 50 mm	Special deal for larger water users	Price capped to 110% of 1992 level	$0.40 /kl
Determination of second tier water price ($/kl)			
All meter sizes	Marginal cost of supply	Considerable uncertainty as to the correctness of the basis of the calculation (see discussion below)	$1.05
Special deals	High peak usage	5% of usage = 2nd tier[77]	

Key features of the tariff are discussed below.

Calculation of costs. There are several different methods of allocating costs between consumer classes. The three principle methods are average cost, equal percentage of marginal cost and embedded cost. The average cost approach averages total costs across all consumer classes to come up with a uniform unit tariff applicable across all

[77] During the high season months, industrial and commercial customers may be eligible for reduced bills under a special municipal ordinance (General Provision N of Rate Ordinance number 170435) if their consumption for each of two consecutive high season monthly billing periods is more than 200 percent of their winter average consumption (December through March) and is also at least 9 kl/month above their first tier usage block. Customers that qualify are allowed 95 percent of their usage at the first tier rate.

customer classes. The equal percentage of marginal costs approach calculates costs on the basis of the estimated contribution to marginal costs of each customer class. The embedded cost method seeks to allocate historic costs on the basis of estimated contributions to these costs on the part of each customer class.[78] The committee found that the difference between these methods was not large and therefore opted for the simplest approach, namely, the average cost approach. It should be noted that the cost allocation to residential consumers in terms of the marginal costing approach is higher than the average costing approach because residential consumption is more "peaky" and hence contributes more to peak capacity costs than does industrial water use.

Comparison with residential tariffs. The basic building blocks of the residential and non-residential tariffs are the same, that is, they both use the same historic average cost for "normal" non-peak consumption and the same marginal-cost based tariff for peak consumption. (It is the calculation of what constitutes peak consumption that differs between the two categories of consumer). There is an important exception to this, namely, there is discrimination in favour of large water users who receive special deals.

No fixed charge. The motivation for scrapping the fixed charge in 1993 was two-fold. First, by reducing the income derived from fixed charges, the unit volumetric tariff could be maximised subject to the revenue constraint (no surplus generation) thus encouraging water conservation by increasing the marginal tariff. Second, the fixed charge was regarded as inequitable for small consumers who paid a higher average unit price for water under this system compared to larger consumers. This motivation was strongest in the case of residential consumers. The equity advantages of applying this policy to non-residential consumers is not clear because small commercial consumers are likely to be subsidised in the new system. (Certain fixed costs are incurred irrespective on the amount of water consumed.) It is not clear that small commercial consumers need to be "protected" in this way.

Peak pricing? The tariff structure creates an incentive for non-residential consumers to reduce the differential between the peak and off-peak season consumption, because it is only this differential (if it exceeds 125% of the off-peak usage) which is priced at the marginal cost. Users who have a fairly constant usage between seasons pay only the first tier price (based on average historical cost) irrespective of the total volume consumed. The committee's thinking underlying this was as follows. First, the only meaningful gauge of a commercial or industrial customers usage level, lacking detailed water audits or substantial customer characteristic data, is to use some sort of comparison to their historical usage. Second, the LADWP's overall marginal water use in the peak summer demand. Third, in terms of this thinking it was accepted that the winter base is recent and acceptable as a base line. Fourth, customers pay wastewater charges based on winter use and this cancels any perverse incentive to waste water in the winter in order to have a smaller second tier water usage in the summer.

The committee estimated that only a small percentage of water sold to non-residential consumers would be priced at the marginal cost (less than 7% of commercial and 4% of industrial water use). Hence the conservation or efficiency incentives inherent in

78 For a detailed discussion of cost allocation approaches, see Beecher *et al* (1991).

this tariff is minimal. In fact, the new tariff structure was "sold" to non-residential consumers on the basis that average tariffs amongst this group would be *reduced* compared to the previous tariff structure (a two-part tariff with a fixed charge and a constant volumetric tariff based on average historic costs).

Historic cost pricing dominates. The net effect appears to have been that large water users have been largely protected from increased prices and are charged predominantly at the level of average historic costs. This is consistent with the history of water pricing in Los Angeles (see Palmer Development Group, 1999d).

Resistance to new development costs. A source of the resistance to the implementation of new development charges applied by the MWD is readily apparent. First, Los Angeles explicitly committed itself to *not* requiring its consumers to pay for the *full* cost of new growth (the intention of the new development charge). Second, large consumers are explicitly protected from the higher marginal cost based price through a special provision which caps water prices for consumers with larger meters (over 50mm) to within 110% of the 1992 tariff. There is also a special deal for consumers who have a high seasonal peak usage which limits the payment of the peak tariff to 5% of their consumption.

Calculation of marginal costs. There was considerable subjectivity and uncertainty attached to the definition and calculation of marginal costs. The committee's report notes that "in a number of instances there was considerable discussion and deliberation as to the most proper procedures" and that "final resolution was not possible in some areas and assumptions were made" (City of Los Angeles, 1992).

Adjustments to meet revenue targets. The LADWP applies a water revenue adjustment factor (WRAF) to all first tier water so ensure that its revenue targets are met. The factor is calculated four times each year as follows: WRAF = (a – b + c) / d where a = quarterly revenue target (excluding revenue from WRAF) for the previous quarter, b = total revenue (excluding revenue from WRAF) for the previous quarter, c = the balance of the WRAF account for the previous quarter, and d = the estimated first tier usage sales for the next quarter.

Pricing under conditions of shortage. When the water supply is insufficient to meet the needs of the City, typically as the result of drought conditions, a system of "drought" or "shortage" tariffs are applied.

The implications for South Africa of the above discussion of the Los Angeles system of industrial water pricing are as follows:

- **Resistance to high marginal tariffs**. The potential resistance amongst commerce and industries to high marginal tariffs should not be under-estimated.
- **Fixed charges**. The rationale employed by the City of Los Angeles to scrap fixed charges for water supplies to non-residential consumers is not convincing.
- **Calculating marginal costs**. The Los Angeles experience of calculating marginal costs demonstrates that the process may be expected to be both subjective and uncertain. Nevertheless, the appropriate and selective application of marginal prices based on an estimate of marginal costs can be a useful tool to provide

incentives to improve technical efficiencies in water use and greater water conservation.

- **Peak pricing**. If there are substantial differences in capacity requirements (and hence capacity costs) between peak and off-peak seasonal usage, then the creation of an incentive to reduce peak season usage will improve the overall efficiency of water usage. The effectiveness of a "peak pricing strategy" (such as that adopted by Los Angeles in the case of non-residential consumers) depends on the extent of seasonal differences in water usage and thus is a matter of empirical investigation in the South African context. The potential for "special deals" to undermine the effectiveness of this strategy should also be examined and taken into account.
- **Paying for system expansion**. If the marginal costs of system expansion are significantly higher than average historic costs (which is the case in parts of South Africa), then it would appear that the pricing system employed by Los Angeles is inadequate as it does not require increased commercial and industrial usage to contribute to these marginal costs to any significant degree. More attention should be given to the implementation of a "new development charge" along the lines advocated by MWD whilst taking into account the cautions already mentioned.

Pricing under conditions of drought – the case of Los Angeles

The LADWP has instituted a system of "shortage tariffs" when drought conditions are deemed to exist and the water supplies available to meet the cities water requirements are considered to be inadequate. The degree of the shortage must be declared (10%, 15%, 20% or 25%). The industrial and commercial tariffs are adjusted as follows:

- The first tier usage block is reduced to 115% (110%) of the average off-peak seasonal usage (instead of 125%) and by the extent of the declared shortage, namely 10% or 15% (20% or 25%).
- The fist tier tariff remains the same.
- The second tier tariff is adjusted according to the schedule given in Table 18.

Table 18: Drought pricing for industry and commerce in Los Angeles

Declared shortage	Normal	10%	15%	20%	25%
2nd tier price ($/kl)	1.05	1.30	1.57	1.83	2.14

The second tier tariffs were calculated on the basis of an estimated price elasticity of water demand which was based on the experiences of the two most recent droughts.[79] The overriding objective was to achieve a rate structure which would enable to majority of consumers to pay the same average tariff they would pay in a normal year *if* they achieve the conservation goal equal to the degree of the shortage declared. The committee noted that this tariff structure was highly conjectural and that actual

[79] It would appear that the above tariffs are based on an estimated elasticity of about between –0.25 and –0.4 although these figures are not quoted on the report.

experience may require the tariffs to be altered so as to better meet the contingencies arising from a particular drought experience.

South Africa should give consideration to the implementation of a drought pricing system which incorporates elements of the system used in Los Angeles.

Seasonal pricing in Tucson and Phoenix

The cities of Tucson and Phoenix are both situated in Arizona, a water poor area. Each city has adopted distinct approaches to water pricing which appear to be particular to their respective histories.[80] It is informative to compare these two approaches with the view to examining the possible implications for South Africa.

Phoenix has adopted a constant volumetric rate (which varies according to the season) with a fixed fee which includes a free allowance.[81] The fixed fee is based on the cost of meter reading and bill administration and varies between $5 and $33 per month depending on meter size. Three seasons are defined: low season (December through March), medium season (April, May, October and November) and high season (June through September). The volumetric rates are as follows: low season – 0.39 $/kl, medium season – 0.46 $/kl and 0.58 $/kl. These rates include wastewater treatment charges and do not discriminate between consumer classes.[82]

Some important points related to this tariff structure are as follows:

- **Rejection of block rates**. Phoenix has previously implemented increasing block rates. The WSP staff were able to convince the Citizen's Water Rate Advisory Committee that there was no equitable way to set block rates because of the variety of water use situations. The committee therefore rejected all use of block (for both residential and non-residential consumers.
- **Rejection of customer classes**. The WSP staff and consultants were unable to demonstrate significantly different costs to supply different classes of consumer. The advisory committee therefore decided to scrap the customer classes and apply the same tariff to all consumers.

The tariff structure for industry and commerce in Tucson is somewhat different. Wastewater charges are levied separately. The city provides two types of water – potable water and reclaimed water – each with a different tariff structure. The reclaimed water is provided at a constant volumetric tariff of 0.39 $/kl to all consumers. The tariff structure and levels for potable water supplied to industries in Tucson are summarised in Table 19. The tariffs distinguish between peak (May through October) and off-peak (November through April) usage. Commercial tariffs are the same as industrial tariffs with the exception that the basic rate is 0.49 $/kl. The reason for this differentiation is not clear.

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80 A brief overview of the history of water pricing in Tucson in provided in Palmer Development Group (1999d). For a discussion of the history of water pricing in Phoenix, see Mee (1997).

81 Of 17 per month in October through May and 28 kl per month in June through September.

82 Further detail on the tariffs in Phoenix was not readily available. For example, it is not clear if some industries face separate wastewater charges based on pollution load. It would be surprising if this were not the case.

Table 19: Industrial water tariffs in Tucson

Tariff component	Charge	Basis for determination of charge
Minimum charge	$5 - $305 pm	*f* (meter size); includes "free" allowance of 8 kl
Basic rate	0.43 $/kl	Based on actual historic costs
Peak surcharge 1	+ 0.34 $/kl	Levied in peak season on all consumption in excess of off-peak average for each consumer
Peak surcharge 2	+ 0.09 $/kl	Levied in peak season on all consumption in excess of 150% of off-peak average for each consumer

Source: Tucson Water (1999)

The Phoenix water tariff structure is the simpler of the two. The higher tariffs in the peak months are premised on the increased capacity required to meet the extra demand. All users are required to pay the higher tariffs during the peak usage months.

In Tucson, the tariff structure is a refinement of that used in Los Angeles (see Los Angeles case study), making use of two levels of peak usage rather than one. The result is that industries with smaller seasonal variations in peak usage will still be required to pay a higher marginal price for the increased usage (compared to the case in Los Angeles). Industries who do not require potable water can purchase the lower quality reclaimed water at a cost significantly below the cost of the potable water. (No information was available on the basis for the determination of the price of the reclaimed water.)

Both tariff structures include a "free" allocation of a certain basic of water which is included in the minimum monthly charge. The rationale for this in the case of commercial and industrial water uses is not clear. It appears that the motivation is based on equity, that is, equal treatment of non-residential and residential consumers.

The possible implications of these pricing structures for South Africa are as follows:

- **Two possible routes for peak season pricing**. The examples show two equally feasible routes for peak seasonal pricing. Although the motivations underlying each are the same (higher prices during peak season to create incentives to reduce peak demand and hence same on peak capacity costs), the underlying philosophy and the distribution of the burden is different in each case. In Phoenix, *all users* are required to pay a higher unit charge for *all units* consumed during the peak period on the basis of the assumption that all users and all units of consumption in the peak season contribute equally to the seasonal peak demand. In Tucson, the higher unit charge is only levied on the differential increase in consumption between off-peak and peak seasonal demand (in the case of commercial and industrial consumers) on the assumption that it is only the increase in consumption between seasons that is responsible for the additional capacity required to meet the peak demand.[83] The approach adopted by Phoenix has greater merit if an important pricing goal is water conservation (provided the peak season water price

[83] The tariff structure for residential users is a progressive block structure. For details, see Palmer Development Group (1999d).

does reflect marginal cost) because all units consumed during the peak season are priced at the marginal cost and hence the cost of water to industries will be higher. On the other hand, if the marginal cost of water is driven by capacity expansion rather than seasonal peak usage, then neither approach is adequate on its own to provide the correct price signals related to decisions to increase water usage. In South Africa, both seasonal peak usage and capacity expansion contribute significant to capacity costs. Hence South Africa should examine a combination of peak pricing (along the lines of one or other of the two models described here) *and* new development charges.

- **Free allowances for commerce and industry**. The justification for providing free allowances to commerce and industry is weak and there is no reason to emulate this practice in South Africa.

- **Increasing blocks for industry and commerce**. An experimental implementation of increasing block rates for industry was a failure with the result that all increasing block rates (residential and non-residential) were scrapped. There is no sound rationale for defining blocks for commerce and industry and hence such a tariff structure is not recommended for South Africa.

- **Political sensitivities**. The nature of the water tariff structures developed in Phoenix and Tucson are strongly related to their particular political histories. The implementation of tariff reforms in South Africa must take the political and economic context into account. For further discussion on this, see Palmer Development Group (1999bd).

Increasing block rates for industry in Mexico City

The justification of increasing fixed block rates is weak because there is no rational basis for setting the block boundaries and the intermediate water prices. It is probably for these reasons that relatively few countries employ fixed block rates for non-residential consumers.

Where increasing block rates are applied, the system may be used as a mechanism for subsidising water by discounting water costs for smaller water users. In this case, the marginal rate of the top block is set equal to the actual average historic cost and the lower intra-marginal rates result in subsidies.

Fixed increasing block rates were employed in Mexico.[84] These tariffs are shown in Table 20. Information of average historical and marginal costs were not available.

Table 20: Industrial and commercial water tariffs in Mexico City, 1995

Block (kl/month)	0 - 30	to 60	to 120	to 240	to 420	to 660	to 960	more
Tariff ($/kl)	0.40	0.67	0.77	1.00	1.17	1.40	1.63	1.87

[84] This information is taken from NRC (1995). Mexico City has subsequently embarked on a process of privatisation of the management of its water supply. Tariff structures and levels may have changed in the interim. More recent information was not readily available.

The rational for such a system is weak and they are not recommended for South Africa.

Industrial pricing in a water scarce environment – Israel

A review of pricing practices in Israel was undertaken on the premise that lessons could be learnt about pricing industrial water in a water scarce environment. Unfortunately, the available information was sketchy.[85]

In Israel, the government acts as custodian of the water resource and water use is controlled by the Water Commissioner. There are no private rights to water use, rather users receive allocations (quotas).

The national water company, Mekorot, manages the distribution of bulk water throughout Israel. Charges for water supplied by Mekerot are set by the Water Commissioner. These charges, which are uniform across the country, are differentiated by user group: agriculture, industries and urban areas. The basic structure of the bulk water tariff is set out in

Table 21: Bulk water tariffs in Israel, 1997

User category	Charge ($/kl)	% of quota	Comment
Agriculture	0.16 0.19 0.26	0 - 50% 51 - 80% 81 - 100%	Tiered pricing introduced 1st in 1974, abandoned in 1979 and reintroduced in 1989
Industry	0.26	100%	
Urban areas	0.35	100%	

Source: Yaron (1997)

This system was developed with the motivation of meeting egalitarian as well as efficiency objectives. Nevertheless, the system has a number of weaknesses:

- **Quota mismatches**. An imbalance between supply and demand has arisen over time because the quota system (as implemented) has proved to be to rigid. For example, in 1990 the urban areas required 25% more water whereas the kibbutz and moshav farms required 24% less water than the quotas provided. Secondary markets for water have developed as a result – both inter-farm transfers and farm-city transfers – even though these are prohibited by law. These are usually mediated indirectly through private water supply companies.
- **Prices do not reflect costs**. The price of water is uniform across the country whereas the costs of supplying water varies significantly between regions.
- **Rising marginal costs**. The cost of supplying additional water into the national (or regional) network is significantly higher than historical average costs.

85 Information was obtained from Yaron (1997) and the Ministry of Foreign Affairs web-site www.israel-mfa.gov.il (accessed 18 March).

Industries (and other consumers) wishing to use more use are not provided with a price signal which reflects these additional costs.

The water allocation and pricing system was developed in Israel to meet specific social and political objectives. The system has held up remarkable well considering the extent of water scarcity in Israel. Nevertheless, its weaknesses in the face of growing pressures on the resource are becoming evident and there are efforts underway to reform the system (Yaron, 1997).

Benchmarking industrial water usage – South Africa

The Water Research Commission has funded a number of industrial water usage studies under the NATSURV banner, each of which sought to define and measure specific water intakes (SWI) within the industry. A SWI is the ratio of kl of water required to produce one unit of output, where outputs are defined in some suitable unit such as tons, carcasses, hides or kg. SWI results for various paper and pulp mills are shown below.

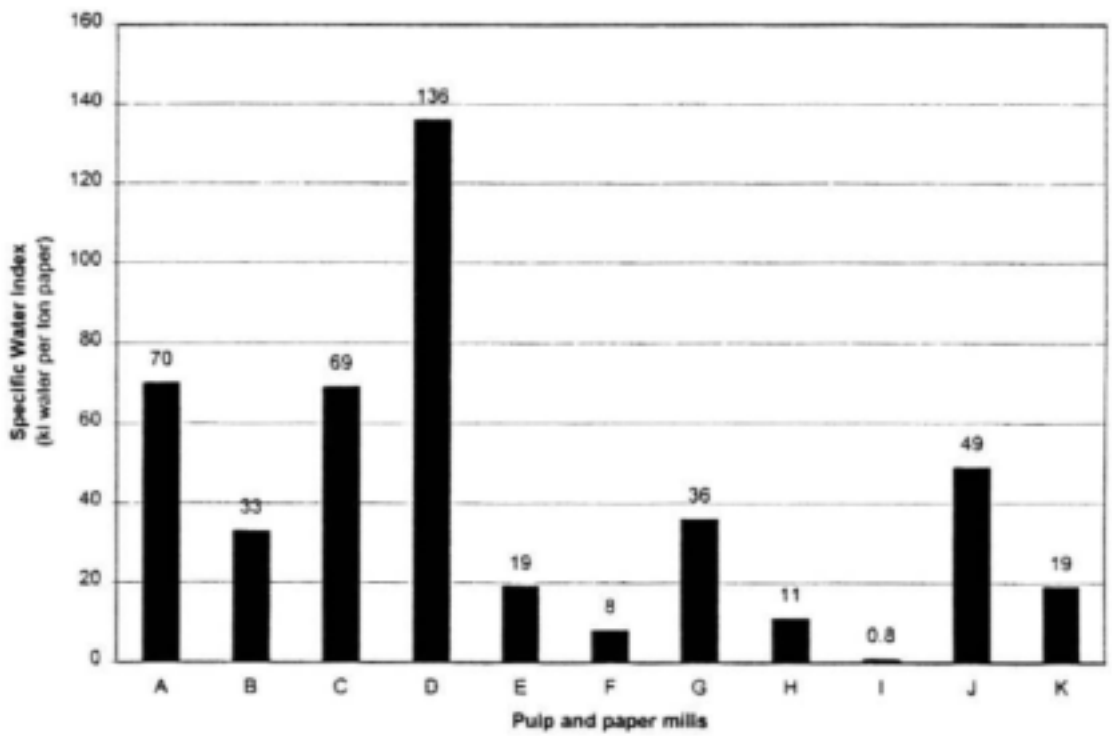

Figure 9: Specific Water Intakes for the pulp and paper industry.

The range of SWI measures is astonishingly broad, varying from 0.8 to 136kl/ton of output, effectively two orders of magnitude.

Normalising the SWI results for a variety of industries shows that this situation is not that unusual either.

Table 22: Normalised SWIs for a range of industries.

Industry	Sample size	Mean SWI	Max SWI	Min SWI	Std Dev.
Malt brewing	8	100	129	81	15
Electroplating	22	100	409	10	101
Anodising	13	100	266	8	83
Phosphating	9	100	332	24	103
Soft drinks	25	100	190	47	30
Sorghum malting	5	100	179	36	60
Sorghum brewing	8	100	154	74	29
Red meat abattoirs	21	100	262	40	55
Paper & pulp mills	11	100	332	2	96
Poultry	17	100	274	58	49

Source: (WRC 1986, 1987a,b, 1989a-g, 1990a,b, 1993a,b)

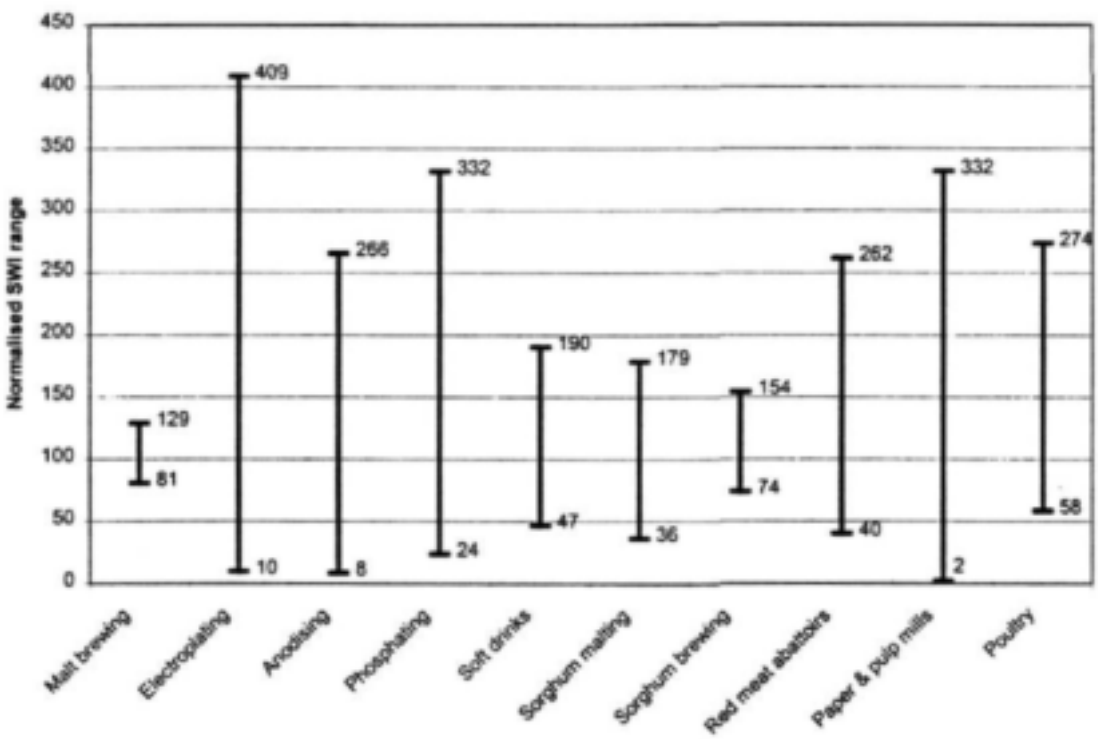

Figure 10: Specific Water Intakes for a range of industries.

The wide variations amongst these results demonstrate the difficulty of establishing reliable benchmarks for industrial water consumption. Variations in production processes, products and many other factors make the *measurement of output* a very difficult exercise. It is generally not feasible for a WSP to define and monitor industry outputs over time. Consequently, it is generally not possible to define and monitor water use efficiencies and to link these to a water tariff in a practical and enforceable manner.

A quota-based tariff system – Paarl

As part of the WRC project which developed these guidelines a number of case study interviews were undertaken, including Paarl Municipality.

Paarl is a small local authority in the Western Cape with some 18 000 residential and 1000 non-residential water customers. Around 20 of the non-residential consumers are large water-consuming industries, with some consuming as much as 500 000kl per annum. Industrial demand is strongly seasonal, since most industries are engaged in fruit processing and wine production.

Conscious of the limited water resources available in the South Western Cape the municipality adopted a quota-based water tariff in 1990 as a means of encouraging water conservation. The tariff is applied to those industries who consume more than 100kl/day, amounting to 22 users in 1999. The council's policy is presented below.

Paarl Water Quota: Heavy Industry

A Philosophy

1. Not to restrict growth of industry
2. To set quota for five year period so as to encourage industry (by imposition of penalty tariff on exceeding quota) to conserve water so as to:
   a) promote water conservation measures
   b) limit peak water demand from our Wemmershoek supply
   c) keep the effluent flows to an acceptable level
3. To consider applications for increased quotas in a favourable light if:-
   - consumption falls within a five year projection plus one δy [standard deviation]
   - excess water is available
   - effluent can be accepted

B Policy

1. Water quotas for heavy industry (industries with daily average exceeding 100kl per day) calculated every five years using previous 10 years data and projected 5 years ahead.
2. Previous 10 years data smoothed, line showing projected growth/decline of water consumption obtained and standard deviation (δy) calculated
3. Setting quota for next five years:
   a) If decreasing tendency found take projection for first year of five year period plus one δy as quota for period
   b) If increasing tendency found take projection at midpoint of period plus one δy as quota figure for period (i.e. at 3rd year)
   c) If quota set is in excess of Dept of Water Affairs permit quantity for an industry quota shall be permit quantity until industry has obtained permit, and supplied copy to ourselves, for municipal set quota.
   d) Water quotas shall become operative as from 1 July of the first year of the five year period
   e) Industries may apply for increased quotas during the five year period provided, as stated in A3, consumption falls within current five year projection plus one standard deviation and additional water is available and effluent can be accepted.

(Paarl Municipality, 30.4.1990)

In 1998/99 the industrial consumption tariff was R1.58/kl, up to the monthly quota limit, and R2.37/kl above this limit - in other words a 50% penalty. By comparison, the highest block of the residential inclining block tariff was set at R1.96 for consumption over 80kl per month.

It is useful to examine a typical industrial demand pattern to gain some insight into the difficulty of setting such quotas.

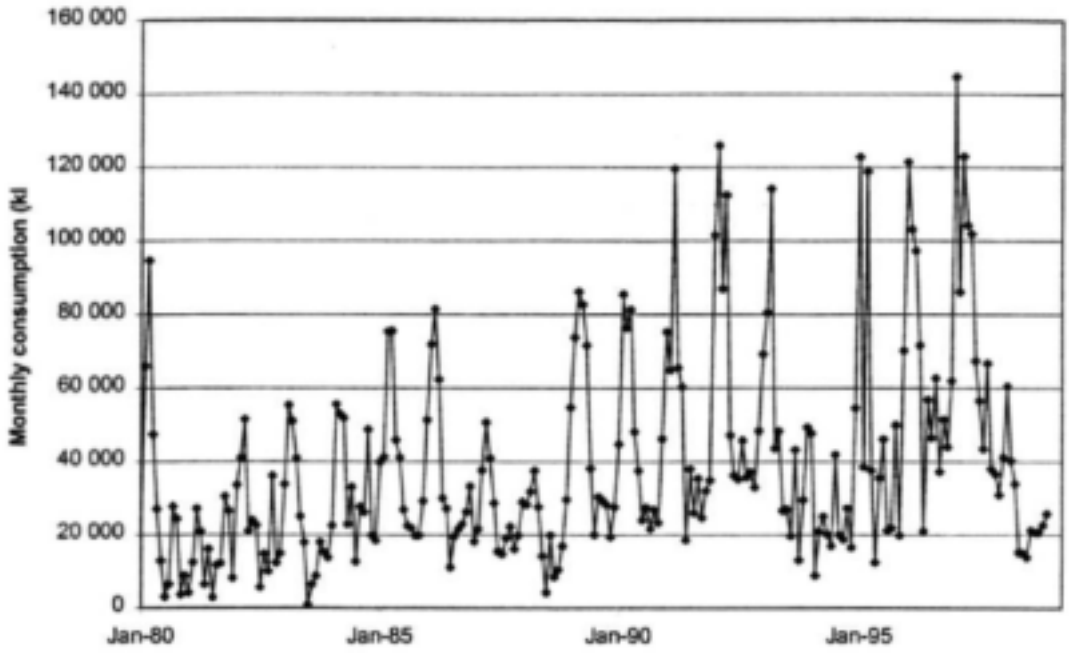

Figure 11: Twenty year monthly water demand history for a Paarl industrial consumer.

The demand is peaky, seasonal and erratic, mainly as a result of external factors such as sales and the availability of raw materials. As a result this industry frequently exceeds its water quotas during months of peak production activity.

At some stage in the mid-90's the Council decided to amend the policy from a five year quota review to an annual quota review. Yet by 1999 the new policy had still not been put into effect and the 22 industrial customers were still operating on the basis of the old quotas.

Interestingly, none of the Council officials who were interviewed were able to recall a single complaint about the quota system. This is surprising since the quotas had not been adjusted for at least five years. In one case an industry with a quota of 697 kl per month was consuming 7 541 kl per month, ten times their official quota, but had not complained. Council officials suspected that the company's phenomenal growth, and consequent profitability, meant that managers were focussing their attention on increasing production capacity, rather than on managing input costs such as water.

Key features worth noting about Paarl's quota policy are that:

- Industry quotas are based on projected demands, which in turn are derived from *historical* water consumption data;
- Industries with a history of declining usage do not receive declining quotas;

- No consideration is given to levels of industry output; and hence
- No consideration is given to the efficiency with which water is used in the production process.

At present the Council has no means of evaluating the extent to which quotas are achieving its aim of promoting industrial water conservation. Whilst the quota system probably has some impact it fails to meet the criteria of being *fair*, in that its impact on industries is indiscriminate, in that it is a function of external factors rather than internal usage efficiencies. For this reason the quota system is not recommended for use in South Africa.

Block tariffs – the case of Hermanus

Hermanus is a popular seaside resort in the Southern Cape with a permanent population of 19 000 and a peak seasonal population of 60 000. The town's main water supply comes from the De Bos dam which was completed in 1976, at which point it was estimated that the 2.8 million kl per annum water allocation should last until 2010. By 1994, however, the property boom in the area lead to the water allocation being exceeded, although 30% of the demarcated erven were still to be developed. Extrapolation of this trend indicated a final demand as high as 4.9 million kl per annum. Hydrological analysis showed the water resource development options to be very limited. The municipality therefore decided to embark on a major water conservation campaign, with assistance from the Department of Water Affairs and Forestry.

The resulting twelve point plan consisted of the following elements[86]:

1. **Assurance of supply tariff**: Set at R40 per month for normal residential consumers, this unusually high fixed charge ensures that holiday home owners make a contribution during off-peak seasons;
2. **Block rate tariff**: An eleven block consumption tariff was established, rising from R0.30/kl for the first 5kl per month to R10.00 for consumption above 100kl per month.
3. **Working for water project**: Alien invaders, such as wattles, gums and pines, were cleared from the dam's run-off slopes. This project was funded from a DWAF grant and provided jobs for 120 unemployed residents.
4. **School water audits**: Schools were audited as a means of encouraging children to undertake water audits in their own homes.
5. **Water loss management**: A loss management programme was introduced to reduce unaccounted-for water from its initial level of 18%.
6. **Retrofit programme**: A programme to retro-fit water appliances and fit on-site leaks was established.

86 Information drawn from Hermanus, 1997 and interviews with Mr James van der Linde, Hermanus Town Engineer.

7. **Water-wise gardening**: Some 26% of water supplied in Hermanus was used for gardening purposes. A programme was therefore launched to encourage gardeners to use indigenous, low-maintenance plants.
8. **Water-wise food production**: Small scale farmers were encouraged to use recycled water and to garden efficiently.
9. **Metering**: Prepayment meters, combining water, electricity and domestic security functions, were piloted.
10. **National water regulations**: Hermanus participated in the establishment of DWAF's national water regulations.
11. **Communication**: An intensive public relations programme was launched to keep water users informed of the programme.
12. **Informative billing**: An informative billing system was developed, consisting of an information page which accompanies the usual municipal bill. The colourful page presents the consumer with a graphical display of the last 12 month's consumption, clearly indicating the make-up of the individual tariff blocks and its effect on the monthly bill.

Non-residential tariffs. Some 6% of Hermanus' water demand arises from commercial and industrial consumers. The rising block tariff approach was extended to these consumers by means of a concept known as a Residential Unit Equivalent (RUE). Essentially each non-residential consumers was allocated a certain number of RUEs, which scaled the residential tariff. For example, a 'three RUE' commercial consumer is expected to pay three times the monthly basic charge and each consumption block is multiplied by three. The calculation of the number of RUEs for each non-residential consumer was based on a range of criteria. Some received RUEs based on their historical 12 month consumption average. Others were based on the number of erven that the business occupied.

Quota reviews. Although the Town Council is officially willing to review a non-residential consumer's RUE allocation on an annual basis, the onus for initiating the review process is seen as lying with the consumer. In 1999 the Town Engineer reported that there have been virtually no requests for RUE reviews since the system was implemented three years previously. In fact the Council does not have a system in place to review RUE allocations.

Tariff reviews. As a result of its 1996 tariff reforms the Council has made a substantial surplus on the water trading account which accrues to the general rates account. Water tariffs have not been amended since the conservation programme was introduced.

Interviews with commercial enterprises. As part of this case study seven commercial enterprises were interviewed, including a car-wash; a backpackers lodge; a plant nursery; a laundry; a large up-market hotel; a fish restaurant and a concrete products manufacturer.

Water consciousness. Commercial and industrial water consumers display an unusually high level of water consciousness and attribute this to the public relations programme and the informative billing sheets.

Alternative supplies. The car wash, the nursery, the brick making business and the backpacker's lodge had all considered investing in alternative supplies or water reuse for situations where potable water was not required. However, only the backpackers hostel had implemented its plans - using a well for garden watering. The other businesses had not invested for various reasons, including a lack of certainty around the municipality's policy on charging for ground water abstraction (brick maker); insufficient time to recover the investment in constructing a well before selling the business (nursery); and the capital cost of installing a submergible pump (car wash).

Demand management. The car wash business choose to wash cars by hand whenever possible, rather than using the automatic machine - effectively substituting labour and chemical cleaners for water and electricity inputs. The nursery had experimented with watering periods to minimise water consumption. The backpackers lodge had recently fitted low flow shower heads and low capacity cisterns, but had decided not to utilise grey water from its laundry for aesthetic reasons (ugly pipes). None of the other businesses felt that it was possible to undertake any demand management, due to the nature of their business. All the interviewees pointed to the difficulty of controlling water demand since it is derived from productive activities.

Tariffs. Most interviewees understood the concept of the rising block tariff, but none really understand the basis of their RUE allocations or planned to ask for a review. In all cases the monthly water bill formed a very small proportion of total input costs and only a few managers monitored their bills. In general managers had mixed feelings about the tariff, recognising the need for water conservation, but questioning the effectiveness of a penalty tariff for business users.

Key lessons. The Hermanus case study is useful in that it demonstrates that effect of combining tariff reform with consumer education programmes. However, the extension of inclining block tariffs to industrial and commercial consumers by means of a quota system cannot be considered to represent good practice for a number of reasons:

- The allocation of RUEs is not based on criteria which are demonstrably rational, fair or transparent;
- The system does not take production outputs into account, and hence does not consider efficiencies of use; and
- As in the Paarl case, no reliable system has been put into place to review RUE quotas. Consequently expanding businesses are penalised, whilst contracting businesses benefit.

For these reasons the use of any quota-based system, such as RUEs, is not recommended.

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