Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH•NEW ZEALAND

Lincoln University Digital Dissertation

Copyright Statement

AN APPLICATION OF ECONOMIC THEORIES AND CONCEPTS TO WATER MANAGEMENT IN NEW ZEALAND

Presented in partial fulfilment

of the requirements for the Degree

of

Master of Science

in the

University of Canterbury

by

Denise F. Church

Joint Centre for Environmental Sciences

University of Canterbury and Lincoln College

1978

ABSTRACT

This report describes an economic assessment of the policies and strategies used to manage water resources in New Zealand. A number of economic theories which relate to water allocation and water pollution control are outlined, with an emphasis on pricing theory. Results of a survey undertaken on charges made for municipal water and sewerage services and regional water board charges are given. The strategies used in New Zealand to manage water resources and to provide finance for water-related services are then evaluated in the light of overseas policies, and the strategies suggested by economic theory. It is concluded that a greater use of pricing policies based on marginal cost pricing, which relates charges to the cost of providing water services, would lead to a more efficient and equitable allocation of water resources. Specific recommendations for changes to water supply and sewerage service pricing, and for changes to existing water and soil management legislation are outlined.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Water forms a basis for man's production and consumption activities. Its importance was realised even by early civilizations. The ancient Greeks considered water to be one of the four "cardinal elements of existence" (Walker 1975), and effective control of water use was a major factor in the success of civilizations in Mesopotamia and Egypt. Yet despite the fact that it is indispensible, particularly in Western civilizations, water has had a very low value in comparison with other commodities. Water resources have generally been so abundant, relative to the demand for them, that they have been available "for the taking". Mitchell and Kurak (1976) comment that "apparently because water does fall from the Heavens, we feel it is our right that we use all we want without cost." Similarly it was stated in a report for the United Nations Water Conference 1977 that EEC countries have encountered problems through "a reluctance to change from traditional views of water as being free and abundant with an inherent right to use it as one pleases." In economic terms, water has been considered as a free good.

Because New Zealand has relatively plentiful supplies of water, it is hardly surprising that water supplies have been considered inexhaustible, except for isolated areas or in the short term. The development and use of water resources proceeded on this assumption until a few decades ago, and planning for water use in some cases still reflects elements of this view.

Today it is evident in many countries that water has become relatively scarce, in that there are many users competing for limited resources. At the same time as economic and population growth have brought about increases in the use of water for industrial and domestic purposes and as a medium of waste disposal, there has been a growing awareness of the importance of the "quality of life". In New Zealand particular value is now placed upon the availability of resources for recreational use and the other intangible benefits (e.g. visual and aesthetic) arising from them (Commission for the Environment, 1977).

Thus there are a multitude of conflicting interests, not only between the potential developers, but between those who wish to develop and those who wish to preserve water resources. Water managers are faced with the problem of reconciling concern for the environment with society's desires for the material benefits arising from the development and use of water resources.

If a resource is scarce, then it is in the interests of society that the resource be used so as to ensure the maximum beneficial return, and that suitable devices be developed to allocate water in a way which is compatible with this objective. The success of management in achieving the objective will be, to a great extent, determined by the policies chosen.

Although problems of water pollution and water supply shortages have been evident in New Zealand for some time, it is relatively recently that any real control over water use has been exerted, apart from the imposition of certain health

standards. Over the past 2 or 3 decades, a variety of strategies and techniques for managing water resources have been developed. These strategies have included payment in various forms for municipal water supply and sewerage services, and a comprehensive water rights system governing the use of natural water. A large number of statutes, regulations and by-laws pertaining to water use now exists.

At the same time as the development of these strategies has taken place, there has been considerable interest shown by economists in various economic aspects of water use. Earlier work focused on the benefits arising from water use, particularly in terms of hydro-electric power and irrigation projects. Attention has been given to the factors affecting demand for water, particularly pricing policies and their effects on both municipal water and sewerage service demand. More recently a a number of theories relating to pollution have been developed, and methods of controlling water quality have been examined from an economic viewpoint.

It has generally been accepted that a number of these economic theories are of considerable use in bringing about the efficient and equitable allocation of scarce water resources, although it is not claimed that economic theory will provide all the answers. (Readers are asked to note that words underlined in the test are defined in the glossary.)

In particular, economists have considered the pricing mechanism to be a powerful means of achieving the above objective. The general function of prices in the economy is to allocate resources amongst various consumption and production activities.

Prices are signals for both consumers and producers, providing checks and balances for production and consumption of goods under government control, as well as private goods. With regard to water related services, prices may be used for a number of purposes, including the recovery of costs incurred in supply, the allocation of costs to the beneficiaries of a service, and the avoidance of over-investment in water development. While it is true that market imperfections would prevent the efficient allocation of water by the market mechanism alone, economists argue (National Water Commission 1973) that the incorporation of a pricing system within current legal and administrative frameworks would enhance the efficiency of water use.

An examination of water supply/disposal and water management policy in New Zealand reveals that there has been little recourse to the pricing mechanism as a means of controlling water use. Predominantly, there have been a variety of institutional and legal arrangements which have sought to allocate water by non-market means. The management of water resources has frequently been approached as a problem of engineering rather than economics, and little if any consideration has been given to the impact of prices on demand. Such an attitude may have been justifiable when water resources were virtually inexhaustible, but it is obvious that this is no longer so. It now seems essential to consider the wider use of economic analysis as a basis for management policies.

This project conducts an economic assessment of the policies and strategies used in the management of water resources and water related services in New Zealand. Section 2 examines a number of economic theories, and their applicationn to water allocation problems. In particular, it considers the properties of water which differentiate it from other commodities and its nature as an economic good; that is, whether it can be considered as a private, social, or merit good. This differentiation has important implications for the management of water resources, determining whether a pricing policy can or should be applied. This section will also cover the effectiveness of different types of pricing policies, and the theories related to unpriced effects (externalities) and their implications for pollution control strategies.

Sections 3 and 4 examine the legal and administrative framework of water management in New Zealand, and outline the results of the survey undertaken of charges for water and water related services. The theories outlined are used as a basis for answering some of the questions which arise regarding water management and water services. For example:

- Should pricing be used as a means of allocating water resources?

- Should the pricing of water take into account income distribution objectives?

- What level of pollution is optimal; and who should bear the costs of pollution control, and the remaining damage costs?

New Zealand policies are contrasted with overseas practice, and examined in the light of the ideal approaches suggested by economic theory. Section 5 assesses the extent to which current water management systems do use pricing policies, demonstrates where prices are not set in an efficient or equitable manner, and suggests areas where an improvement of pricing policies could lead to a better use of water resources, and water related services. Finally in section 6, recommendations are made for the shape of future water management policies.

2. SOME ECONOMIC THEORIES AND THEIR USE IN WATER MANAGEMENT

2.1 WATER RESOURCES - THEIR PROPERTIES AND USES

It is not the aim of this report to carry out an exhaustive analysis of the properties of water resources, and the uses to which they can be put. However, there are certain special features of water which need to be recognized before a well-informed discussion about water resource allocation can take place.

Resources are frequently defined as being "stock" (non-renewable) or "flow" (renewable). Water belongs to the latter category in that it has a capacity for self-renewal; its use for one purpose does not necessarily prevent it from being used later for other purposes. This capacity for self renewal has important implications for water management. Hamilton (1971) points out that

> "Water is a living medium which fluctuates .... according to regular biochemical cycles .... The sufficiency of the cycles depends upon the assimilation and transformation by each state of the products of the preceding one".

In other words, the self-renewal capacity of water is largely determined by the uses to which it is put.

Also important is the fact that water, like air, is mobile over the face of the earth. Thus it can be considered as a "common property" resource, in which it is difficult to gain absolute rights of ownership. As a "fugitive" resource, water is no-one's property until it is captured. But as Dales (1968) comments, "everyone's property is no-one's property". This

common property feature of water has important implications for economic considerations of water allocation, and gives rise to market imperfections. However, the presence of these does not imply that economic analysis is of no value in solving water allocation problems.

Early economic theory stemming from the writing of Adam Smith emphasized the importance of the "invisible hand" effect in ensuring the efficient allocation of resources. Adam Smith stated that

> "Every individual is continually exerting himself to find out the most advantageous employment for whatever capital he can command. It is his own advantage indeed, and not that of society which he has in view. But the study of his own advantage naturally, or rather necessarily, leads him to prefer the employment which is most advantageous to society". Each individual was "led by an invisible hand to promote an end which was no part of his intention." (Adam Smith in Tisdell 1972).

However, more recent writers have introduced the concept of the "invisible foot" whereby private self-interest "kicks the common good to pieces" (Daly 1971). In situations a) where individuals do not take into account the unpriced effects which they impose on others, or b) where individuals cannot make decisions about social goods which are rational in terms of society's good without some coordinating social rule, then the operation of the market fails.

It is also essential to realise that very substantial interdependencies exist among water uses (National Water Commission 1973). Water is typically used and re-used until "lost" through evaporation or to groundwater aquifers or the oceans.

A unit of water within a stream may be used for navigation, waste dilution and disposal, recreation, hydro-electric power and fish production. On the other hand, water may be removed from a stream and used for municipal, industrial, and agricultural supply. A certain proportion of the water removed eventually becomes available for reuse, but it may be substantially changed in quantity.

The use of water for one purpose will generally restrict its availability for non-compatible uses.

Some attempts have been made to define the extent to which one use of water precludes other uses. Traditionally a distinction is made between "consumptive" and "non-consumptive" uses, which Walker (1975) defines as follows:

> "Consumptive uses ..... include any uses which are consumptive of either quantity or quality of the resource, and therefore affect other actual or potential users."

Human and animal consumption, and water incorporated in or used in the production of goods for consumption are examples of consumptive uses, and are often referred to as "withdrawal uses". The use of water for waste disposal can also be regarded as consumptive.

Walker defines non-consumptive uses as being those which

> "may depend on particular quality and quantity being available, (but) do not usually reduce or affect either quantity or quality."

These include recreational uses (direct, as for swimming and boating, and indirect, usually visual or aesthetic considerations), use as a life medium for aquatic biota, for power production,

and for transportation and navigation. Such definitions are not entirely satisfactory, however, since even the "non-consumptive" use of water may make it less available to other users. Furthermore, uses which are incompatible in one situation may be compatible in another.

The nature of use has an important bearing on the prices which should be charged for water or water-related services. It is emphasized by the National Water Commission (1973) that the critical factor is that:

> "the evaluation of water should give full recognition to the effect that each use has on subsequent uses ..... Ideally water uses would be priced on the basis of how much of the "usefulness" is taken out of the water."

This implies that quantities of water used are not the only factor to be considered for abstraction pricing (Johnson 1970).

A further concept arising from such interdependencies is that water and waste-water need to be considered as one good, in limited supply. Case (1972) argues that water quality problems can be viewed as only one aspect of the broader problem of water allocation and development in general. The degradation of water quality involves the diminishing of available supply, while the provision of extra supply generally gives rise to an increase in waste-water. Such relationships have tended to be overlooked in New Zealand, where a single use approach to water management has often been evident.

Despite the fact that water as a commodity has some special features, Hirschleifer et al (1968) note that it does not have the unique importance that some writers would suggest. Committments to clean water "at all cost" are no more likely to encourage an efficient allocation of water than disregarding water

pollution problems. Nor is it necessarily true that private ownership of a common property resource is unwise or dangerous. However, the following examination of the use of economic measures to motivate better use of water will bear in mind the features which differentiate it from other commodities.

2.2 WATER AS AN ECONOMIC GOOD: SOCIAL, PRIVATE AND MERIT GOODS

Before evaluating the charging policies used in New Zealand to regulate water use, it is appropriate to outline why many economists feel that the pricing mechanism can and should be used as a means of allocating water and water services.

Economists commonly talk about "private" and "social", goods. The distinction between these is shown in Table 1. Private goods are characterized by the features of excludability and rival consumption. The benefits of consumption accrue only to the consumer; consumption of the good by one individual precludes its consumption by another. Furthermore, it is possible to exclude individuals from consumption of private goods. It is generally agreed that, under certain conditions, the market is an efficient mechanism for the provision of private goods.

For social goods, however, a different mechanism of provision is needed because the criteria of excludability and rival consumption do not apply. Market failure may arise because exclusion of individuals is too costly, or impossible

TABLE 1: The features of private and social goods

(after Mulgrave and Mulgrave 1973)

		CONSUMPTION	
		Rival	Non rival
EXCLUDABILITY	Feasible	1	3
	Not feasible	2	4

Case 1: private good

Case 4: pure social good

Cases 3 and 4 together: usually considered as social goods because they involve non-rival consumption.

Case 2: not usually considered as a social good because consumption is rival.

even though exclusion should be applied through the pricing mechanism to achieve the most efficient use of available resources. Market failure may also arise where the consumption of a good by one individual does not preclude its use by another individual. These causes of market failure may be combined, into a case where exclusion both cannot and should not be applied, since it would be impossible, and inefficient if it were possible. Examples of such "pure" social goods include clean air, and national defence. Social goods tend to be publicly provided. Since the market mechanism does not reveal social good preferences, choices are indicated through the voting process.

In reality, such sharp polarization between private and social goods does not occur. Mixed situations of various types arise, and social-good type problems appear wherever private consumption generates externalities, or unpriced effects on other individuals (see Section 2.4.1). These unpriced effects are not taken into account by the market mechanism, and hence some form of public regulation is required.

A third type of good, the merit good, is also defined by economists. Certain goods are held to be "meritious" by public decision makers, and their provision is supported in various ways. These merit goods may be social or private goods, according to previous definitions. Merit goods generate benefits which extend beyond the initial consumer, that is, the person actually receiving the good. Merit goods may be directed

towards the poor, for example, the provision of low cost housing. Other examples of merit goods include water supply and sewerage services (which aim to maintain public health), and education. The provision of merit goods allows for externalities which are not taken into account in individual consumption decisions. For example, it is in the public interest that individuals consume a certain level of water and sewerage services because their health has effects not only on themselves, but on the whole community.

How then should water and water related services be regarded? Are they social goods, which should not be charged for because the consumption of the resource by one individual does not affect consumption by another? Or are they merit goods which should be provided at no charge, or at a very low charge, in order to achieve certain social objectives?

Perhaps there was a time when water was so plentiful relative to demand that it could be regarded as a social good. Furthermore, the maintenance of certain levels of public health and standards of living would appear to be a justifiable social objective. Does this then mean that the pricing mechanism should play no part in the allocation of water resources and services? On the contrary, it can be shown that pricing is a powerful and effective tool for the efficient allocation of water resources. Consumption of water by one individual does affect consumption by another, and exclusion through pricing is possible; therefore water is far more a private good in nature than a social good. Furthermore, it can be shown that

requirements for water are far in excess of the amounts of water needed for essential purposes. It is not in the public interest to subsidise the wasteful and inefficient use of water resources. Water needs to be considered as a mixed good. It can be allocated efficiently by a pricing mechanism, but since externalities are associated with the use of water, government intervention is required to ensure that prices reflect these "unpriced effects" generated by water use.

2.3 PRICING POLICIES FOR WATER AND WATER SERVICES

Unless a commodity is available in limitless quantities, an expansion in the output of one item usually requires the withdrawal of resources from the production of some other item. As pointed out in Section 1, the general role of prices in the economy is to balance benefits and costs at the margin. In the case of the perfect market, prices are determined by a market mechanism which automatically adjusts prices so that the quantity of goods demanded equals that of goods supplied. In cases where market failure occurs, some form of pricing or charging policy is required.

Traditionally, water resource management has been based on a preoccupation with engineering structures, and the objective of meeting forecasted "requirements" (Hanke and Boland 1971; Mann 1970). In particular, engineers have tended to assume that the quantity of water demanded is independent of price (Lobb 1975). However, a number of studies (Morgan 1973; Young 1973) have shown that water consumption is affected by price,

among other factors. Hanke (1975) pointed out that pricing policies of water enterprises are more often founded on financial than economic criteria. The "engineering" approach of setting prices for water supply is contrasted with the "economic" approach in Fig. 1. Hanke also noted that financial criteria are often applied "ex post" and are not an integrated part of a pricing-investment process.

The United Nations Economic and Social Council (1977) suggested a number of criteria which should be considered in assessing pricing policies.

i) Allocative efficiency. Economic efficiency is served by a pricing policy which follows the marginal cost pricing rule. This implies that water users should pay the full incremental cost of the water they consume. Where subsidies exist, water is underpriced and overused so that incremental costs exceed incremental benefits. Prices need to be considered in terms of a) the resource cost information which they convey to consumers, and b) the incentive consumers have to react rationally to that information.

ii) Equity. This criteria is concerned with the distribution or incidence of benefits and costs. Two principles may apply. The first, concerned with a users ability to pay, would make prices higher for those with high incomes. However, this principle is not consistent with allocative efficiency. It is often argued that an "ability to pay" pricing policy is an inefficient and inappropriate means of meeting income distribution objectives. The second principle defines equity in terms of

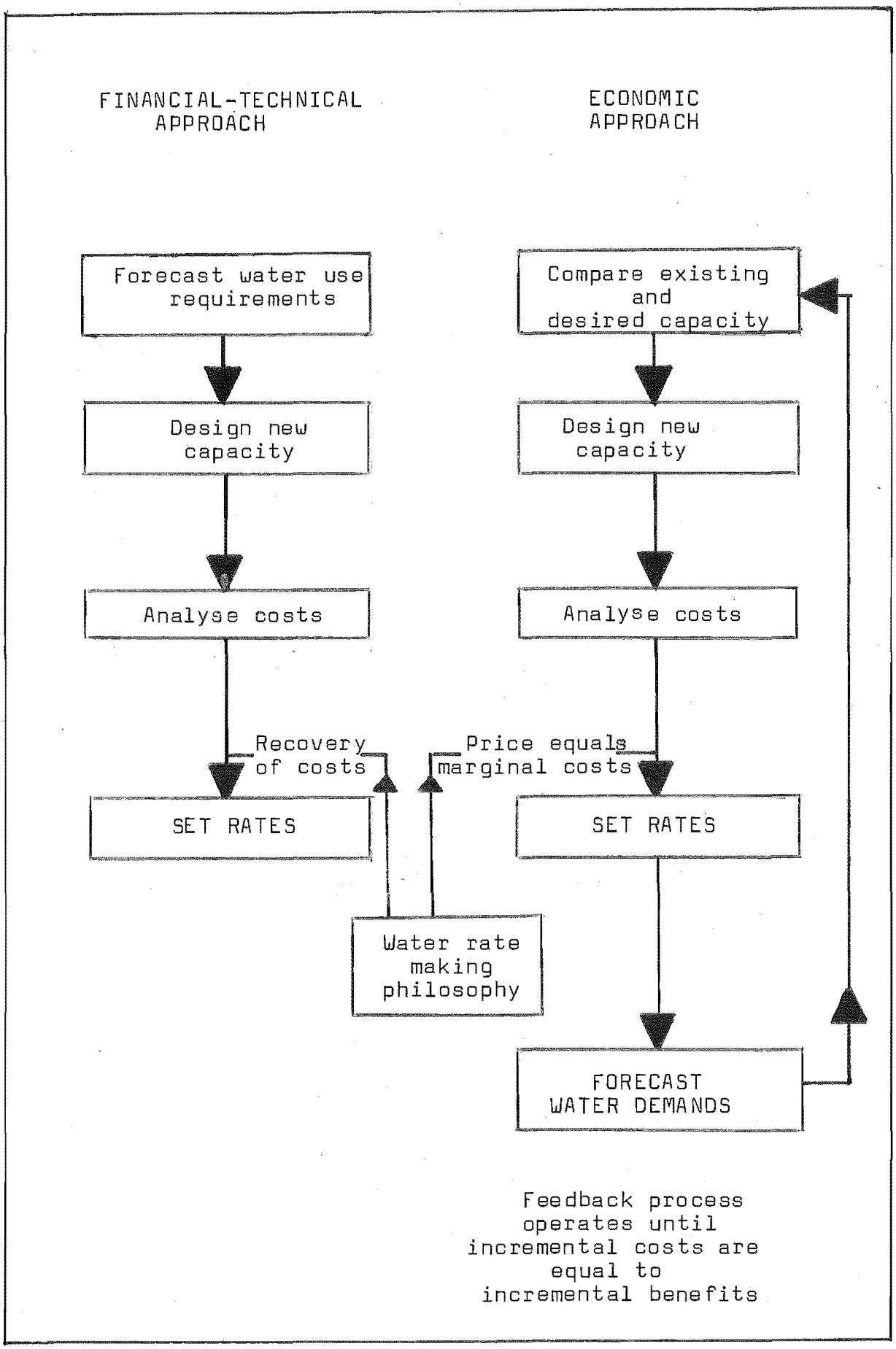


FIGURE 1: Approaches to the setting of water prices (after Hanke, 1975)

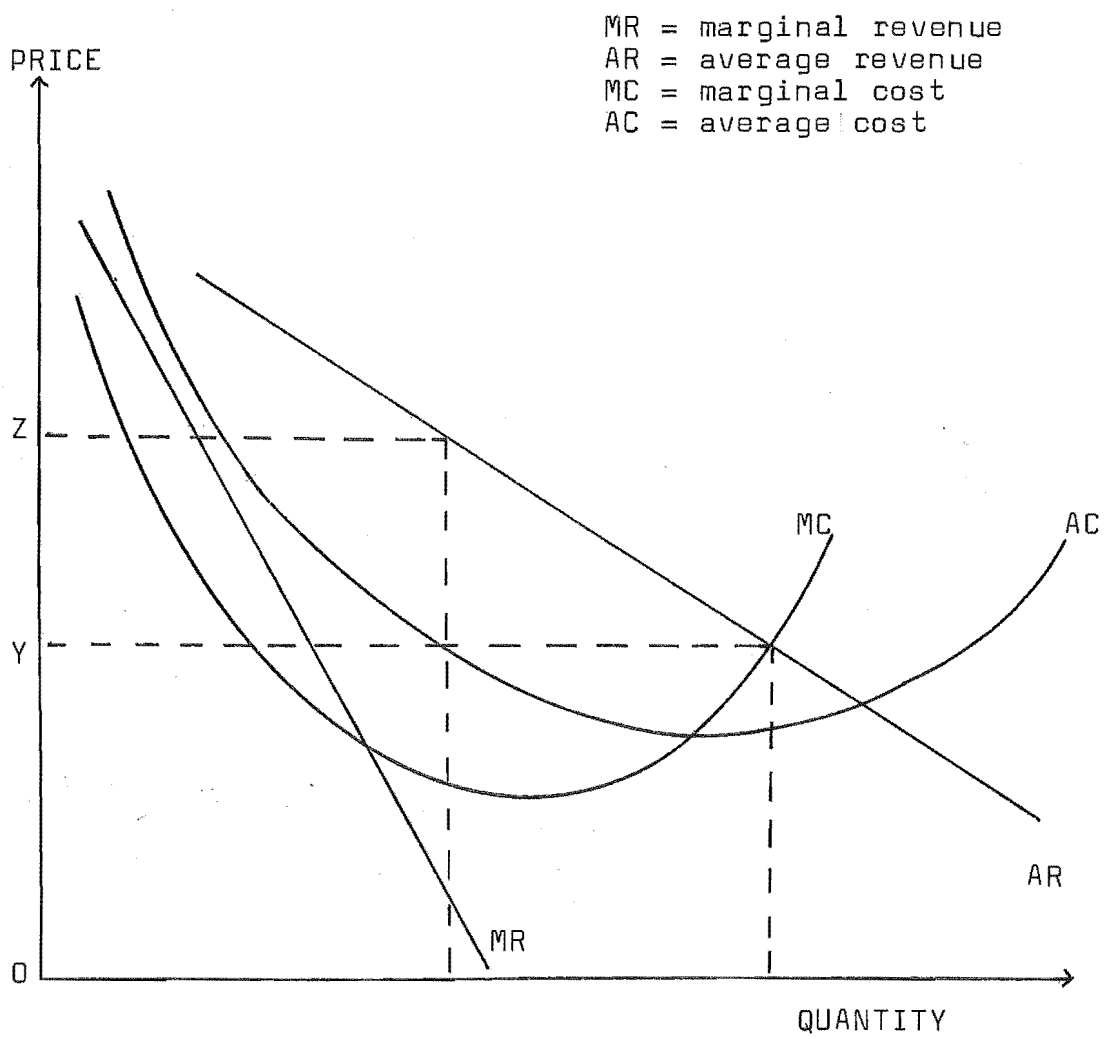
consumers receiving equal benefits meeting the same costs. This principle is compatible with the efficiency objective since consumers would pay in proportion to benefits received.

iii) Administrative costs. Certain costs are involved in establishing any pricing system. It must be ascertained that these costs do not exceed the allocative benefits derived from marginal cost pricing.

Hanke and Davis (1973) mentioned a fourth criteria, investment information. They stated that "Adopting a pricing system generates useful information regarding the consumers willingness to pay for additional units of output".

2.3.1 Marginal cost pricing

Charging for water on a "financial" basis, or attempting to control water use by regulations, generally implies that charges do not serve their allocative function. Economic theory reasons that, with economic efficiency as a criteria, social welfare is maximised when the price of a service or commodity is equated with the cost of producing another unit of the same service or commodity. If price is set below the marginal cost of producing a commodity, then the value of the extra unit to the consumer (the price) is less than the value of the resources that went into its production. Too much of the commodity is being produced and consumed, foregoing the use of resources for more beneficial purposes (Fig. 2). Herein lies the principle of incremental or marginal cost pricing. This principle can be applied to a wide variety of water allocation problems including water supply, and water pollution control.



Explanation: The basic rule for efficient pricing is that price should equal marginal cost. If MC falls short of AR or price, then society gains by producing more, For example, if price is set at Z, then the value to the consumer of an extra unit is greater than the cost of producing this unit.

The above situation could apply to a water utility not facing decreasing costs, and can be compared to the decreasing cost situation in Figure 3.

FIGURE 2: An explanation of marginal cost pricing

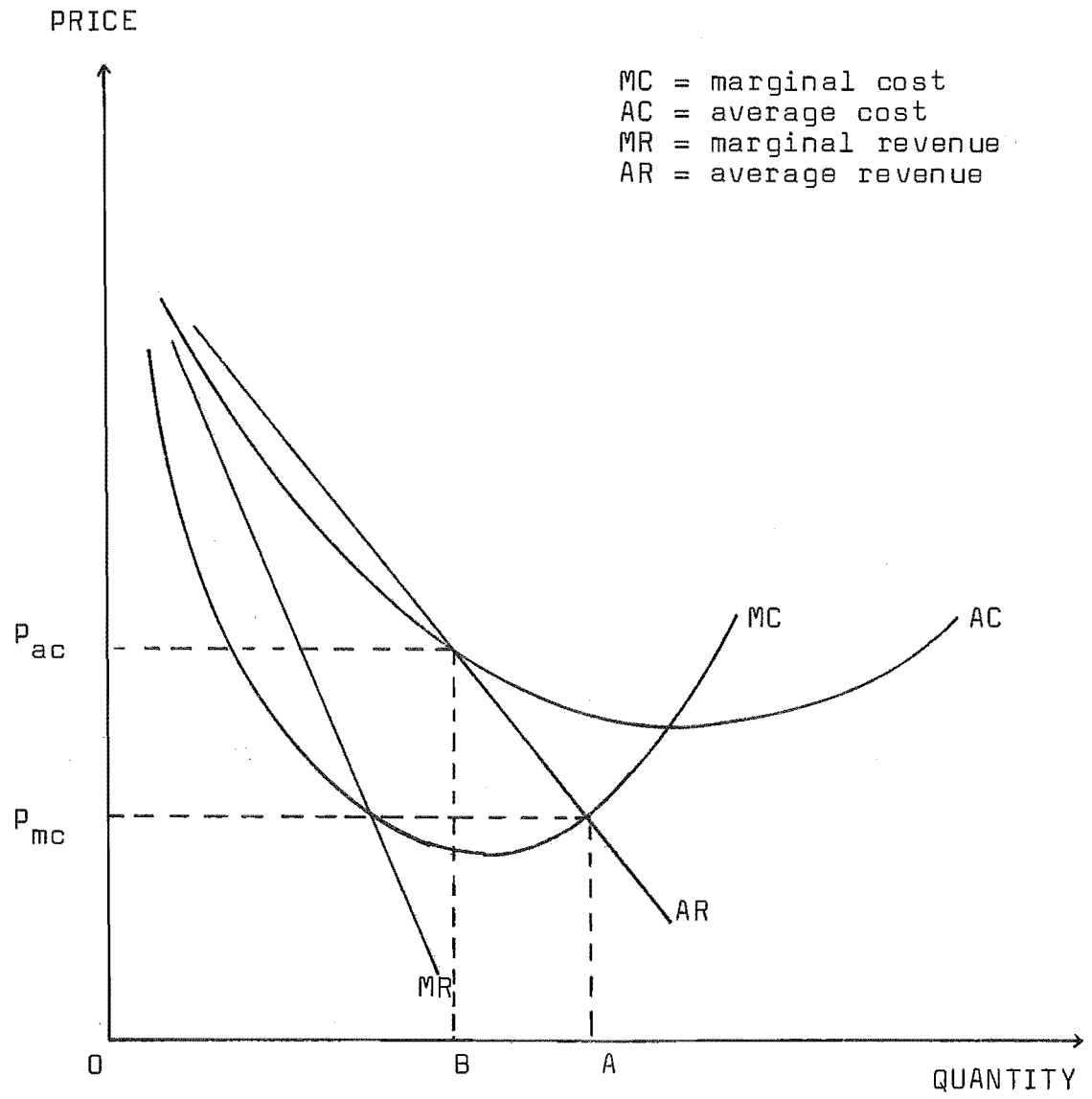
Hanke and Davis (1973) state that the relevant marginal cost concept is that of the marginal opportunity cost, or the value foregone by not using the resource for alternative purposes. As emphasized previously, water has many competing uses, and hence its marginal cost in one use should reflect not only costs involved in providing the water service (e.g. treatment and delivery costs), but also the value of other uses of the water foregone.

It is true that the "ideal" marginal cost pricing policy cannot always be applied, through problems of information, implementation and administration. However, the discussion in Section 5 will demonstrate that, as Hanke and Davis (1973) asserted, "even a loose application of the marginal principle would be a significant improvement" on present charging systems.

2.3.2 Marginal cost pricing in decreasing cost industries

At times, marginal cost pricing may not meet the financial objective of pricing systems; charges related to marginal costs may fail to yield sufficient revenue to cover a utility's costs. This phenomenon arises when production of a good is subject to decreasing costs. "Natural monopolies" arise, and without government intervention profit maximising behaviour by a monopolist would lead to too little output at too high a price (see Fig. 3). Government often supplies goods, such as water services, where production is subject to decreasing costs.

Certain adaptions to pricing policies can be made so that the utility covers its costs, but also minimises the losses associated with the efficiency objective. The deficit may be



Explanation: According to efficiency rules, price is set equal to marginal cost, and output OA is produced; but at this level, average revenue is less than average cost, since the average cost curve is still declining, and marginal cost must be less than average cost.

A loss is therefore incurred by the firm. However, if price is set at levels such as P_{ac} output will be lower than OA.

A public utility will thus seek a pricing strategy which prevents financial losses, but also minimizes efficiency losses due to departure from the marginal cost pricing rule.

FIGURE 3: Price setting in decreasing cost industries

financed in a number of ways: from general revenue, by the use of two part tariffs, and by rate differentiation. The cost of water supply can be considered as being attributable to two factors; variable costs related to volume consumed, and fixed costs not related to volume. Many economists have argued that the use of a two part tariff would lead to a smaller efficiency loss than other pricing policies if the flat fee could be kept small so that few potential users are kept from participation. Additional charges could then be based on the marginal cost principle, relating to the costs involved in providing various volumes of water. Two part tariffs are already used in a number of areas. Rate differentiation may involve differentiation between classes of users, or quantities of water consumed. If higher charges are made for the first units of water consumed, with lower charges for additional units, the efficiency objective may not be met. Consumers may be encouraged to consume larger amounts of water without regard to the capacity costs they impose on the water service.

2.3.3 Peak Load pricing

The demand for water is characterised by extreme variability over time. In order to attain efficient resource allocation, prices need to be related to the incremental costs of charges in consumption (taking into account forward looking costs). Equipment has to be designed to meet peak period demands (Table 2). Prices based on average costs encourage overutilisation of resources during peak periods, and off-peak users subsidise peak users.

TABLE 2: Allocation of plant facilities by costs and design horizons

(after Hanke 1975)

FACILITY	DESIGN HORIZON	PERCENTAGE OF TOTAL COST
Distribution main	peak hour	6.9
Distribution storage and booster pumping	peak hour	27.1
Transmission mains	maximum day	31.1
Pumping	maximum day	14.3
Treatment	maximum day	3.9
Source (reservoir)	annual use (based on safe yield)	7.6
TOTAL		90.9
	Unassignable	9.1

Writers such as Hirschleifer et al. (1968) argue very strongly for the imposition of marginal cost pricing to bring about efficient use of water supplies. Large urban areas present the most intense demand for water, and relatively high costs may be incurred in transporting, purifying and distributing water supplies possibly gathered at great distances from points of consumption. Increases in water supply capacity may therefore be very costly, and there is sound justification for a pricing policy which reflects these high costs of providing additional capacity. Peak load pricing can be seen as a "modified" form of marginal cost pricing which may "smooth out" demand patterns and lead to a more efficient use of existing capacity.

If prices at peak demand periods equate the limited supply with demand, then consumers who do not value peak period consumption highly will shift their demand to the off-peak period. In some cases it may be argued that where excess capacity exists during off-peak periods, it would be inefficient to limit its use by charging a price. However, on equity grounds this may not be acceptable, since peak consumers may feel that off-peak users should not be given a "free ride".

2.4 EXTERNALITIES AND POLLUTION PROBLEMS

Social systems rely on rules, techniques and customs to allocate scarce resources. Capitalist systems rely heavily on the market mechanism and private property rights. However, as has already been emphasised, water is a common-property resource which is less amenable to private ownership than other commodities. Alchian and Demsetz (1973) state that people who have communal

rights will tend to exercise these rights in a way which ignores the full social consequences of their actions. Externalities are unpriced effects which may arise from consumption or production activities: the consumption or production of a good by one individual or firm may affect the welfare of other consumers, or the production of other firms. The essence of externalities, whether in production or consumption, is that their costs and benefits are not reflected in market prices, and hence the decision of the producer or consumer on the level of the externality producing commodity does not take into account the commodity's external effects.

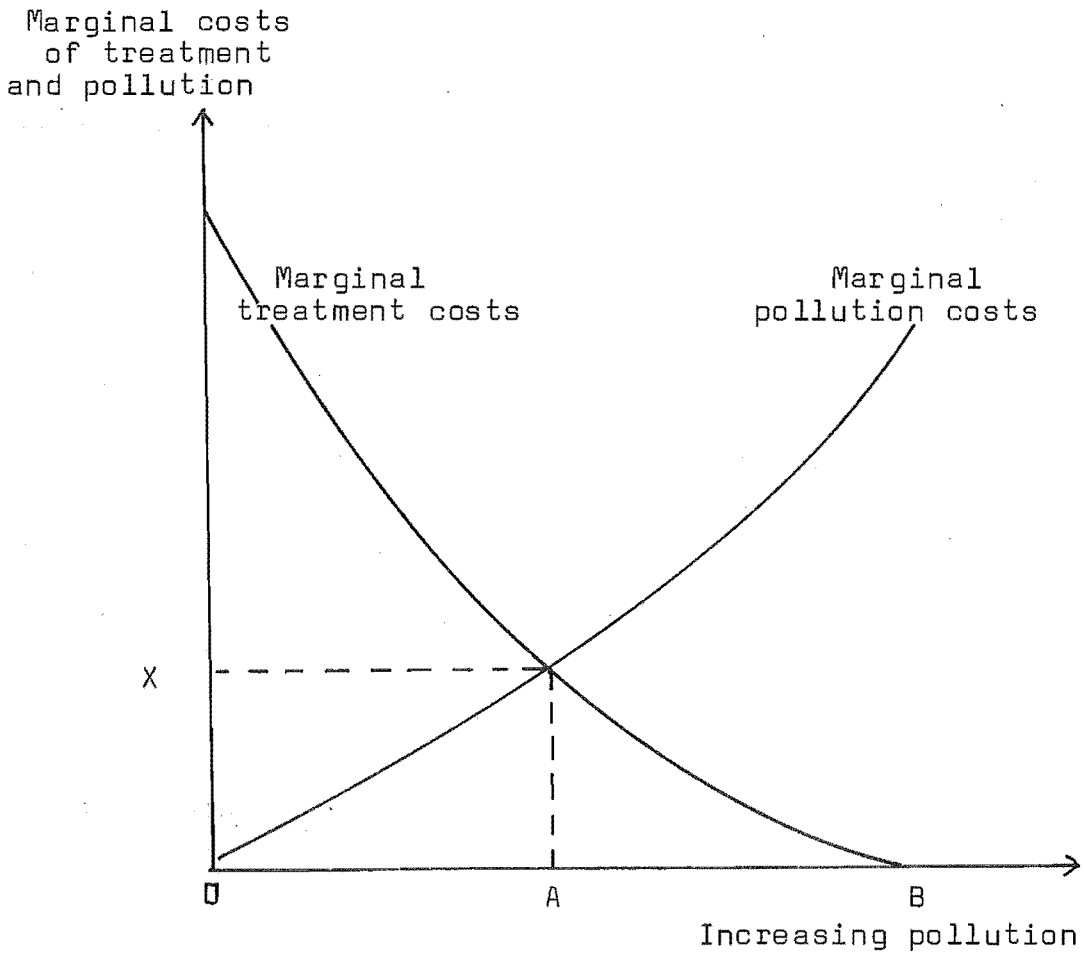
In some cases externalities may be beneficial; the eradication of garden pests by one householder may also benefit his neighbour's garden. Water pollution is a commonly occurring example of an external cost. Until recently, many economists tended to treat externalities as extraordinary events. However, Kneese (1971) argued that externalities need to be treated as pervasive and systematic phenomena.

Pollution arises because the waste disposal capacity of the environment is provided free, or at too low a charge. Firms seek to dispose of their wastes in a least-cost manner, which may involve discharge of wastes into rivers and other water bodies. However in most cases, the firm does not take into account the costs imposed on downstream users. These costs can be considered in terms of opportunities lost (foregone water supply or recreational activities), but they may not be measured easily in monetary terms (Section 4.2.1). Efficient allocation of

water requires that externalities be taken into account. The marginal principle applies; that is, net social benefits will be maximised when the marginal costs of treating wastes are equal to the marginal benefits derived from waste treatment (Fig. 4). Market forces in a free economy will result in pollution level B ; the firm maximises its benefits from pollution.

The Coase theorem (Coase 1960) argued that economic efficiency is achieved regardless of who bears the cost of externalities, and that a solution may be obtained by bargaining between polluters and those affected. However, Kneese (1971) showed that there are several problems inherent in this solution. Firstly, the parties involved are generally not equal; and bargaining costs may be high. Secondly, a question of equity arises. In bargaining, each party may feel that they are required to pay for a basic right (the right to dispose of wastes, and the right to a clean environment). Furthermore, "free rider" problems may arise because pollution abatement is a social good. The individual self-interest cannot be relied upon to bring about the optimum level of pollution abatement, and the market solution to pollution control is ineffective.

Central and regional government agencies may use a variety of methods to ensure that polluters "internalize", or take full account of, their pollution costs. It can be shown that those policies which have at least a basis in marginal cost principles (reflecting the marginal opportunity costs of pollution) will be an effective and efficient means of achieving water quality objectives. The advantages and drawbacks of various pollution control measures are discussed in Section 2.4.2.



Marginal treatment costs = costs to polluter of treating wastes

Marginal pollution costs = marginal pollution damage costs to those affected by the pollution

Explanation: The optimal level of pollution (OA) occurs when the cost per unit of waste treatment equals the public benefit arising from the treatment of the waste unit. Without pollution control regulations, producers will maximize their benefit from waste disposal, causing pollution level OB. This is an inefficient solution, because up to point OA, the benefits from waste reduction exceed the costs of waste reduction.

FIGURE 4: The definition of optimal pollution levels

2.4.1 The evaluation of costs and benefits associated with pollution control

A knowledge of the costs and benefits arising from various levels of pollution control is necessary in order to define the optimum level of pollution. However, while certain benefits and costs such as the cost of constructing treatment plants and the value of commercial fisheries can be readily assessed, other intangible benefits such as aesthetic and recreational values are less easily defined. In spite of this difficulty intangible costs and benefits should not merely be ignored, particularly since positive long term increases in the demand for environmental resources may be occurring (Knetsch 1974; Gregory 1971). The problem of valuing intangible benefits and costs is associated not only with pollution control, but with the estimation of the opportunity costs involved when water is abstracted for supply purposes.

Some economists have regarded the problem of valuing intangibles as being insurmountable (Dales 1968). However, Baumgart (1976) stated that benefits and costs must be "valued, not ignored because of difficulties in quantifying them". A number of methods for valuing aesthetic, ecological, social and recreational factors have been suggested (Thom and Darby 1975; Brockshire et al 1976; Stone et al 1970; Howe 1971; Knetsch 1974). There are examples of situations where these valuation methods have been applied. Nemerow and Faro (1970) estimated the total dollar benefits and costs associated with the use of a lake in New York state. The various uses affected

by water quality changes were studied, and changes in the benefits associated with these uses as pollution control varied were calculated.

It is not proposed to give a comprehensive outline here of the methods which can be used to estimate costs and benefits of pollution control. However, the availability of such methods shows that it cannot be argued that it is impossible to set pollution related charges because of a lack of information on intangible values.

2.4.2 Methods of pollution control

The question of establishing the "best" methods for pollution control is a complex one which has been debated by many economists (Marshall and Rueg 1975; Kneese 1963; Solow 1971; Johnson 1968; Surrey 1970; Roberts 1970; Dales 1968). The criteria applied to pricing policies (Section 2.3) are relevant, as well as several others. Control strategies need to be:

i effective, that is, capable of achieving desired water quality levels;

ii efficient, achieving the water quality objective at minimum cost;

iii flexible, capable of adapting to changes in social values or costs; and

iv equitable, with different user groups bearing a reasonable share of pollution control and damage costs. Furthermore, control measures should provide adequate incentives for improvements in waste treatment, and encouragement to use low waste-generating production methods.

Among the pollution control strategies which have been used are financial measures (grants and subsidies), direct regulations (such as effluent standards), separate facility arrangements (water classification), output taxes, effluent charges, licences, and voluntary agreements. Ross (1974) compared these methods according to the above criteria, and results are presented as Table 3. The Committee on Water Pollution Control (1976) also compared various methods, and noted that voluntary agreements, while flexible, do not force dischargers to abide by an abatement code. The former New Zealand Pollution Advisory Council was an example of a body which initially used this method to effect water pollution control.

It is not the aim of this review to carry out an exhaustive examination of the advantages and disadvantages of various pollution control measures. However, it is notable that only some of these methods involve any form of pricing policy. Many policies seek to achieve water quality standards by regulation, rather than by forcing polluters to internalize pollution costs through effluent - related charges. It has already been emphasised that society generally accepts as reasonable that the price of a good or service should be related to the cost of providing it. The price mechanism is thus used to guide individuals and firms in their production and consumption decisions. The assimilative capacity of water is not a social good, since more pollution from one source reduces the assimilative capacity available to another source. McIntosh (1977) argued that

TABLE 3: An evaluation of pollution control measures

(after Ross 1974)

Type of control measure	Performance against criteria					
	Equity	Effectiveness	Efficiency	Flexibility	Research Incentives	Administration Costs
Grants	Poor	Good	Poor	Adequate	Poor	Poor
Subsidies	Poor	Adequate	Good	Adequate	Poor	Poor
Direct Regulation	Adequate	Good	Poor	Adequate	Adequate	Adequate
Separate facilities	Adequate	Good	Adequate	Adequate	Adequate	Adequate
Polluter taxes	Adequate	Good	Poor	Adequate	Adequate	Good
Output taxes	Good	Adequate	Adequate	Adequate	Adequate	Good
Effluent charges	Good	Good	Good	Adequate	Good	Good
Licences	Good	Good	Good	Good	Good	Good

> "on the grounds of common charging practice and principles .... it is difficult to deny that there is a case for charging for direct discharges .... but there are immense practical problems in introducing such charging systems .... which could well outweigh the possible theoretical advantages."

These constraints include problems in setting charge levels, changing existing systems, measuring discharges, and uncertainties in effectiveness. Despite these constraints, it can be argued that control of pollution through pricing policies (the levying of taxes on the basis of effluent discharge, or the sale of discharge licenses on the open market) is the most efficient way of achieving desired water quality standards. Section 5 will examine the extent to which New Zealand water management agencies have used pricing policies as a means of water pollution control.

3. WATER MANAGEMENT IN NEW ZEALAND : THE ADMINISTRATIVE AND LEGAL FRAMEWORK

In order to consider the policies which control water use in New Zealand, some understanding is required of the legal and administrative management framework which exists. There are a variety of statutes and organisations involved. It is appropriate to consider municipal water supply and sewerage systems together, since these water uses are administered under a system largely distinct from that which controls abstraction from and discharge to natural waters. Territorial local authorities are primarily responsible for municipal water supply and sewage disposal, while the National Water and Soil Conservation Organisation, and regional water boards, are primarily responsible for the management of natural waters. The following sections outline the various statutes and institutions involved, with brief descriptions of their functions and development.

3.1 THE MANAGEMENT OF NATURAL WATERS

3.1.1 The legal framework

The development of an effective management system for natural waters has progressed from reliance on fragmented pieces of legislation to reliance on a comprehensive, rationalising water law, the 1967 Water and Soil Conservation Act (Walker 1975). However, a number of other acts are still relevant, and these are listed in Table 4. Also involved are a number of local acts (e.g. the Wellington Regional Water Board Act 1972, the Tasman Pulp and Paper Company Empowering Act 1954)

TABLE 4: Statutes concerning water use in New Zealand

(after Commission for the Environment 1977)

STATUTE	FUNCTION
Water and Soil Conservation Act 1967 (and Amendments)	Control of water quality: classification; offences. Establishment of water boards, water rights, use of underground water.
Counties Act 1956, and Municipal Corporations Act 1954	Bylaws for local control of water pollution; trade waste bylaws; control of water supplies and sewerage works; provision for making charges and constructing works.
Soil Conservation and Rivers Control Act	Functions of catchment boards; erosion and catchment control.
Marine Pollution Act 1974	Oil discharges; ocean dumping; penalties.
Fisheries Act 1908	Power to make regulations relating to water pollution.
Harbours Act 1950	Disposal of wastes in harbour areas.
Police Offences Act 1927	Some provision for penalties under this Act.
Land Drainage Act 1908	Powers and functions of drainage boards.
Wildlife Act 1953	Powers to make regulations.
Marine Reserves Act 1971	Management of sea and foreshore.
Public Works Act 1928	Construction of works such as irrigation schemes.
Lake Wanaka Preservation Act 1973	Special regulations.
Manapouri-Te Anau Development Act 1963	Special conditions for development of lakes.

and some Acts which refer to specific places (eg the Lake Wanaka Preservation Act 1973).

A notable forerunner to the present comprehensive Act was the 1953 Water Pollution Act which included a section on Trade Waste By-Laws and formed a national advisory council on water pollution. The 1963 Waters Pollution Regulations were important in giving this council investigatory and control powers and functions.

The preface to the Water and Soil Conservation Act 1967 defines its basic purposes as being

> "An Act to promote a national policy in respect of natural water, and to make better provision for the conservation, allocation, use and quality of natural water..., and for promoting and controlling multiple uses of natural water and the drainage of land, and for ensuring that adequate account is taken of the needs of primary and secondary industry, water supplies of local authorities, fisheries, wild-life habitats, and all recreational uses of natural water."

Prior to the 1967 Act, water rights consisted of the natural rights of the land owner, and acquired rights. These rights were of use rather than ownership, since water has never been subject to the rules of private property except when appropriated and taken into possession. The 1967 Act invested in the Crown all rights of use in respect of natural water (Williams 1975), that is

> "the sole right to dam any river or stream, or to divert or take any natural water, or discharge natural water or waste into any natural water, or to use natural water".

The Act defines the structure of the National Water and Soil Conservation Organisation (Fig. 5) and the functions of both the Organisation's various components and the regional

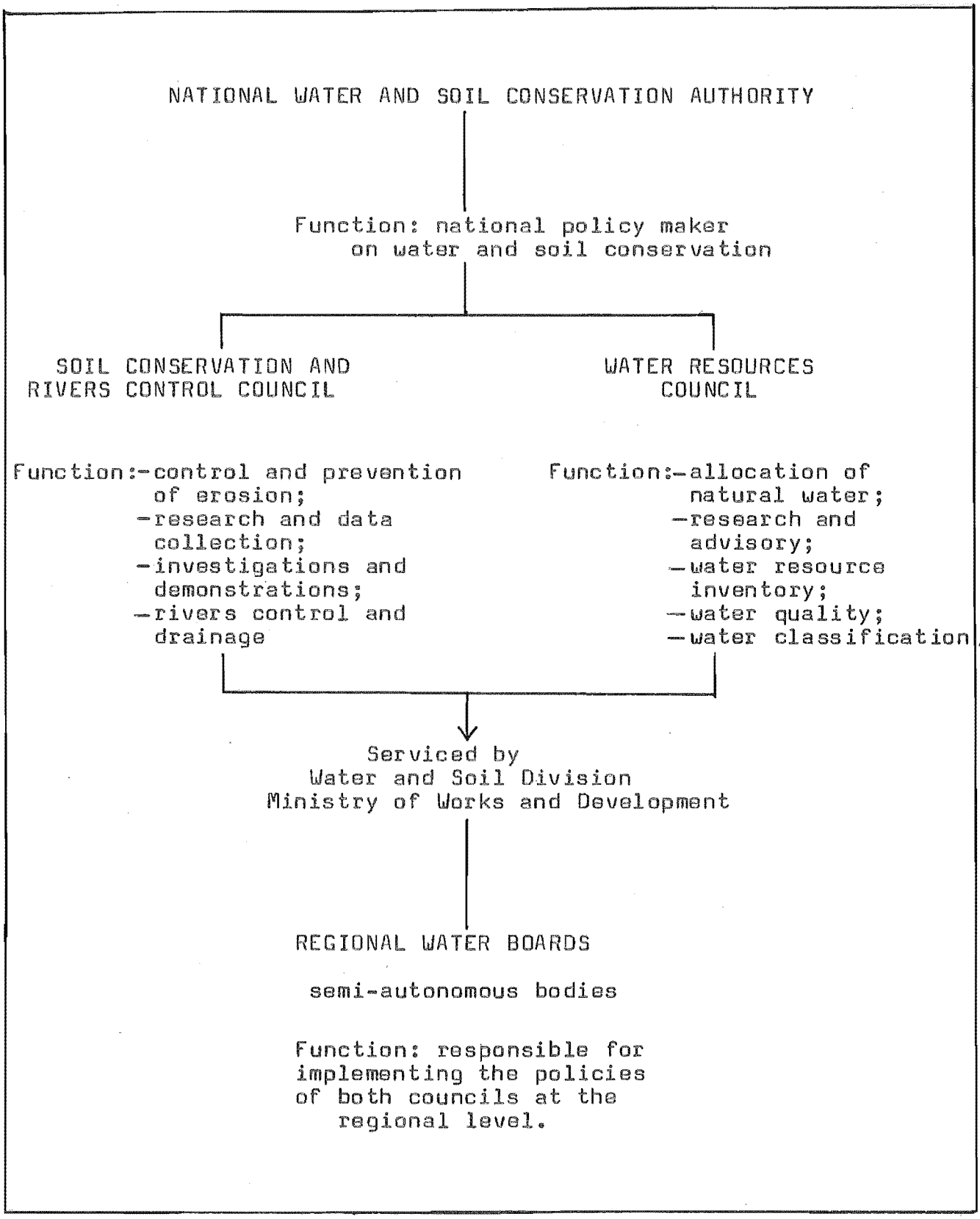


Figure 5: The administration of water management agencies in New Zealand

water boards. It also defines the two major avenues by which control of water use may be exerted: that is, by classification, and the granting of water rights. These are briefly described in the following paragraphs.

a) Classification The Act promotes a system for the classification of natural waters in New Zealand; that is,

> "a declaration of the minimum standards of quality at which the natural water so classified shall be maintained in order to promote in the public interest the conservation and the best use of that water."

The process of defining classifications has been delayed because of Town and Country Planning Appeal Board decisions against a number of classifications.

b) Water rights The water right system provides considerable control over most operations involving water use, including the abtraction, damming and diversion of natural waters, and the discharge of wastes into natural waters. Except for certain uses defined in the Act (the taking of water for domestic, stock, or fire-fighting needs) or in the General Authorisations instituted by the regional water boards, or a few special cases, all prospective users are required to apply for a water right. Such applications are processed and granted by regional water boards, except in the case of Crown applications which are granted by the National Authority. Both processes are subject to appeal to the Town and Country Planning Appeal Board.

3.1.2 The functioning of the regional water boards

The role of the regional water boards lies primarily in carrying out the provisions of the 1967 Act and Amendments. As well as processing applications for water rights, the boards are responsible for performing surveys and formulating water allocation plans.

When considering an application for the discharge of wastes, the board is required to balance competing interests by taking into account the possibility and cost of alternate methods of disposing of the waste in question, or of abstracting it from the effluent prior to discharge. Where the application is for the right to take water, the applicant must show the extent to which the use of the water applied for will be beneficial to him, and due regard must be given to other uses and future demands. It is required that the regional water boards also safeguard recreational needs, scenic and natural features, fishing, and wildlife (Williams 1975).

The only provision for charging under the Water and Soil Conservation Act occurs in relation to the granting of water rights. Firstly, Regulation 4(i) of the Water and Soil Conservation Regulations 1968 requires that every application for a water right made under Section 21(3) of the Water and Soil Conservation Act 1967 is to be accompanied by a fee of $4. Section 24(2) of the Act states

> "The reasonable expenses and costs of the Board and of the applicant and other parties to the application shall be borne as the Board may direct or left where they fall. Provided that the Board may, if it thinks fit, require payment

> of a deposit against expenses and costs before dealing with an application, and may reserve its decision in respect of final allocation of expenses and costs for separate consideration and decision when ascertained."

Thus the applicant may be held liable for at least some of the costs incurred in processing the application. A board may also require some form of deposit from those objecting to the granting of a right. In October 1977 Parliament approved the introduction of regulations which allowed an increase in the fee mentioned above from $4 to $30. Furthermore, the Amendment Bill also allows water boards to charge an annual fee of up to $10 to each holder of a water right. At the time of writing these amendments have not been incorporated into water board policy because the regulations governing them have not been released.

The only situation in which powers are given to a board to charge directly for amounts of water abstracted from natural waters occurs under the Wellington Regional Water Board Act 1972, where this board is able to charge for groundwater abstractions in the Hutt Valley region. However in relation to other groundwater, section 9 of the 1973 Water and Soil Conservation Amendment Act states that:

> "Nothing in any bylaw made under Section 4 of this Act shall authorise any Board to make a charge against or levy upon the owner or occupier of any land in respect of any natural water taken on the land or from any bore on the land."

In relation to offences against the Act, Section 34 of the Act states that where unauthorised use of water takes place

> "every person who commits an offence ..... is liable on summary conviction to a fine not exceeding $2,000, and if the offence is a continuing one to a

further fine not exceeding $100 for every day during which the offence continues " and that

"the court may direct that such portion of the fine imposed as the Court may deem necessary shall be paid to any body or person (not being a local authority or public body to which section 109 of the Public Revenues Act 1953 applies) to cover any costs incurred by that body or person in removing, burying, or otherwise disposing of or neutralising the effects of any discharge which gave rise to the offence."

The Soil Conservation and Rivers Control Act 1941 allowed Catchment Boards to levy an administrative rate on the capital value of all rateable property within its area. When the 1977 Amendment to the Act comes into force, the maximum allowable rate will be 0.05c in the dollar. It is notable that when Catchment Boards acquired the functions of regional water boards under the Water and Soil Conservation Act 1967, no extra provision was made for funding. Some regions that have low valuations have been unable to obtain sufficient revenue to meet all "administration" costs and the National Water and Soil Conservation Authority has had to supplement income of those regions by providing grants. For the financial years from 1971/72 to 1975/76 grants totalling $2,543,000 have been approved.

3.2 THE PROVISION OF WATER RELATED SERVICES

3.2.1 Water Supply

3.2.1.1 Municipal water supplies

In 1975, approximately 87% of New Zealand's population was served by public water supplies (Board of Health Report 1975). Territorial local authorities have the right to construct and

maintain such water supplies under the terms of the Municipal Corporations Act 1954 and the Counties Act 1953. For example, section 240 of the Municipal Corporations Act states that:

> "The Council may construct waterworks for the supply of pure water for the use of the inhabitants of the district ..... and may keep the same in good repair ....."

A comprehensive water supply and sewerage and sewage disposal subsidy scheme, administered by the Department of Health, encourages the provision of main water supplies. The scheme provides for subsidies in two categories; firstly, on the principal content of charges for loans raised prior to 1969, and secondly for water supply, sewerage and sewage disposal proposals (Report of the Interdepartmental Committee on the Financing of Local Authority Works, 1975). Subsidies for the latter are at the flat rate of $1 for $2 after the deduction of a basic cost factor of $5 per head of the population served by the scheme (although the deduction did not apply to initial sewerage reticulation schemes). At 31 March 1974 more than 103 local authority water supply projects had been approved for assistance under this scheme, with a total subsidy approval of $4,473,207.

Subsidy assistance is restricted to the residential content of works, and hence any industrial content is deducted from the estimated scheme costs before being considered for subsidies. Local authorities are also expected to recoup costs from subdividers whenever reasonable (sections 351B and E of the Municipal Corporations Act 1954, or section 27 of the Counties Amendment Act 1961).

The above two Acts both contain provisions for charging for water supplied. Three separate systems for financing water supplies exist: separate rates, metered consumption charges, and uniform charges. The Acts specify the maximum rate in the $ which may be levied, and the limit of the minimum charge which may be set. There is also provision for half-water rates to be levied on properties which are capable of being, but are not connected to the water supply. Section 95(3) of the Municipal Corporations Act 1954 states that:

> "Instead of levying a rate ..... the Council may, by special order,
>
> a) make charges in respect of the ordinary supply of water, according to the quantity of water consumed by any person receiving the same as measured by meter, of such amount as may ... be fixed ... or agreed on ..., or
>
> b) ..... make a uniform annual charge in respect of the ordinary supply of water as may ... be fixed."

Similar provisions for half-rates and minimum rates apply. Councils may also make charges for "extraordinary" uses of water, within the meaning of any by-law defining that use (for example, special charges for showers, baths etc installed in buildings other than dwelling houses).

3.2.1.2 Rural and irrigation water supply

A special subsidy scheme applies for rural water supply, providing subsidies towards the cost of piped water supply to rural areas. This scheme is administered by the Ministry of Works and Development. Subsidies are also available for the construction and maintenance of irrigation water supply, under

the control of the National Water and Soil Conservation Authority, which established a national policy on irrigation supply in the early 1970's. Local irrigation committees were set up to investigate new schemes and approve existing schemes. Proposals are investigated by the Ministry of Works and Development on the basis of their engineering and agricultural feasibility, and economic and water resource studies. Smaller systems may also qualify for assistance by way of loans.

An article in Soil and Water (Anon 1977) stated that:

> "the policy of successive governments has been to increase charges annually to recover operating and maintenance costs of schemes, and later, interest on a proportion of the capital costs involved."

Charges for older irrigation schemes are being reviewed.

The same article states that:

> "Irrigation schemes developed more recently in the Waitaki Valley and at Hawea have provision for their water charges to be adjusted to meet operating, maintenance, and interest charges, once their construction and development period has been completed."

This is in contrast to past policy where Government has carried the capital costs of schemes, and the balance of the cost in supplying water to farms in irrigation areas. All irrigation proposals are subject to water right application procedures. As most applications to take water for large schemes are made by the Crown, such applications are commented on by the regional water board involved, but granted by the National Authority (refer to S2.1.1).

3.2.2 Municipal sewerage services

3.2.2.1 General charges

The provision of sewerage services is subject to similar control and incentive procedures as outlined for municipal water supply. Under the Counties Act and the Municipal Corporations Act, councils may make provision for the drainage of their district, may construct and repair drains, and may levy charges for these services. A separate drainage rate may be made, subject to a maximum rate in the dollar (rateable value) and a maximum allowable minimum charge. Instead of levying such a rate, a uniform annual charge can be made. The uniform charge often relates to the number of water closets/ urinals contained in a building. Similar allowances as for water supply are made where properties may be, but are not, connected to a public drain; in such cases a half-rate or half annual-charge may be levied.

As outlined in the section on water supply, subsidies are available to local authorities for the provision of sewerage services, under the Health Department's Water Supply/Sewerage and Sewage Disposal subsidy scheme.

3.2.2.2 Trade wastes charges

Under the 1967 Water and Soil Conservation Act, local authorities may make special charges on wet industries for sewerage services provided. Section 26 L of the Act states that:

> "Any local authority may make by-laws not inconsistent with this Act ... with respect to the discharge of any trade wastes ... from trade premises into any sewer controlled by the local authority."

Under such bylaws, the following may apply:

a) industry may be required to notify the local authority of the volume, composition and discharge of its wastes;

b) periods of the day during which wastes may be discharged may be determined;

c) injurious components must be removed.

The Act makes specific allowance for charges to be made. Section 26 L states that local authorities may

> "require the occupiers of trade premises from which trade wastes are discharged into a sewer to pay to the local authority such charges ... as may be specified ... for the reception of trade wastes into the sewer, and the disposal thereof, regard being had to the composition and volume of the trade wastes ... and to any additional expense incurred or likely to be incurred by the local authority in connection with the reception or disposal of the trade wastes."

However, there is some restriction on the rights of the local authority to make charges. Charges must a) be necessary for the treatment of wastes to reduce them to a state equivalent to the average strength or quality of domestic sewage normally discharged into the sewers of the authority; or b) be in respect of the reception and disposal of excess sewage from trade premises. Trade waste charges must also take into account any by-product recovery by the local authority, and are not permitted to exceed the costs involved in waste treatment. Certain premises may in fact be exempt from charges if the local authority wishes to

"encourage industry". There is also provision under the Act for industry to appeal against charges imposed. In certain cases, local authorities may, with the approval of the Minister, enter into specific cost-sharing agreements with certain industries.

4. SURVEY OF CHARGES FOR THE USE OF WATER AND WATER - RELATED SERVICES

In order to ascertain how the charging provisions of the Acts involved in water management were actually implemented by various local government bodies, a postal survey of 19 regional water boards and over 60 other local authorities was carried out (see Appendix I for survey details). A smaller number of agencies, primarily in the Auckland area, were visited. The local authorities surveyed included all cities, a number of suburban local authorities in Auckland, Wellington and Christchurch, a number of drainage and sewerage boards, and a smaller number of county councils. The aim was to focus on those areas where a significant proportion of the population was likely to be provided with water supply and sewerage services, and where some sort of policy on trade waste disposal was likely to have been developed.

Replies were received from all authorities surveyed in the Auckland area, and most cities, but there were lower rates of reply from the borough councils and county councils in other areas. Hence a large proportion of the information contained in the following sections relates to the Auckland area, although this is not meant to imply that the implementation of charging policies is any "better" or "worse" in this area than in others.

4.1 CHARGES MADE BY REGIONAL WATER BOARDS

Appendix II summarises most of the information received from regional water boards, although further information relating to charges made by the Auckland Regional Water Board

TABLE 5: Water right charges: Auckland Regional Water Board and Taranaki Catchment Commission

i) Auckland Regional Water Board

TYPE	CATEGORIES 1 ($75)	2($125)	3($200)	SPECIAL
Take water, dam	Less than 400 cubic m/day	More than 400 cubic m/day	Municipal supply	NO SET FEE APPLICANT MEETS COSTS
TakeThermal water			Yes	
Discharge stormwater (subdivision)	Under 2 ha	2-8 ha	Over 8 ha	
Discharge farm waste	Yes			
Minor waste-water discharge		Yes		
Other waste discharges			Yes	

ii) Taranaki Catchment Commission

Similar to the above except that:

a) $30 category used for minor take water rights, treated farm wastes, discharges from small subdivisions, and diversion for farm improvements.

b) Instream uses of water may be treated in the $30 category or as a special case, for which applicants meet reasonable costs.

c) General authorisations (no fee) are given for small local authority stormwater discharges and septic tanks.

and the Taranaki Catchment Commission is shown in Table 5.

It is clear that a fairly wide variation exists between the maximum and minimum fees levied for water right applications ($200 and $15). Most boards, however, have charges in the range of $20-$30. Although not evident from the Appendix, there is also variation in the types of water use for which no fee is charged; that is, those covered under general authorisation. While some general authorisations are nationally supported, some boards feel that general authorisations commit the board to a particular approach on matters of detail before enough is known of problems that may arise (Walker 1975).

Those boards which have a graded scale of charges for different types of applications intend that these should reflect the costs involved in processing the application. The general view held is that applications for discharge rights usually involve higher investigation costs. However, there is certainly no standardized view of the way in which costs incurred in investigations should be allocated. Many boards charge applicants for costs incurred only in exceptional circumstances, for example, when a special tribunal is held. The Southland Catchment Board charges applicants only for costs incurred in holding the hearing. When industrial cases are under consideration, full costs of the hearing are charged against the applicant. In other cases, the Board may absorb some of the costs. The Rangitikei-Wanganui Board, on the other hand, base their standard application fee/

deposit of $38 on the average cost incurred in processing rights. This Board keeps a tally of investigatory and process costs for a right, and if these costs exceed $38, the excess is charged to the applicant. However, the Manawatu Catchment Board pointed out that a major problem lies in distinguishing between those investigations relating specifically to the applications, and those related to water resources management generally.

There are a few boards which have not yet formed a policy of recovering costs from applicants. It is notable, however, that a number of other boards have recognised the costs involved in processing water rights, and are currently considering the question of who should bear these costs. There is a trend towards acceptance of the principle that users should pay for the services which they receive. It is likely that the increased fees which can now be made by boards ($30 application fee and $10 monitoring fee) will significantly alleviate the immediate financial problems encountered by many boards.

4.2 WATER SUPPLY CHARGES

Charges, and other information relating to water supply, are outlined in Appendix III. The charges referred to are the charges actually levied on the ultimate consumers of water (occupiers/owners of property) within a local authority area. However, in many cases the local authorities are not themselves responsible for the initial supply of water, but merely for the distribution, within their area, of water supplied by a central water authority. In the Auckland area, the Auckland Regional Authority acts as the central supply

authority, while the Wellington Regional Water Board performs this function in the Wellington area. The Wellington Regional Water Board has also taken over the water distribution functions of the Wellington City Council. Both agencies charge local authorities for bulk water supplied.

A high percentage of municipalities surveyed use separate charges or rates for water supply (Table 6). Many local authorities have instituted universal or limited metering systems, charging for water on the basis of metered consumption (Table 6). This is particularly evident in the Auckland area, where all consumers (except domestic consumers in Auckland City, and some in Waitemata City) are metered and charged primarily on the basis of consumption. The Municipal Association of New Zealand noted in a paper on separate rates and charges for services (1970) that there is a specific historical reason for the metering of water supplies by Auckland municipalities, since water was originally supplied in bulk by the Auckland City Council, and charged for on a gallonage basis. This made charging by metered consumption the obvious system for the area.

However, for authorities outside the Auckland area, annual charges and separate rates are a more commonly used revenue-gathering device for domestic consumers than metering. The survey carried out by the Municipal Association in 1970 revealed a similar trend, with 19 of the 24 surveyed authorities having universal metering being in the Auckland

TABLE 6 - Separate rates and charges for water supply

	Consumers	
a) Local Authorities:	Domestic	Other
Number levying separate charge	37	40
Number without separate charge	3	-
Number of replies received:	40	40
b) Basis of charging for water	Domestic	Other
Separate rate	10	
Uniform annual charge	5	
Metered consumption	18	35
Combination system	4	5
	37	40

TABLE 7 Separate rates and charges for sewerage services

	Number of authorities
General rate	20
Separate rate	9
Annual charge	5
	34
Trade waste charges	24
No trade waste charges	10
	34

area. In many cases a separate rate is levied, calculated on a rateable value (capital, unimproved or annual) basis. A minimum annual charge is often set. In other cases, the water rate is also the minimum charge, and metered charges are applied on water consumed above the amount allowed by the value of the rate. Where there is no universal metering, meters are frequently installed on residential properties which have private swimming pools.

Annual charges vary from a minimum of $15 to a maximum of $34. The separate rate levied varies from .138¢/$ to .2¢/$, although unfortunately many authorities did not specify whether this rate was levied on unimproved value or capital value. The Municipal Association (1970) noted that there is provision within the Rating Act to levy separate rates on different systems of rating from the general rate, although their survey revealed that only 11 municipalities had taken advantage of this provision. Information provided by the present survey was insufficient to confirm whether this number had increased.

In nearly all areas surveyed, industrial and other large consumers such as hospitals and schools are metered (Appendix III) and charged according to metered consumption. Again, some form of annual charge or minimum charge may be applied as shown by the "combined" systems in Table 6. Commercial users are metered only in some areas. In municipalities such as Christchurch City and Lower Hutt City, half water rates are levied on commercial premises.

If the users draw more water than the half water rate entitlement, they then pay according to extra consumption.

There is considerable variation among charges levied on industry. In a few cases, (mainly provincial centres) only large consumers or water-based industry are metered, while others pay separate rates or annual charges. Metered consumption charges vary between 25¢/1000g and $1/1000g. In a few cases, a form of declining block schedule operates. The Auckland City Council levies a reduced water rate where consumption exceeds 40 million gallons per quarter, on a seasonal basis. Usually only the freezing works qualify for this concession. Similarly Mt Roskill Borough, One Tree Hill Borough, and Wanganui City state that they reduce charges as consumption increases, although the quantities involved are again so large that only very large consumers would benefit from reduced rates.

Other special provisions relating to industrial and commercial premises exist. For example, in Upper Hutt City general rates on industrial and commercial properties are, by virtue of the differential rating system, higher than those on residential properties. Such consumers are therefore allowed to use 1000 m^3 of water each year free of charge, with any quantity in excess of that amount being charged for. Special agreements may exist between the local authority supplying water, and large consumers. In Invercargill, parties to the Bluff pipeline agreement meet a proportion of pipeline costs.

Many authorities allow a reduction in charges to institutions such as schools and churches. This reduction varies between areas; a 16.5% reduction in Wanganui City, 12% in Ellerslie Borough, 10% in Howick Borough, and unspecified reductions in other areas. There are a number of other examples where the rate charged varies according to use: for example, in Napier, where the Harbour Board and Harbour Board shipping pay higher rates than other commercial enterprises.

Some data on water consumption was also gathered and this is presented in Appendix III. Unfortunately there is a lack of standardization between different authorities in the way that consumption measurements are recorded. The most easily comparable results are those from the Auckland area. The significance of consumption levels will be discussed in Section 5.

The survey also revealed that separate rates and charges sometimes do not cover the entire costs of water supply. For example, Invercargill City meets 20% of the total cost of water supply from general rates.

4.3 CHARGES FOR SEWERAGE SERVICES

4.3.1 General charges

As for water supply, local authorities use a variety of means to recover costs incurred in providing sewerage services. Appendix IV outlines data obtained from survey respondants.

It is evident that fewer authorities use a separate rate or charge for drainage/sewerage services than for water supply (Table 7). This was also revealed in studies

carried out by the Municipal Association (1970) and the Territorial Local Government Council (1975). The latter survey showed that while 41 out of the 46 councils (city, borough and county) surveyed levied separate rates and charges for water supply, only 16 levied a separate rate or charge on sewerage/drainage services. However, some councils may not have provided these services.

To some extent, the type of charge made is determined by the way in which the service is provided. While some authorities manage their own sewerage and sewage disposal services, in several cases these services are provided by separate ad hoc authorities which levy constitutent local authorities. The Auckland Regional Authority, North Shore Drainage Board, and Hutt Valley Drainage Board levy local authorities on a per capita basis. The Christchurch Drainage Board, on the other hand, rates on the capital value of properties within its district. Separate rates are levied for sewer maintenance and sewer loans. The five local authorities involved collect rates on behalf of the Board.

Unfortunately only two separate rates were specified, these being .12¢/$ for Invercargill City, and .2185¢/$ rateable value for Wellington City, although a number of other authorities do levy such rates. The basis on which uniform annual charges are made varies between authorities. Annual charges per dwelling or business unit range between $23 and $35. However, annual charges are also made on the basis of the number of

WC/urinal units, and these charges range between $9.50 per unit and $40 per unit. Again, the charges levied do not necessarily reflect the cost involved in providing the service, since the costs of drainage/sewerage services are not always covered by the separate charges made.

In some cases, connection and disconnection fees are charged. A number of authorities also charge subdividers for the cost of sewerage systems, or require that the subdividers install such systems.

4.3.2 Trade waste disposal

Wet industries are charged both on the basis of trade waste charges, and on rateable value where separate rates are assessed. However, in the latter case, separate rates may be offset against trade waste charges.

The trade waste charges reflect the additional costs of treating trade waste as compared to domestic sewage from a property of equivalent rateable value. The actual amounts charged by various organisations are set out in Table 8. The Auckland Regional Authority bases its charges on the percentage contribution that trade wastes make to the loading on the treatment plant (Table 9). Costs thus reflect that suspended solids and blochemical oxygen demand (BOD) levels from trade wastes are proportionally higher than those from domestic sewage. Charges levied by the Invercargill City Council are formulated on a similar basis.

TABLE 8 : Trade waste charges

AUTHORITY	CHARGES
Auckland Regional Authority	Volume: $20/g/minute/annum Suspended solids: $210/1001b/day/annum BOD : $400/1001b/day/annum
North Shore Drainage Board	14.5¢/1000g
Christchurch Drainage Board	Volume: $8.49/l/minute/annum Suspended solids: $7.25/kg/day/annum Biochemical Oxygen demand: $9.08/kg/day/annum
Invercargill City	Monthly charge $= \frac{1}{12} \times \frac{1}{2} \left(\frac{BOD}{PBOD} + \frac{SS}{PSS}\right)(AO + AL)$ PBOD = plant design BOD load PSS = plant design SS load AO = Annual operating cost (= $65, 576 for 1976-77) AL = Annual capital cost (= $73, 954 for 1976-77)

TABLE 9: Methods of trade waste charge calculation - Auckland Regional Authority

(after Gummer, pers. comm.)

Fair Charge to Industry for use of System 1973/1974:

Flow			
	Capital Expenditure		
	Domestic flow	116.6 mgd	89.1%
	Trade wastes	14.2 mgd	10.9%
	Operating Costs		
	Domestic Flow	45.4 mgd	84.3%
	Trade wastes	8.5 mgd	15.7%
Suspended Solids	Domestic Use 549,510 population at 0.103 lb per day	56,600lb	42.2%
	Trade wastes (by deduction)	77,500lb	57.8%
BOD	Domestic Use 549,510 population at 0.167 x 2/3*	61,178	50.7%
	Trade wastes	59,558	49.3%

* 1/3 removed by sedimentation.

Trade wastes charges are calculated on the basis that trade wastes contribute the above percentage loadings to each category. Costs attributable to each category are calculated on a separate basis.

Approximately 31.4%, 34.9%, and 33.7% of total treatment costs are attributable to Volume, Suspended Solids, and BOD respectively.

The North Shore Drainage Board stated that current charges were set some time ago, and are due for revision. A trade wastes charge in the vicinity of 36¢ per thousand gallons is probably more realistic. Revision of the Hutt Valley Drainage Board charges is also taking place.

In other areas, provision for trade waste charges may be made by specific agreement between the local authority and the industry concerned. For example, the Timaru City Council levies an annual charge on the local freezing works as a capital contribution to the main sewer outfall ($1,770 in the year ended 31 March 1977). Similarly, an agreement exists between the Dunedin Drainage and Sewerage Board and the Roslyn Mills for the payment of trade wastes charges.

5. DISCUSSION

This discussion will relate charging practices followed in New Zealand to: a) the theory described in Section 2, and b) overseas practices. Recommendations will be made as to where pricing policies could and should be implemented and improved upon.

It is true that the situation in New Zealand regarding both water supply shortages and water pollution is not as severe as in some areas in Europe or North America. With New Zealand's shorter rivers, and the frequency of waste discharge to coastal waters, water is probably not used and reused to the same extent as for example the Thames, where sewage effluent makes up 14% of flow, and the Rhine, which contains 40% treated effluent at average flows. Solutions to water shortages and pollution problems which are viable overseas may not be viable in New Zealand, and this discussion will attempt to point out how such overseas solutions might be adjusted to New Zealand conditions.

5.1 WATER SUPPLY

As has been discussed in Section 2.2, water for supply purposes cannot be treated as a pure social good. Consumption is rival, and sale to particular consumers is possible. Water supplied through municipal reticulation systems can be sold, and direct charging may be appropriate. However, water supply services cannot usually be provided efficiently through private firms for reasons of decreasing costs (Section 2.3). Furthermore, water supply services

have certain "merit good" elements. It has been asserted that distributional considerations should be allowed for in pricing decisions, recognizing that certain services, or levels of service, should be provided on a subsidized basis. However, it has also been stated frequently that subsidization may be an inefficient means of achieving income distribution objectives, depending on whether the products in question weigh more heavily in high-income or low-income budgets. These factors will be taken into account in the following discussion. However, it will be argued that water supply services should primarily be considered as private goods. Above a certain level of water consumption necessary for the maintenance of health (adequate water for cooking, hygiene), water is not an "essential" good. The benefits obtained from such higher levels of consumption are essentially private, without significant spill-over benefits occurring. It will be shown that the financing of water supply services on the basis that water is a "merit" good will provide neither efficient nor equitable solutions to water allocation problems; the application of marginal cost principles to water pricing is a preferable alternative.

A consideration of overseas charging principles shows, however, that marginal cost pricing is far from being a common phenomenon, both for reasons of technical and administrative feasibility, and political acceptability. It is true that experience in the United States and Europe has demonstrated the beneficial effects of metering. Flat rate charges for water use can be considered as an open invitation to waste, since there is no incentive to correct leaks and generally to make more efficient use of

water. A flat rate assumes that consumers are homogenous with respect to both quantity consumed and costs of water supplied, and hence the price of additional water units to the consumer is zero.

In contrast, metering makes consumers aware of the amounts of water consumed, and relates charges to use. A few writers, such as Lobb(1975), have claimed that domestic consumers are not responsive to price changes. Price is not the only factor important in determining demand for water; however, Hanke and Flack (1968), Young (1973) and Morgan (1973) show that price has a significant effect. The initial psychological effect of meter installation is important, as illustrated in Fig. 6, although Gallagher and Robinson (1977) stated that "while universal metering is a prerequisite to the introduction of an effective water price policy, the installation of meters per se does not guarantee an efficient use of water."

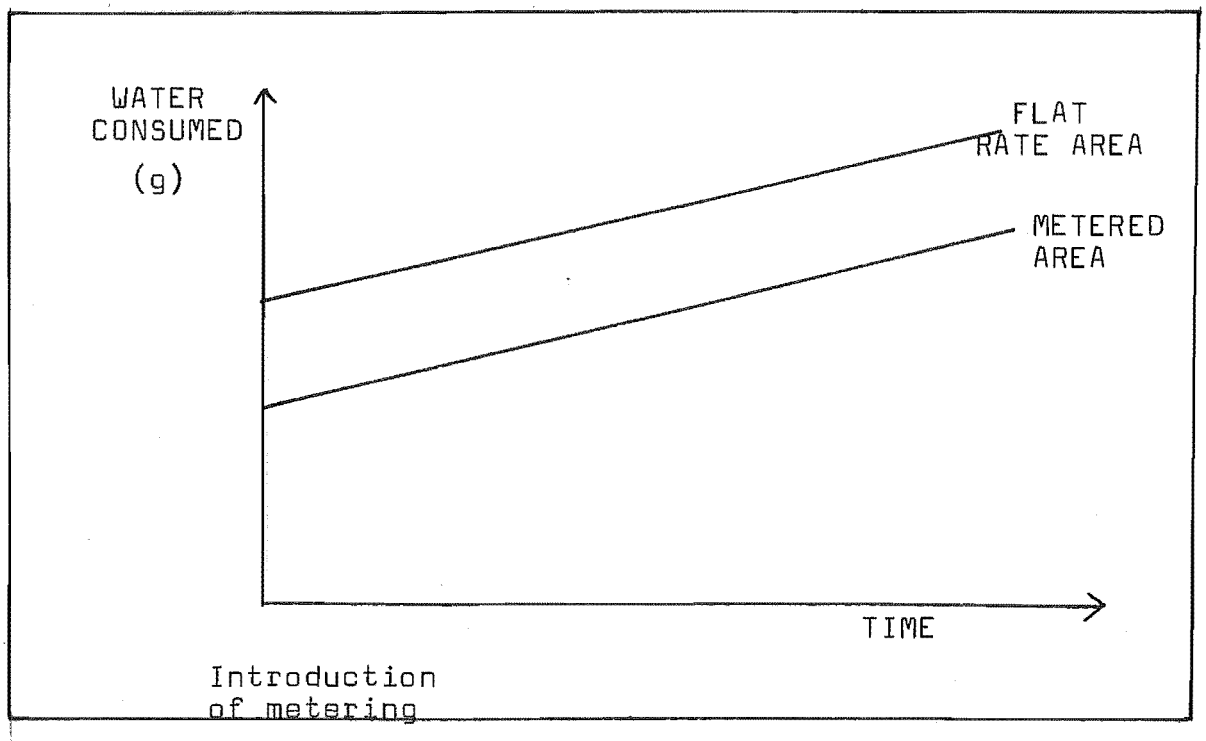


FIGURE 6: Effect of meter installation on demand in Boulder, Colorado

(Hanke and Flack 1968)

Reduced demand means that capital costs can be reduced, and operating and processing costs lowered. Of course, these benefits do have to be weighed against the costs of installing and maintaining metering equipment. The National Water Commission (1973) suggested that, in the United States, the introduction of metering and increases in water prices may also have effects on the use of water-using applicances, encouraging the use of modified appliances.

A number of American water utilities have instituted "two-part tariffs" to overcome the problems encountered due to declining water supply costs. Consumers frequently pay a "lump sum" charge in addition to paying for metered water consumption. Hanke (1975) pointed out that, although universal metering has been implemented in a number of areas in the United States, pricing has tended to be on the basis of average historical costs. However, as argued in Section 2.3, the demand for water tends to be variable over time and space, so average cost pricing leads to an inefficient use of resources where peak users subsidize off-peak users.

Some American utilities have attempted to overcome the problems of peak demand by instituting peak cost pricing. Afifi (1969) noted the need for pricing policies to smooth load patterns, and suggested a two-part seasonal rate, which incorporated a seasonal rate and a per unit rate. To a certain extent, particularly in dry areas,such seasonal rate differentials exist. For example, in El Paso, Texas, the water utility raised summer water rates (along with a consumer education programme in which awards were given for low water-using landscaping) to achieve reductions in summer water demand. Similarly, Leversedge

(1974) and Hogarty and MacKay (1975) found that drops in peak demand occurred where peak load pricing was instituted. Even more sophisticated means of charging for peak demands are now being developed. Feldman (1975) suggested a form of metering which would allow peak hour or maximum day pricing. This meter would operate through responsive rate variation or pressure sensitivity; however, technological factors would make meter installation and maintenance costly. The writer has not found any examples of the implementation of such a scheme.

In contrast to peak load pricing, some utilities have ignored marginal cost principles in implementing declining block tariffs for water consumption (that is, water rates per unit decrease as consumption increases). Hirshleifer et al. pointed out that such rates were undesirable from the point of view of economic efficiency. However, attitudes are changing. Recently, a number of water utilities have proposed increasing block tariffs which include a "life-line" block at a cheaper rate which is intended to cover basic needs. This takes into account "merit good" aspects of water supply, ensuring basic health and welfare standards.

Furthermore, Keller (1977) noted that utilities have begun to recognize the substantial financial burden that new water connections impose on existing users, and connection fees are being adjusted so that more of the cost is being borne by the new consumer. However, Keller also points out that in some cases, such increasing charges have been politically unacceptable.

In the United Kingdom, far less use is made of metering for domestic consumers; charges tend to be made on the basis of rateable value (Gilliland 1977). The principle of "parity" is still in use; that is, charges for measured consumption are fixed so that the income per 1000 gallons of water supplied by meter is the same as the income per 1000 gallons supplied to unmetered consumers in aggregate. There is some conflict in the United Kingdom as to whether demand control through price is acceptable. Some water utilities still argue that "a publicly owned, technical monopoly is obliged to meet all demands" (Water Research Centre Symposium Proceedings 1977).

In Australia, charges for water supply are generally made on the basis of property value. The commercial sector pays a significant contribution towards the revenues received by the water authority, because property valuation in the central business district tends to be higher than elsewhere, while this sector represents only a small proportion of total water consumption. Recently a number of studies on water pricing policies in New South Wales and Victoria have been carried out. Gallagher and Robinson (1977) suggested that a two-part pricing policy would be suitable in Australia. There would be a fixed annual charge, which would include a payment for the provision of fire fighting service capacity, and a price per unit of water consumed.

What then is the situation regarding charging for water supply in New Zealand, and how does it compare with overseas practice? Background information on water charging is set out in Sections 3 and 4, and Appendix III.

An Auckland Regional Authority internal report (1976)

stated that the water supply objective of this authority was "to make bulk water available as and when it was demanded by customer local bodies", and that capital works programmes were drawn up accordingly. A similar water supply philosophy has been held by many other supply authorities. However, it is now recognized, at least by some water suppliers, that a reappraisal of water supply philosophy is required, particularly in view of the much higher costs often involved in meeting additional demands for water.

It is notable that none of the local authorities surveyed, except perhaps the Auckland Regional Authority, had given much consideration to the use of pricing policies as a means of regulating demand. Firstly, the financing of water supply through general and separate rates means that charges bear no direct relation to the amounts of water used. Under this system there is no incentive for consumers practice water conservation measures. If it is accepted that water is a private good, and that users should be charged according to quantities consumed, then it needs to be considered whether rateable value is a reasonable proxy for water consumed, and the costs that a user imposes on the water supply system.

As has been pointed out, the costs of supplying water vary markedly with time and space. Obviously, a property's rateable value does not necessarily bear any relation to the peak demands which a consumer exhibits, nor to the costs of supplying water to the property. Considerable cross-subsidization may occur between rate-payers, particularly where

differential rating systems do not take account of water supply costs. For example, it has been shown that it is generally cheaper to supply water in more densely settled areas, and that smaller properties tend to use less water for irrigation and gardening purposes. However, if a higher rate is struck on inner city properties with lower water supply costs, or if inner city properties tend to be higher in value, then these properties may well subsidize suburban rate-payers who may both use more water, and require costly water supply systems. This feature was recognized by the Upper Hutt City Council, which gives a free water allowance to more heavily rated commercial properties. Where water supply is financed on a rateable value basis, consumers who use water wastefully, have appliances which consume large amounts of water (for example, dishwashers, waste disposal units), or who fail to check for water leaks, are subsidized by other ratepayers.

If water was considered to be a merit good then it is true that financing through rates does not lead to socially undesirable reductions in water use, since charges are not related to amounts of water used. However, the consideration of merit goods often involves the question of directing such goods towards the poor (Musgrave and Musgrave 1973). It needs to be recognized that rates tend to be regressive in nature, so that even if distributional considerations are to be allowed for in pricing decisions, a regressive rate structure would not achieve an objective of subsidizing lower income individuals.

On the other hand, it might be true that other means of raising water authority revenue, such as taxes based on income, would be even less desirable from an efficiency viewpoint, unless it could be shown that water use was related significantly to income. Gallagher and Robinson (1977) showed in their Australian study that in-house water demand could be related to income, although they did not establish this relationship for out-door domestic uses. In their model, they used numbers of taps, showers, washing machines and toilets as a wealth-income proxy. However, a study by Howe and Linaweaver (1967) showed an inverse relationship between income and water demand in some areas. There have been no studies undertaken in New Zealand of this nature, so it is not possible to say what impact income has on water consumption.

The annual charges made by some authorities may to a certain extent reflect water usage, particularly if related to numbers of toilet units, baths or showers. However, a flat annual charge assumes that all users impose the same costs on the water supply system, which is a highly unlikely event. Those who consume small amounts of water, and exert low peak demands on the system, subsidize consumers of larger amounts. A few authorities in the Auckland and Wellington areas do try to lessen the subsidization effect by metering domestic ratepayers likely to consume large amounts of water, for example, those with swimming pools. An argument has been put forward that increases in annual charges may result in increases in consumption as ratepayers attempt to "get their money's worth out of the system."

Metering as a means of charging for water supply is widely used in New Zealand for commercial and industrial users and, to a lesser extent, for domestic users. There are marked variations between charges, and in some areas charges may not meet the costs of supply. It has been emphasized by a number of writers that it is not sufficient to merely install meters; charges per unit need to be meaningful and to reflect the costs of supply if there is to be any influence on consumer demand.

In some areas in New Zealand, there have been considerable decreases in water consumption with the introduction of metering. Mansergh (1970) reported a 50% reduction in consumption after water supplies in Onehunga Borough were fully metered, while Parkinson Cowan Ltd. (1976) noted marked decreases in consumption after the introduction of metering in parts of Tauranga County. Once consumers are aware that charges are related to water consumed, they are more likely to adopt water conservation measures, and also to ensure that water is not lost in inefficient distribution systems. In New Zealand, more than 10% of water supplies may be "lost" in transmission from sources to consumers.

It is somewhat difficult to determine the exact relationship between price and consumption levels. The Auckland Regional Authority has attempted to relate domestic consumption in their area to charges per unit. However, it must be recognized that consumption per head is also related to factors such as family size, property size and climate. It would appear that in Auckland, the only unmetered area (Auckland City) has a markedly higher consumption per head than other areas. De Courcy (1976), in an Auckland Regional Authority survey, noted that the lowest consumption per head

occurred in Waitemata City, which also had the highest charges. It is somewhat difficult to compare current consumption figures from the survey of local authorities because of the lack of standardisation of returns. Some authorities differentiate between domestic and other uses, while others do not. However, it is clear that on a nation-wide basis, authorities without domestic metering had considerably higher domestic consumption figures than authorities with universal metering (Gummer 1976).

Economic theory suggests that most efficient use of water will occur when prices reflect the marginal costs of water supply. There are only a few examples of declining block structures, one of which (Auckland City Council) does take into account seasonal differences in the availability of water. Generally within New Zealand charges for water supply, whether related to metered consumption or not, are based on historical average costs and hence do not cope with the problems of peak demand. Even where consumption is metered, costs may be subsidized from the general rate. As a result, even metered charges do not reflect the costs of additional supply sources and consumers have no incentives to reduce peak demands.

Arguments against metering have asserted that low income families would be forced to reduce consumption to unacceptable levels in terms of health standards. However, the American concept of "life-line"rates would appear to cope with this problem, and presumably could be implemented fairly readily in areas with domestic metering. Special allowances are already made by some authorities such as Wanganui City, Howick and Ellerslie Boroughs, for churches and schools, which may receive water at a lower rate than other consumers (Appendix III). Water here seems to be treated as a "merit

good" in that it is being supplied for purposes deemed to be socially and culturally desirable. Whether or not this is a suitable method of public assistance of education and religion is somewhat open to debate; but provided the subsidization does not encourage wasteful use of water, it can be justified on the basis of its social value. It may in fact be more socially and politically acceptable to provide such subsidization than to provide general financial aid.

Some other charging principles used in New Zealand can be justified in terms of promoting efficient water use. For example, the charging of unconnected properties for the availability of water supply encourages the full utilization of reticulation systems. The fact that subdividers must meet some or all of the costs of reticulation systems means that there is less subsidization of new connections by existing consumers.

The provision of central government loans for water supply purposes also gives recognition to the fact that the provision of safe, clean water supplies can be considered as a national objective. However, it is true that the availability of such loans may make the construction of extra supply capacity an "easier" alternative than other methods of equating supply with demand, such as the regulation of demand through pricing policies or the encouragement of water re-use. In particular, so long as the maintenance of public health standards is deemed to be all-important, it may be difficult for local authorities to introduce water re-use schemes.

There are many areas for improvement of water charging systems in New Zealand. Of course, the administration and

technical costs of implementing metering systems must be weighed carefully against the benefits of reductions in demand for new capacity. In some cases it may well be that such costs outweigh the benefits. However, in view of the rapidly escalating costs of providing new supply, there are sound reasons for local authorities to investigate very carefully the feasibility of universal metering.

There are other alternatives to the introduction of metering: flat rate charges could be made on a per capita basis. This system has been investigated in Britain, where it was found that the administrative costs of changing from an existing, workable system were too high in comparison to the likely efficiency benefits. It is quite probable that the same argument would hold against the introduction of per capita charges in New Zealand.

Many areas in New Zealand already have partial metering, and most of the Auckland area has universal metering. In these areas, there is scope for the introduction of peak demand charges. It is clear from the restrictions which have to be applied over dry summers, and a comparison of peak to average demands, that a peak loading problem does exist. It is not suggested that the highly sophisticated forms of metering suggested by Feldman (1975) are as yet economically or technically feasible. However, even a two-stage summer / winter rate could alleviate some of the demand problems, particularly if applied to large consumers such as wet industry. Domestic consumers would probably also need some form of education programme. This approach has already been suggested in an Auckland Regional Authority report (1977) which stated that

(1977) which stated that:

> "An active water conservation programme to acquaint the public and industry with the problems and costs associated with increasing water consumption, and the promotion of conservation measures would help to alleviate water supply problems."

The same report suggested that it might be desirable to alter bulk pricing structures so that consumption above "normal" requirements was charged out at an increased rate. Gummer (1976) stated that "prices should be maintained at a level high enough to discourage excessive demand". However, as Johnson (1968) argued, an increase in technical efficiency through misuse of the price system does not bring about economic efficiency. A very careful assessment of the marginal costs of water supply, and the administrative costs of peak load pricing (for example, additional metering) would need to be made before an authority made any decision to implement seasonal or peak load pricing.

One final point about current water charging systems in New Zealand is that these do not reflect the opportunity costs of foregone uses of water. In contrast, there is provision under English law for water to be priced at least partly in terms of water resource scarcity. Water supply authorities have to compete with other users for available natural water, but unless costs inflicted on other users are taken into account when considering the expansion of supply capacity, an authority may not be sufficiently encouraged to investigate other supply sources such as waste water treatment and re-use.

5.2 SEWERAGE AND SEWAGE DISPOSAL SERVICES

As for water supply services, it can be argued that sewerage and sewage disposal services should be treated as a private good. However, certain external benefits arise in that the maintenance of a certain level of public health cna be considered a social necessity; the benefits from the use of sewerage services are not entirely private. Even so, it can be shown that the treatment of sewerage services essentially as a private good, with some allowances for merit goods (as for water supply pricing), will ensure the most efficient use of the service.

The theoretical arguments for charging are again based on marginal cost pricing; ideally users should be charged in accordance with the costs their wastes impose on disposal and treatment systems. Thus charges usually need to be related to both quantity and quality of wastes released.

5.2.1 Domestic sewerage services

In general, the financing of domestic sewerage services has not been on a "user-pays" basis. Historically, sewerage services have been regarded as an "essential" public service, where charges should not be related to provision of the service. In Australia and Britain, the financing of sewerage systems has relied heavily on charges made on the basis of rateable value of properties. Rees (1977) pointed out that this involves a considerable degree of cross-subsidization between users , since commercial premises in central city locations may pay a disproportionate amount of total costs. Rees estimates that for Australian cities, the removal of this subsidy would result in a 30%

increase in domestic charges. A similar charging system exists in Canada.

In New Zealand, most local authorities finance sewerage services from general or special rates (Appendix IV). It is not possible to draw any relationship between rateable value and the use of sewerage services, and hence consumers are not charged for the amount of the service they consume. The costs of providing sewerage services vary between areas, and thus there is probably a considerable degree of cross-subsidisation between users, as in the Australian example. As for water supply, to the extent that sewerage services should be considered as merit goods, this method of financing does not discourage use of the service. However, it also does not discourage wasteful or excessive use of sewerage services, and since rates are regressive in nature, would not meet accepted income distribution objectives were these held to be an objective of sewerage service pricing. It is also notable that sewerage rates are based on average historical values rather than "forward looking" costs.

Flat rates for the provision of sewerage services are also fairly common overseas; however, these involve zero unit prices, and usually are low charges based on historical construction costs. In New Zealand, flat charges may be made on a per-dwelling basis, as in Devonport Borough, or on the basis of the number of toilet units, showers and baths, as in Tauranga and Porirua Cities. Charges made on the latter basis are probably somewhat more equitable, in terms of relating the incidence of benefits to the cost of providing the service, than are rateable value basis charges.

However, there is a significant difference between the amounts of waste generated by different households, based on household size, the use of appliances such as waste disposal units, and other factors such as roof area (De Courcy pers. comm.). Flat rate charges do not take into account these differences, or provide any incentive for waste reduction.

A number of other bases have been suggested for annual charges. Stormwater runoff, which can contribute a major pollutional load to drainage systems, is related to impermeable areas. Hence it has been suggested that impermeable area should form a basis for annual charges. Per-capita charges, or charges for the use of certain household appliances , could be made (Lester 1977). All these are theoretical possibilities; however, a distinct advantage of present charging systems is that they are simple, and easy to enforce. Charging on the other bases mentioned would involve considerably increased administration costs which could well outweigh the efficiency benefits of implementing the charges.

The costs of providing new sewerage connections are considerable, and although subdividers may meet some costs, existing users also help to meet the cost of sewerage system expansion. Downing (1973) has pointed out that effective pricing of new connections can be a means of implementing urban growth policy. For example, connection fees could be increased in lower density areas where the cost per household of providing services was higher. Some local

authorities in New Zealand charge undeveloped properties, through general or special rates, for availability of access to sewerage services, and this policy would seem to encourage the more efficient use of available systems. However, if the size of the charge is low, as it seems to be in several areas, consumer choice may not be affected by it.

In the preceding section on water supply, the use of income based charges is mentioned. Such charges could be justified if it could be shown that the use of sewerage services was related to income.

It is generally agreed that the cost of measuring and monitoring discharges from individual households would be technically difficult and prohibitively expensive, even though it is feasible for wet industries (Rees 1977). However, there is a relationship between amounts of water consumed, and amounts of water discharged to sewerage systems. An Auckland Regional Authority internal report (1976) stated that in Auckland "approximately 75% of all bulk water finds its way into ARA sewers". Most planning for water supply has paid little attention to the consequent demand on other services such as drainage. However, some Auckland authorities are now considering a joint pricing philosophy for water and drainage. A few other countries have already recognized the relationship between water and wastewater. For example, in Japan, wastewater disposal and treatment taxes are payable on the basis of water consumed (OECD 1977).

Certainly charges made on the basis of water consumed would reflect sewerage system use more closely than flat rate charges or property rates. They would encourage both water conservation and lowered waste production. Ideally, these costs would reflect the costs of increasing waste

disposal capacity, It might be possible, in addition, to levy some form of surcharge on excessive waste generating systems such as kitchen waste disposal units. Universal metering would be necessary for such a system to be effective.

The availability of government subsidies in New Zealand for the construction of sewerage services again reflects that certain public benefits arise from such services. The maintenance of public health standards is held to be a social necessity, which justifies the provision of subsidies. However, the encouragement of efficient sewerage system use through user charges need not conflict with the public health objective, particularly if "lifeline" rates, as suggested for water supply charges, are adopted. It is notable that such "lifeline" rates might need to be related to household size in order to avoid charging excessive amounts to larger families. This could present administrative problems, particularly in contrast to most present charging systems, which are commendable in terms of their ease and simplicity of administration.

In summary, if local authorities are to encourage the efficient use of sewerage services, then charges need to be related much more closely to use made of the service. Water consumption would seem to be an adequate indicator of sewerage system use for most domestic consumers.

5.2.2 Trade wastes charges

In the case of industrial concerns, the use of pricing policies is somewhat different. It is generally agreed that industry should meet the cost of sewerage services provided to it, and charges for trade wastes

usually follow this philosophy by making charges on the basis of the quantity and quality of wastes.

Drainage authorities in both Europe and America levy charges on the volume and strength of wastes. In the Netherlands, charges are related to chemical oxygen demand (COD) and the concentration of nitrogenous substances, with an additional levy on heavy metals. The French base charges on suspended solids levels, COD, and biochemical oxygen demand. Flat rate charges are also applied to certain industries, where a relationship between pollution and the quantity of ouput, or some other measure of activity, has been established. Sewerage taxes may also be based on water consumption.

There are a number of examples in the American literature of trade waste charge introduction or increase bringing about considerably decreased waste loads (Downing 1973; Elliott 1973;Ethridge 1973; Gelb and Myers, undated). In some cases industry has been encouraged to implement changes which result in net savings in production costs, even with surcharges included (Ethridge 1973). The introduction of processes such as water recycling may help firms to reduce water supply charges as well as waste disposal charges.

At least one large wet industry in New Zealand has been encouraged to implement waste treatment techniques because of rising trade wastes charges. The company involved has in fact achieved a net production gain through the use of water re-cycling and by-product recovery. The response of industry to rising trade waste charges will, however, depend upon the flexilility of production processes. Gelb and Myers (undated) and Hartford(1976) commented that

fast growing industry, with a relatively rapid infusion of new production facilities, could react more readily to trade waste charge increases than slower growing industry.

Trade waste charges made in New Zealand do tend to reflect the costs of processing industrial wastes. Rates are often based upon the proportion of the sewage load contributed by industry (for example, in Auckland and Invercargill). Even so, domestic ratepayers may in some cases subsidize wet industry. For example, the Auckland Regional Authority services a population of 600,000, and an equivalent trade waste load of 840,000 persons. However, total charges paid by industry amount to considerably less than half of the total cost of sewerage system operation. Furthermore, charges are based on average historical costs, and do not reflect the rapidly increasing cost of providing extra treatment plant capacity. Whether or not wet industries should be subsidized is open to debate. More realistic charging policies may not cause undue hardship to industry. They may in fact cause industry to reconsider their water use and waste discharge policies, with the possibility of achieving a net financial gain. The administration costs involved in the levying of trade wastes charges may not be particularly high, especially if it can be shown that waste discharges are related to water consumed. There is a sound argument for authorities not currently levying trade wastes charges to reconsider the feasibility of doing so, particularly in the light of rapidly escalating construction costs.

The National Water Commission (1973) stated that "user charges levied on industrial users of municipal waste treatment plants offer promise not only of fairly distributing waste treatment costs, but of radically reducing the quantities of industrial waste discharged, and of reducing the costs and complexities of municipal plant operations".

However, it must be recognised that while trade waste charges may achieve the above objectives, in most cases they do not reflect the costs imposed on individuals and the public through the discharge of municipal wastes to water bodies such as rivers and estuaries. Decreased water quality will limit the availability of water for other uses, and failure to reflect this phenomenon in municipal sewage disposal charges means that services are underpriced. This problem will be discussed further in the following section.

5.3 THE MANAGEMENT OF NATURAL WATERS

The management of water bodies in their "natural" state differs somewhat from the situations already discussed where authorities are responsible for providing a service, be it water supply or sewerage services. Bodies such as New Zealand's regional water boards are responsible for ensuring that pollution and water abstraction are controlled at an acceptable level. Various countries have different definitions of what that level should be, but there seems to be a growing acceptance of the "user-pays" principle, in that polluters or abstractors should

have to pay for their use of water. This implies an inherent acceptance of the idea that the benefits of water use for commercial enterprises are essentially private, accruing to the individuals who use the water rather than the general public. On the other hand, it is generally believed that water should be made available without charge for recreational uses such as fishing.

A wide variety of pollution control methods have been applied overseas, and there is still debate as to which of these allocates water most efficiently and equitably. Commonly used to control discharges are systems of licences, permits, and prohibitions, which are often based on emission standards. In some cases standards involve outright bans (e.g. the Canada Fisheries Act, which prohibits discharging into waters "frequented by fish"). More often standards specify maximum values for discharges of waste (France, Canada, United States, Netherlands). In France and Canada, special emission standards are set for different industries. Many countries recognise the relationships between water quality management and quantitative policy. A bill being introduced to levy financial charges on wastewater in Germany is partly intended to achieve concurrently a relative reduction in the quantities of water abstracted. In New Zealand, there is provision within the relevant Acts for water management authorities to specify levels of discharge quality and quantity based on individual situations. A process of directly regulating emissions is followed.

Another policy used has been the water classification or "separate facilities" approach. Quality categories in France and Japan are based on the possible uses of water. In the United States it was found to be too difficult to correlate effluent limits with environmental quality. However, pollution restrictions are more severe when receiving waters are to be used for water supply purposes or recreation. It is notable that strict emission standards may be waived if the discharger can show that there is no reasonable relationship between the extra waste treatment required by the stricter standards and the resulting benefits derived. This approach is also used in New Zealand, although it is too early as yet to determine whether it will be effective in achieving desired water quality standards. Classification systems probably do not have all the drawbacks envisaged by Ross (1974). In New Zealand classification has taken into account present use, and the number of situations where polluters would have to shift or greatly increase treatment costs is probably small.

In 1972 the Council of the OECD adopted the "Polluter-Pays-Principle"; that is, that the polluter should be made to meet the costs of pollution control and prevention measures, and should be given incentives to reduce pollution by moving towards less polluting products and technologies. An OECD publication (1977) reports that all the OECD countries have adopted the "Polluter-pays-Principle", and are now applying it in different degrees. One aim has been to keep application of the principles as simple as possible; however, damage functions are often hard to define in monetary terms.

Draft legislation in Germany has attempted to create a feedback between the amount of effluent discharged and the

fees paid. Imhoff (1974) reports that, in Germany, industry which discharges directly to rivers pays on the basis of its pollution load. The income from effluent charges is used to pay for additional water pollution control measures such as wastewater treatment, impounded lakes, or instream aeration. Discharges also require a licence which may demand specific effluent standards. Imhoff also stated that:

> "long experience of the water associations has shown that effluent charges are a practical way to at least collect money from a polluter and to finance equalizing measures ..... moreover the effluent charge may cause a polluter to treat or pretreat the wastewater if the relative costs are advantageous."

In France, charges are made under basin- agency programmes which have an ultimate aim of equating private costs (the payment of charges or expenditure on water treatment) with social costs (damage prevented or compensated). Charges are collected from, and revenue is distributed among, users who require action by the basin authority or benefit therefrom. Subsidies may be given to industry for treatment purposes. Distribution of collected charges takes into account the relative amount of damage caused; the cost of operations is borne by polluters and water consumers. Similar charges are levied in the Netherlands, where levies on discharge into state waters are redistributed in the form of grants towards the investment costs of treatment plants. Regulations in Finland compel polluters to bear the cost of reducing pollution or compensating for any damage caused; an indemnity may be paid to victims of damage. A similar system exists in Japan.

In contrast, while British river basin authorities are able to levy charges for direct discharges , they control water pollution primarily on a regulatory basis. Similarly there is a general lack of financial charges in the United States and Canada, although schemes for pollution charges are being developed. Under the effluent charge scheme in Calgary, Alberta, firms which agree to treat their own wastes are reimbursed all effluent charges collected during the previous three years.

New Zealand law makes no provision for effluent fees of any kind, although fines have been set for discharges which contravene regulations. However, as Fish (1973) noted, "recourse to the law is a wholly inadequate means of ensuring efficient and effective pollution control ..... but is an essential background requirement". In New Zealand, few water pollution prosecutions have taken place; and even when charges have been proven, fines have tended to be small. Some water boards feel that the time and administrations costs involved in bringing about a prosecution are simply "not worth it". Knetsch (1973) suggested that in the long run, regulation may depend on voluntary compliance.

Economic theory would suggest that the combination of pollution control measures used in New Zealand are far from optimal. That strategies are not entirely effective is demonstratable from the growing incidence of polluted waters. Direct regulations do not recongise the different costs of achieving standards from different sources. On the other hand, direct regulations are administratively more simple because their information costs are lower than for other types of control measures. It could well

be argued that the present system is only beginning to operate successfully, and that further changes would involve unreasonable administrative and information costs.

From an economic point of view, however, direct regulations are neither efficient nor equitable as a means of allocating water resources. If it is accepted that the internalization of costs is a desirable feature of control measures, it is clear that this is not achieved by present strategies. The public often meet on undue share of damage costs, particularly in cases where discharges are not subject to water board control (discharges from metropolitan sewage works may be exempt from such control). Of course, the sudden implementation of effluent charges might not be politically feasible. They may not even be feasible in the long run, although many writers have emphasized that there are better ways of subsidising certain industries than through a lack of charges for effluent disposal. It cannot be denied that effluent fees would have the desirable features of encouraging lower waste production, and providing a source of revenue to carry out "clean-up" programmes. There are problems in settin optimal pollution levels and discharge fees, particularly when many of the costs associated with increasing pollution are "intangible". However, methods of estimating these costs are being developed (Section 2.3.1), and the problem cannot be dismissed as insurmountable. There are sound arguments for New Zealand water management authorities to take a searching look at effluent charging strategies applied overseas, particularly in Germany and the Netherlands. Even if information constraints require that charging for pollution be implemented on a simplified basis,

any move towards cost internalization would be an improvement on present policies.

There are a few other solutions to pollution control problems, such as output taxes and auctioned licences, which have been suggested by economists. The writer has been unable to find any existing examples of licence strategies, even though the purchase of discharge licences through the open market is held to be economically efficient and effective. The Environmental Protection Agency (1971) commented that the purchase of assimilative capacity through licences raised objections about

> "the equity of selling a publicly owned good to a private interest, the difficulty of making allowance for public waste discharges, and the monopoly position potentially provided to any bidder who might wish to corner the market for waste discharges in a particular watershed."

On economic grounds, these reservations can be dispelled; it is assumed that firms will buy licences up to the point where it is cheaper for them to treat wastes, so a monopoly position need not arise unless it reflects the best allocation of waste disposal capacity. There are no firm grounds on which to treat public waste discharges differently from private discharges if the only "merit good" aspect of public sewage treatment facilities is the maintenance of public health. There would seem to be a contradiction in objectives if authorities seek to maintain low municipal disposal prices for public health reasons, on one hand, while polluting natural water bodies on the other. However, it is true that a successful licencing scheme has high information costs, since it would need to consider the proximity and times of discharge of pollutants, as well as quantities discharged.

Most of the policies discussed so far have dealt with point sources of pullution. New Zealand water management legislation makes no explicit provision for the control of non-point pollution sources such as agricultural fertilizers, which may be major factors in the degradation of some New Zealand lakes. Taylor (1975) proposed a regional market for rights to use fertilizer which would operate in much the same way as a market for pollution licences. This strategy could be useful where catchment areas were small, or at least easily definable, but again would probably present unreasonably high information costs, and could be politically unacceptable as well.

The regulation of water abstraction requires a somewhat different approach, although again it is true that the benefits of industrial and municipal water use (subject to the provisos in Section 5.1) are largely private. The costs which users impose upon others are often "intangible"; but nevertheless, strategies can be developed which estimate these costs and formulate charges accordingly. The benefits arising from charging realistic prices for water abstraction are similar to those arising when users pay marginal costs of water supply; that is, charges promote efficiency in water use.

In the United Kingdom, charges paid for water abstracted from rivers or groundwater sources are based on the source of the water, the season, the use made of it, and the kind of water discharged. Martindale (1977) states that:

> "it is obvious that someone who abstracts water from a surface source only in the winter imposes a far smaller burden on resources than in summer, and sensibly charges should reflect this".

Furthermore the charges reflect the quality and quantity of water which is returned. For example, there is a distinction between once through cooling water where there is little or no deterioration in water quality, as compared to water discharged as sewage. There is also provision in the English Water Resources Act for special weightings to be applied whenever exceptionally high abstraction rates over a particular period severely tax a particular source of supply.

Some water boards in New Zealand have already advocated charging for water on a quantity taken basis, both as an encouragement of water conservation, and a means of finance for water boards. Already, in certain areas, those abstracting significant quantities of water are required to meter their use for management purposes. It is likely that there would be significant reaction against the implementation of charging, particularly from farmers who consider it their "inalienable right" to draw water for farm purposes. However, with the number of conflicting uses now competing for water, it would seem essential that the most efficient use is made of available water. A particular conflict is evident between irrigation and recreational uses. Charging could provide a source of revenue to provide or enhance alternative recreation areas. Information and administrative problems do arise, but are probably not as severe as the problems encountered in pollution control. Water boards should be encouraged to investigate possible methods of implementing a charging policy for water abstraction,

bearing in mind that charges should reflect a region's water resource situation.

Charges made by regional water boards currently do little to encourage water conservation measures. Many boards effectively subsidise the costs of granting a water right by charging fees ($15 - $30) far below investigation costs. Other boards are adopting a "user-pays" policy for application charges. Again this does little to affect quantities of water used, although it would appear equitable that those who intend to make significant use of a water resource should bear the costs of investigations initiated by their applications.

The introduction of the new monitoring fee seems to be only a means of gathering revenue. There is a wide variation in the costs of monitoring various water rights, and a standard fee does not reflect this variation. To a certain extent, it is in the public interest that rights should be monitored, and hence it can be argued that the public should bear some of the costs of monitoring programmes. However, it can also be argued that those whose activities bring about high monitoring costs should pay on the basis of costs incurred. This should be used as an incentive for firms who contravene water right conditions to improve their performance, particularly in cases where complaints are received. Future reviews of legislation should bear in mind the above factors, particularly the introduction of a pricing policy as a supplement to current legislative controls.

6. CONCLUSIONS

The following conclusions can be drawn from the comparison of water management strategies used in New Zealand with those used overseas, and with the relevant economic theory.

1. Water and water services should be treated essentially as private goods, although recognition should be given to the externalities arising from water use.

2. Economic theory shows that the most efficient means of allocating water is through pricing policies which are based on marginal cost principles. Current methods of financing water services through rates and annual charges appear to be neither efficient nor equitable.

3. Observations both overseas and within New Zealand demonstrate that the implementation of universal metering leads to more efficient use of water resources. Local authorities currently without universal metering should investigate the administrative and technical feasibility of implementing such a scheme.

4. Metering alone does not necessarily encourage efficient water use, and needs to be accompanied by a realistic pricing policy which reflects marginal supply costs. New Zealand data illustrates the variability of demand over time. The implementation of some form of peak load pricing, particularly seasonal pricing, could bring about major increases in the efficiency of water supply system use.

5. The recognition of the need for consumer education regarding water use by bodies such as the Auckland Regional Authority is commendable. To be effective, pricing policies must be of a form which can be readily understood, and acted upon, by the public.

6. The measurement of domestic wastes on the same basis as trade wastes does not appear to be technically or administratively feasible. However, studies in New Zealand indicate that there is a measurable relationship between water consumed and water released to sewers. Local authorities should investigate the possibility of charging for sewerage services on the basis of water consumed, since it is likely that charges made on this basis would lead to a more efficient use of sewerage systems.

7. Trade waste charges appear to be a reasonably efficient and equitable means of recouping the costs of industrial waste collection and treatment. Local authorities should ascertain that these charges reflect the costs of increasing system capacity.

8 Existing strategies for the management of natural wastes appear to be lacking in a number of respects.

i) While water right applications fees cannot be expected to serve as a means of regulating water use, they should reflect, nevertheless, the costs of processing water right applications. Boards currently using flat-rate charges should examine the alternative systems used by the Auckland and Taranaki Water Boards, and the Rangitikei-

Wanganui Water Board, both of which are preferable to flat rate charges from the economic point of view.

ii) The new monitoring fee is likewise of little use as a management tool. It is unlikely to bear any relation to the costs of monitoring individual rights, and therefore appears to be an inequitable charge. If user charges for water abstractions were instituted, monitoring costs could be reflected in these.

9. Economic theory demonstrates that the control of water use by regulatory methods does not encourage water conservation practices, and may not lead to least-cost solutions to water pollution problems. It has been shown overseas that regulatory methods may often be ineffective in achieving water use and water quality objectives. Water and soil legislation should allow water boards to levy charges based on quantities of water abstracted and the quantity and quality of water discharged. There would need to be flexibility in these charges to allow for regional differences in demands for water.

10. Until such time as charges for water and water-related services adequately reflect the opportunity costs involved in any particular use of water, management bodies cannot expect to achieve an economically and socially optimal allocation of water resources.

ACKNOWLEDGEMENTS

I wish to thank the following for their help in the preparation of this report:

My supervisor, Dr C. Scott of the Economics Department, Auckland University, for advice and guidance in the planning and completion of the project.

Mr B. Wither and other staff of the Auckland Regional Water Board, for useful discussions and information made available during the early stages of the project.

Miss K. Swanson, for her efforts in typing the text.

Francis Dickinson, whose advice, help, and encouragement is most gratefully acknowledged.

GLOSSARY

aquatic biota	water-dwelling life forms (plant and animal).
efficient	in the economic sense, refers to achieving a given objective at minimum cost (social and private costs).
equitable	"fair" or "just", according to a pre-determined objective, which may be in terms of either ability-to-pay, or benefits received; see Section 2.3.
external costs and benefits	see externalities.
externalities	unpriced effects which may arise from consumption or production activities; see Section 2.4. Also referred to as external costs or benefits; spillover costs or benefits.
groundwater aquifers	underground rock formations containing water in recoverable quantities.
market inperfections	phenomena which may lead to the inefficient allocation of resources if the market mechanism is relied upon. Examples include externalities such as pollution; monopoly situations; situations of non-rival consumption.
merit goods	goods where consumption by one individual confers benefits on other individuals; Government may deem the provision of such goods to be desirable, and provide them at low cost. See Section 2.2 Examples: education, public health services.
monopoly	situation where a good or service is produced by only one producer. Public utilities such as electricity, water supply are frequently "natural monopolies'

because of the decreasing cost structure of the industry.

private goods — goods whose consumption benefits are enjoyed by only one individual; individuals can be excluded from the consumption of private goods, usually through the price mechanism. See Section 2.2.

social goods — goods which involve non-rival consumption e.g. clean air. Usually individuals cannot be excluded from the consumption of social goods. See Section 2.2.

spillover costs and benefits — see externalities

wet industry — a commonly used term to describe industries which use large amounts of water in production processes.

REFERENCES

Afifi, H.H.H. 1969. Economic evaluation of water supply pricing in Illinois. Journal of the American Water Works Association v61: 41-48.

Alchian, A.A. and H. Demsetz. 1973. The property rights paradigm. Journal of Economic History v33: 16-28.

Anon. 1977. Irrigation water supplies. Soil and Water v13; no.6:

Auckland Regional Authority. 1976. Internal reports. Works Division.

Auckland Regional Authority. 1977. Report of the working party on uses for sewage effluent. Auckland Regional Authority internal report. 59p.

Ayres, R.U. and A.V. Kneese. 1969. Production, consumption, and externalities. American Economic Review v59: 282-298.

Baumgart, I.L. 1976. Environmental considerations in water planning. Proceedings of the New Zealand Water Conference 1976: 77-85.

Board of Health. 1975. 1975 grading of public water supplies in New Zealand. Board of Health, Wellington. Report Series. no.25. 64p.

Brockshire, D.S., B.C. Ives and W.D. Schulze. 1976. The valuation of aesthetic preferences. Journal of Environmental Economics and Management v3: 325-346.

Case, F.H. 1972. Economics of water quality and wastewater control. Journal of the Sanitary Engineering Division, ASCE v98: 427-434.

Coase, R.H. 1960. The problem of social costs. Journal of Law and Economics v3: 1-44.

Commission for the Environment. 1977. A guide to environmental law in New Zealand. Government Printer, Wellington. 157p.

Committee on Water Pollution Control. 1976. Report to the National Water and Soil Conservation Organisation. 19p.

Dales, J.H. 1968. Pollution, property and prices. University of Toronto Press, Toronto. 111p.

Daly, H.E. 1971. Towards a new economics - questioning growth. In Johnson, W.A. and J. Hardesty (eds). Economic growth versus the environment. Wadsworth, California.

De Courcy, N. 1976. Demands for water in the Auckland area. Auckland Regional Authority internal report. 5p.

Downing, D.A. 1973. Sewer and water pricing and investment policies to implement urban growth policy. Water Resources Bulletin v11: 345.

Elliott, R.D. 1973. Economic study of the effect of municipal sewer surcharges on industrial wastes and water usage. Water Resources Research v9: 1121-1131.

Environmental Protection Agency. 1971. Alternative financing methods for clean water. Washington, D.C. 32p.

Ethridge, D. 1973. The inclusion of wastes in the theory of the firm. Journal of Political Economy v81: 1430.

Feldman, S.L. 1975. Peak load pricing through demand metering. Journal of the American Water Works Association v67:490-494.

Fish, H. 1973. Pollution control financing in the U.K. and Europe. Journal of the Water Pollution Control Federation v45: 734-741.

Gallagher, D.R. and R.W. Robinson. 1977. Influence of metering, pricing policies and incentives on water use efficiency. Australian Water Resources Council Technical Paper no.19. 138p.

Gelb, B.A. and J.G. Myers. Undated. Measuring the cost of industrial water pollution control. The Conference Board, Division of Public Affairs Research, U.S.A.

Gilliland, E.J. 1977. Charging principles for water supply - a practical approach. In Water Research Centre, op.cit.

Gregory, R. 1971. The price of amenity: five studies in conservation and government. MacMillan, London.

Hamilton, R.C.W. 1971. Administration for pollution. School of Political Science and Public Administration, Victoria University of Wellington.

Hanke, S.H. 1975. Water rates: an assessment of current issues. Journal of the American Water Works Association v67: 215-219.

Hanke, S.H. and J.J. Boland. 1971. Water requirements or water demands. Journal of the American Water Works Association v63: 677-681.

Hanke, S. H. and R.K. Davis. 1973. Potential for marginal cost pricing in water resources management. Water Resources Research v9: 808-832.

Hanke, S. H. and J.E. Flack. 1968. Effects of metering urban water. Journal of the American Water Works Association v60: 1359-1366.

Hartford, J.D. 1976. Adjustment costs and optimal waste treatment. Journal of Environmental Economics and Management v13: 215-225.

Hirschleifer, J., J.C. DeHaven and J.W. Milliman. 1968. Water supply - economics, technology and policy. University of Chicago Press.

Hogarty, T.F. and R.J. MacKay. 1975. The impact of large temporary rate changes on residential water use. Water Resources Research v11: 791-794.

Howe, C.W. 1971. Benefit cost analysis for water system planning. American Geophysical Union, Washington, D.C.

Howe, C.W. and F.P. Linaweaver. 1967. The impact of price on residential water demand and its relation to system demand and price structure. Water Resources Research v3: 13-22.

Imhoff, K.R. 1974. Water quantity and quality management in the Ruhr Valley. Journal of the Water Pollution Control Federation v46: 1663-1673.

Interdepartmental Committee on the Financing of Local Authority Works. 1975. Report. Government Printer, Wellington. 32p.

Johnson, E.L. 1968. Economics of water quality management. Journal of the American Water Works Association v60: 1122-1128.

Keller, C.W. 1975. Trends in water rates. Journal of the American Water Works Association v67: 255-257.

Kneese, A. 1963. Water quality management by regional authorities in the Ruhr area. Papers and proceedings of the Regional Science Association v11: 229-250.

Kneese, A. 1971. Environmental pollution: economics and policy. American Economic Review v61:153-166.

Knetsch, J.L. 1973. Alternative pollution control strategies. Board of Environmental Studies Research Paper no.1. University of Newcastle, Australia. 15p.

Knetsch, J.L. 1974. Outdoor recreation and water resources planning. Water Resources Monograph Series. American Geophysical Union, Washington.

Lester, W.F. 1977. Charging principles for effluent and sewage disposal. In Water Research Centre Symposium, op.cit.

Leversedge, F.M. (ed.) 1974. Priorities in water management. Water Resources S mposium, University of Victoria, British Columbia.

Lobb, H.F. 1975. Demand rate economics. Journal of the American Water Works Association v67: 255-257.

Mann, P.C. 1970. A new focus in water supply economics - urban water pricing. Journal of the American Water Works Association v62: 534-537.

Mansergh, D.B.C. 1970. Urban water demands in New Zealand. Proceedings of the New Zealand Water Conference 1970 v2. 12p.

Marshall, H.E.,and R.T. Rueg. 1975. Cost sharing to induce efficient techniques of abating wastewater pollution. Journal of Environmental Economics and Management v2: 107-119.

Martindale, R.R. 1977. Charging for direct abstraction: an industrial view. In Water Research Centre Symposium, op.cit.

Mitchell, J.B. and K. Kurak. 1976. Metered water versus flat rate system. Water and Sewage Works, February 1976: 68-69.

Morgan, W.D. 1973. Residential water demand: the case from micro data. Water Resources Research v9: 1065-1067.

Municipal Association of New Zealand. 1970. Separate rates and charges for services. 15p.

Musgrave, R.A. and P.B. Musgrave. 1973. Public Finance in theory and practice. McGraw-Hill, Tokyo. 762p.

National Water Commission. 1973. Water policies for the future. Report to President and Congress. United States Government Printing Office, Washington.

Nemerow, N.L. and R.C. Faro. 1970. Total dollar benefits of water pollution control. Journal of the Sanitary Engineering Division, ASCE v96: 665-674.

OECD. 1977. Water management policies and instruments. OECD, Paris.

Parkinson Cowan Ltd. 1976. The costs and benefits of universal water metering for local bodies in New Zealand. Internal report. 14p.

Rees. J. 1977. An economic approach to sewer and effluent charges. Water Research Centre Symposium, op.cit.

Roberts, M.J. 1970. River basin authorities: A national solution to water pollution. Harvard Law Review v83: 1527-1558.

Ross, R. 1974. Water pollution control: Economic aspects of policy alternatives. MCom thesis, University of Auckland.

Solow, R.M. 1971. The economist's approach to pollution control. Science v173: 502.

Stone, R. W. Garber and H. Friedland. 1970. Water quality: costs and benefits of irreducibles. Journal of the Sanitary Engineering Division, ASCE v96: 691-697.

Stonyer, E.J. 1976. Water as an economic commodity. New Zealand Water Conference 1976, Proceedings: 14-21.

Surrey, S.S. 1970. Tax incentives as a device for implementing government policy: A comparison with direct government expenditures. Harvard Law Review v83: 705-738.

Taylor, C.R. 1975. A regional market for rights to use fertilizer as a means of achieving water quality standards. Journal of Environmental Economics and Management v2: 7-17.

Territorial Local Government Council. 1975. Survey data from Local Authorities. Internal report.

Thom, D.A. and d'E.C. Darby. 1976. Water and the quality of life. New Zealand Water Conference 1976, Proceedings: 22-32.

Tisdell, C.A. 1972. Microeconomics: the theory of economic allocation. Wiley, Sydney.

United Nations Economic and Social Council, 1977. Report for United Nations Water Conference 1977 from Economic Commission for Europe. 84p.

Walker, E.W. 1975. An appraisal of water use management in New Zealand. MPhil thesis, Massey University.

Water Research Centre. 1977. The economics of charging structures for the water services. Papers and proceedings of the seminar held July 1977. Water Research Centre, Medmenham, England.

Water and Soil Conservation Act 1967 (and Amendments). Government Printer, Wellington. 250p.

Whitely, V. and B.B. Dendy. 1968. Conceptual problems in water quality economics. Journal of the Sanitary Engineering Division, ASCE v94: 841-848.

Williams, D.A.R. 1975. Water quality and the Water and Soil Conservation Act 1967. New Zealand Law Journal 1975: 650-622.

Young, R. 1973. Price elasticity of demand for municipal water: a case study of Tuscon, Arizona. Water Resources Research v9: 1068-1072.

APPENDIX I - SURVEY OF LOCAL AUTHORITY CHARGES

The following local authorities and regional water boards were circularized. Slightly different question formats were used for different authorities, depending on the questions which were applicable (e.g. drainage authorities were only questioned about drainage/sewerage charges).

1 Regional water boards

a) Boards circularized/visited

Boards circularized/visited	Replies
Auckland	X
Bay of Plenty	X
Hauraki	X
Hawkes Bay	-
Manawatu	X
Marlborough	X
Nelson	X
North Canterbury	X
Northland	X
Otago	X
Poverty Bay	X
Rangitikei-Wanganui	X
South Canterbury	X
Southland	X
Taranaki	X
Waikato Valley Authority	X
Wairarapa	X
Waitaki	X
Westland	X
Wellington	X

b) Information requested

1 Fees and deposits required for water right applications

2 Differentiation of fees on the basis of the type of water right.

3 Allocation of investigation costs incurred which were in excess of the applicant's deposit.

4 Fees and/or costs paid by other parties to water right applications (e.g. objectors).

2 Local authorities

a) Local authorities circularised	Replies
Auckland City	X
Birkenhead Borough	X
Christchurch City	X
Devonport	X
Dunedin City	X
Eastbourne Borough	X
East Coast Bays City	X
Ellerslie Borough	X
Gisborne City	X
Glen Eden Borough	X
Hamilton City	X
Hastings City	-
Henderson Borough	X
Howick Borough	X
Invercargill City	X
Kaipoi Borough	-
Lower Hutt City	X
Lyttleton Borough	-
Manukau City	X
Mt Albert Borough	X
Mt Eden Borough	X
Mt Maunganui Borough	X
Mt Roskill Borough	X
Mt Wellington Borough	-
Napier City	X
Nelson City	X
New Lynn Borough	X
Newmarket Borough	-
New Plymouth City	-
Northcote Borough	X
Onehunga Borough	X
One Tree Hill Borough	X
Otahuhu Borough	X
Palmerston North City	X
Papakura City	X
Paparua County	-
Papatoetoe City	X
Petone Borough	-
Porirua City	X
Riccarton Norough	X
Rotorua Borough	-
Rotorua County	X
Takapuna City	X
Taupo Borough	X
Tauranga City	X
Tawa Borough	-
Timaru City	X
Upper Hutt City	X

Waimairi County	-
Waitemata City	X
Wanganui City	X
Wellington City	X
Whangarei City	-

Auckland Regional Authority	X
Christchurch Drainage Board	X
Dunedin Drainage and Sewerage Board	X
Hutt Valley Drainage Board	-
North Shore Drainage Board	X

b) Information requested

1 Method of charging for water supplies (metering), annual charge, general rate etc).

2 Actual water supply charges (cost per gallon, rate in dollar etc).

3 Daily consumption per head for industrial, commercial and domestic uses categories.

4 Special features of water supply charges e.g. reduced rates for large consumers or schools.

5 Method of charging for sewerage services (annual charge, separate rate etc).

6 Actual charge for sewerage services (amount of annual charge etc).

7 Trade waste charges - amounts levied, and basis for formulating charges.

BOARD	FEE PLUS DEPOSIT	ALLOCATION OF ADDITIONAL INVESTIGATION COSTS
Auckland RWB	See Table 5 Range $75-$200	Costs of major investigation may be charged to applicant
Bay of Plenty CC and RWB	$15	In exceptional cases, claimed from applicant
Hauraki CB and RWB	$20	Not usually charged to applicant
Manawatu CB and RWB	$30	Under investigation
Marlborough CB and RWB	$20	Not usually charged to applicant
Nelson CB and RWB	$20	Costs of major investigation may be charged to applicant
North Canterbury CB and RWB	$30	Applicant may be required to contribute to special tribunal costs
Northland CC and RWB	$20	Situation under review
Otago CB and RWB	$20	Not usually charged
Poverty Bay CB and RWB	$20	Not usually charged
Rangitikei-Wanganui CB and RWB	$38*	Costs in excess of $38 are charged to applicant

South Canterbury CB and RWB	$25*	Not usually charged
Southland CB	$50	Applicant may be charged for costs if tribunal is held
Taranaki CC and RWB	See Table 5 ($30-$200)	
Waikato Valley Authority	$25	Underreview
Wairarapa CB and RWB	$20	Not usually charged
Waitaki CC	$30	Not usually charged
Wellington RWB	$30	Costs of complex investigation may be charged to applicant
Westland CB and RWB	$20	Costs of complex investigations charged to applicant

* may cover more than one right

APPENDIX III WATER SUPPLY CHARGES - SURVEY RESULTS

AREA	METERING [1]	BASIS FOR CHARGE[3]	ACTUAL CHARGE	CONSUMPTION[3] (g/head/day)	COMMENT
<u>Auckland Urban Area</u>					
AUCKLAND CITY	C,I, 10% D	Separate rate plus excess charge for metered consumption (A)	55.78¢/1000g	37	Reduced rate if consumption exceeds 40 million g / quarter
BIRKENHEAD BOROUGH	All	Metered consumption (6m)	82¢/1000g	Domestic 28.5 Other 11	
DEVONPORT BOROUGH	All	Metered consumption (6m)	$1/1000g		
EAST COAST BAYS CITY	All	Metered consumption	$1/1000g residents $1.50/1000g non residents Minimum $10.00/annum	Average = 185	$1.00/annum meter rent
ELLERSLIE BOROUGH	All	Metered consumption	85¢/1000g		Special rate schools 75¢/1000g
GLEN EDEN BOROUGH	All	Metered consumption (6m)	90¢/1000g	About 40,000g /household/annum	
HENDERSON BOROUGH	All	Metered consumption (6m except for large consumers - m)	75¢/1000g Minimum $6.00/annum		New connections $60 (½") and $70 (3/4")

AREA	METERING[1]	BASIS FOR CHARGE[2]	ACTUAL CHARGE	CONSUMPTION[3] (g/head/day)	COMMENT
HOWICK BOROUGH	All	Metered consumption (A)	$1/1000g		Discount of 10% to schools
MANUKAU CITY	All	Metered consumption	73¢/1000g	D = 18,000g/ head/annum	
MT ALBERT BOROUGH	All	Metered consumption	85¢/1000g		
MT EDEN BOROUGH	All	Metered consumption	82¢/1000g		
MT ROSKILL BOROUGH	All	Metered consumption D (A) Others (Q)	Minimum $10/year 90¢/1000g Non consumers $1/year	30	Reducing rate over 2 million g / annum
NEW LYNN BOROUGH	All	Metered consumption (6m)	85¢/1000g Minimum $3/6m		School rate 48¢/1000g Non-consumers: .1¢/$ rateable value.
NORTHCOTE BOROUGH	All	Metered consumption (6m)	80¢/1000g	15,930/annum	
ONE TREE HILL	All	Metered consumption D&C (6m), I (m)	68¢/1000g		Reducing rate for industrial consumers.

AREA	METERING	BASIS FOR CHARGE	ACTUAL CHARGE	CONSUMPTION (g/head/day)	COMMENT
ONEHUNGA BOROUGH	All	Metered consumption (6m)	Range 50-59¢/1000g		Special rates for schools
OTAHUHU BOROUGH	All	Metered consumption (6m)	91¢/1000g		
PAPAKURA CITY	All	Metered consumption (6m)	70¢/1000g		
PAPATOETOE CITY	All	Metered consumption (6m)	91¢/1000g		
TAKAPUNA CITY	All	Uniform annual charge metered consumption	Annual charge = $16 $1.00/1000g	11,000g/annum	
WAITEMATA CITY	Some	Annual charge metered consumption	Annual charge = $25.50 Non-consumer = $12.75		Range 52c - $1.02 for extraordinary charges
<u>Wellington Urban Area</u>					
EASTBOURNE BOROUGH COUNCIL	Some	Annual charge or metered consumption	Annual charge: $34 per dwelling/business 25¢/1000g	93	

AREA	METERING	BASIS FOR CHARGE	ACTUAL CHARGE	CONSUMPTION (g/head/day)	COMMENT
LOWER HUTT CITY	C,I	D- separate rate C,I - metered consumption	GI - half domestic rate 64¢/1000g	42 (D)	Average domestic rate = $35
PORIRUA CITY	C,I, schools	D - annual charge Others - metered consumption	Annual charge = $15 C,I : 57¢/1000g		Reduced rate - schools and hospitals - 47¢/1000g
UPPER HUTT CITY	C,I, schools	D - general rate Others - metered consumption	40¢/1000g	94	20% total usage non-domestic Free allowance - 1000m^3
WELLINGTON CITY	large consumers	Separate rate metered consumption	.1975¢/$ rate Minimum $10 metered rate Range 32.7 - 72.7c	98	Non-consumers - half water rate
<u>Christchurch urban area</u>					
CHRISTCHURCH CITY	All	Separate rate and/or metered consumption	25¢/1000g	147 (maximum)	Water rate levied on capital value; allowance of 1000g per 20c of rate charged.
RICCARTON BOROUGH	C,I	Separate rate metered consumption			

AREA	METERING	BASIS FOR CHARGE	ACTUAL CHARGE	CONSUMPTION (g/head/day)	COMMENT
Provincial centres					
GISBORNE CITY	C,I	D - general rate Others - metered consumption	41¢/1000g		
HAMILTON CITY	Some large consumers	Separate rate	2.088% rateable value Minimum = $10 45.5¢/1000g		Non-consumers and commercial premises pay ½ rate. Residential average = $30
INVERCARGILL CITY	I, some C	Separate rate metered consumption	.1381¢/$ rateable value 47¢/1000g (outside city - 93¢/1000g)	72	Non-consumers - half rate Special agreement - see text
MT MAUNGANUI BOROUGH	All	Annual charge metered consumption	Annual charge = $16 (covers 20,000g) Additional 60¢/1000g)	12,000g/annum	
NAPIER CITY	Large consumers	Separate rate metered consumption	.209¢/$ rateable value minimum $6 5 - 13c / 1000 l		Non consumers - half rate; metered charges applied on water consumed above value of rate
NELSON CITY	Large consumers	Separate rate metered consumption	.144¢/$ rateable value minimum = $10 25¢/1000g	130	15% metered
PALMERSTON NORTH CITY	Large users	Separate rate metered consumption	27¢/1000g (ordinary) 22.5¢/1000g (schools) 35¢/1000g (non-rate payer	D = 46 Total = 81	Non consumers - half rate maximum daily use (summer)= 1.33 times average daily consumption

AREA	METERING	BASIS FOR CHARGE	ACTUAL CHARGE	CONSUMPTION (g/head/day)	COMMENT
ROTORUA COUNTY COUNCIL	Some	Separate rate Annual charge Metered consumption	Vary - some in general rate Annual charge = $20 40-75¢/1000g	60-80	Charges vary. Special rate - sewerage construction and water supply
TAUPO BOROUGH	C,I, some D	Annual charge metered consumption			
TAURANGA CITY	C,I (some)	Annual charge metered consumption	Annual charge $30 45¢/1000g	72 (average) 130 (maximum)	Non-consumers $4.50/annum
TIMARU CITY	C,I	D = special rate Other = metered consumption and half rate	.34¢/$ 45.5¢/1000g 57¢/1000g (outside City)	85 (average)	Rate reduces to 41¢/1000g over - 1 million g
WANGANUI CITY	C,I	D = general rate metered consumption	30¢/1000g 70¢/1000g (outside city)		Schools : 25¢/1000g Reduced rate above 20 million g

1 C = commercial
I = industrial
D = domestic
Q = quarterly

[2] Meter readings
A = annual
6m = 6 monthly
M = monthly

APPENDIX IV CHARGES FOR DRAINAGE AND SEWERAGE SERVICES - SURVEY RESULTS

AREA	BASIS FOR CHARGING	CHARGE MADE	TRADE WASTE CHARGES
Major urban areas			
AUCKLAND CITY	Separate rate and set fee; installation fee	Fee fluctuates annually	ARA (Auckland Regional Authority)
BIRKENHEAD BOROUGH	General rate		North Shore Drainage Board
CHRISTCHURCH CITY	Separate rate	charge on behalf of	Christchurch Drainage Board
DEVONPORT BOROUGH	Annual charge	(1977) $24 per unit	North Shore Drainage Board
EAST COAST BAYS CITY	Separate rate		North Shore Drainage Board
EASTBOURNE BOROUGH	Annual charge	$23 per dwelling or business unit	
ELLERSLIE BOROUGH	General rate		ARA
GLEN EDEN BOROUGH	General rate		ARA
HENDERSON BOROUGH	General rate		ARA
HOWICK BOROUGH	General rate		ARA
LOWER HUTT CITY	General rate	Annual charge for residential users outside city = $35	Hutt Valley Drainage Board

APPENDIX IV (contd...)

AREA	BASIS FOR CHARGING	CHARGE MADE	TRADE WASTE CHARGES
MANUKAU CITY	Separate rate		ARA
MT EDEN BOROUGH	General rate		ARA
MT ROSKILL BOROUGH	General rate	Schools charged $2 per sewer connection	ARA
NEW LYNN BOROUGH	General rate	Disconnection fee = $60	ARA
NORTHCOTE BOROUGH	Annual charge	$22 per a) dwelling house or flat, or b) wc/urinal in any other building	North Shore
ONE TREE HILL	General rate		ARA
ONEHUNGA BOROUGH	General rate		ARA
OTAHUHU BOROUGH	General rate		ARA
PAPAKURA CITY	General rate		ARA
PAPATOETOE CITY	General rate		ARA
PORIRUA CITY	Annual charge	$9.50 per wc unit	Not charged
RICCARTON BOROUGH	Separate Rate	Christchurch Drainage Board rate	Christchurch Drainage Board

APPENDIX IV (contd...)

AREA	BASIS FOR CHARGING	CHARGE MADE	TRADE WASTE CHARGES
TAKAPUNA CITY	Separate rate		
UPPER HUTT CITY	General rate		Hutt Valley Drainage Board
WELLINGTON CITY	Separate rate	.2185/$ rateable value minimum $2	Not charged
Provincial areas			
GISBORNE CITY	General rate	Special capital contributions from subdividers	
HAMILTON CITY		subdividers charged at cost	
INVERCARGILL CITY	Separate rate	.120¢/$	Made on four wet industries (see table 8)
NAPIER CITY	General rate		
NELSON CITY	General rate	Non rateable properties - special charge	None
ROTORUA COUNTY		Connection fee $10	
TAUPO BOROUGH	Separate rate		
TAURANGA CITY	Annual charge	$40 per wc unit $10 non consumers	

APPENDIX IV CONT...

AREA	BASIS FOR CHARGING	CHARGE MADE	TRADE WASTE CHARGES
TIMARU CITY	General rate	Connection fee applied	
WANGANUI CITY	General rate	Fee for users outside city - $100 pa	By-lay in preparation