Towards a Resolution of Conflict in Water Resource Allocation

A discussion based on examination of the Rakaia River debate

December 1984

Discussion Paper

Centre for Resource Management
University of Canterbury & Lincoln College, New Zealand

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Resolving Conflict in Resource Allocation:

A discussion based on examination of the Rakaia River debate

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TABLE OF CONTENTS

TABLE OF CONTENTS continued

LIST OF FIGURES

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CHAPTER 1: INTRODUCTION

The growth and development of New Zealand society has been based on the exploitation of natural resources. In response to an increased population and the desire for a higher standard of living, the natural environment has been extensively modified. Concurrent with development has been an increased awareness of the intrinsic values of our land and water resources in their natural state. Marked differences between the demands of various user groups have led to conflict.

To provide order and control of resource uses, Parliament has passed various legislation. Both the Mining Act 1971 and the Town and Country Planning Act 1977 state that the wise use and management of New Zealand's resources must be considered. This principle is also inferred in other legislation (e.g., the Water and Soil Conservation Act 1967), and has been adopted by agencies such as the National Water and Soil Conservation Authority (NWASCA).

The Planning Tribunal was established under the Town and Country Planning Act 1977 as a replacement for the Town and Country Planning Appeal Board. Parliament considered that the Tribunal was the appropriate body to resolve conflicts arising from most resource allocation decisions made under the Town and Country Planning Act and other legislation. The Tribunal has, on occasion, been required to resolve major resource utilisation disputes. Some Tribunal members feel that these disputes constitute policy decisions and are therefore not within the Tribunal's mandate. Judge Turner (1983) has pointed out that the jurisdiction exercised by the Tribunal is not often accompanied by clearly defined legislative guidance. This contention has also been supported by Judge Treadwell (Annan and Others v National

Water and Soil Conservation Authority and Minister of Energy, (1981) 7NZTPA:438).

In the absence of clear legislative guidelines, it is pertinent to identify and examine the types of issues and conflicts involved in resource allocation decisions. The recent NWASCA hearing, held to consider an application for a National Water Conservation Order (NWCO) for the Rakaia River, indicated the range of these issues. Included were demands for in-stream and abstractive uses of the river, scientific, wildlife and scenic values, employment and future uses of the water. The Rakaia debate is both topical and well documented. It is used as an example in this case study.

The aim of this study is to provide guidance for the Planning Tribunal in resolving conflicts in water resource allocation. To achieve this aim, the following two objectives were set:

(1) To develop a guiding principle that could assist the Planning Tribunal when considering resolution of conflicts in resource allocation; and,

(2) To provide a commentary that could assist the Planning Tribunal in its interpretation of evidence and to make valid comparisons between different proposals for resource use.

The remainder of the study outlines the legislative and institutional framework used when a National Water and Soil Conservation Order application is made and discusses the need expressed by the Planning Tribunal for guidance to aid them when making water resource allocation decisions.
The study also develops a guiding principle for decision-making, that: resources should be allocated so as to maximise the well-being of New Zealand society over time. It

is suggested that this principle has relevance to general resource allocation choices. A number of factors contributing to this principle are identified.

The Planning Tribunal bases its decisions on evidence presented to it by various interest groups. The study provides a critical analysis of the quality and relevance of methods which may be used in producing and presenting this evidence. Examples taken from the Rakaia River NWCO Hearing are used to illustrate the analysis.

CHAPTER 2: THE LEGISLATIVE AND INSTITUTIONAL CONTEXT

2.1 INTRODUCTION

This chapter outlines relevant aspects of the existing legislative and institutional framework for resolving water resource allocation problems in New Zealand. It also considers deficiences in the existing framework. Throughout this discussion, the resource in question is taken to be the Rakaia River, its tributaries and associated water bodies. Consequently, attention is primarily directed at those aspects of existing legislation and management practice most relevant to the Rakaia case.

The existing allocation framework consists of two parts, one legal and the other related to management practices. Two Acts provide the legal basis for the allocation of water resources in New Zealand, the Soil Conservation and Rivers Control Act 1941 (SCRCA 41) and the Water and Soil Conservation Act 1967 (WSCA 67). Existing management practice is closely linked to these Acts since interpretation provides - or should provide - the guidelines necessary for effective resource management. It has been suggested by some members of the Planning Tribunal that the Acts do not give sufficient guidance for the task of allocating water resources. Although further amendments have been proposed, this study is written within the constraints of the existing legislation.

The study focusses attention on certain parts of the framework. The first is the National Water Conservation Order Hearing for the Rakaia River, which was conducted by a committee of the National Water and Soil Conservation Authority. NWASCA has also conducted hearings for the Motu and Ahuriri Rivers. The legal procedure for these hearings

is found in the Water and Soil Conservation Amendment Act 1981, the object of which is given in section 2: "to recognise and sustain the amenity afforded by waters in their natural state".

The second focus is the Planning Tribunal. Its function, if required, is to conduct a public inquiry after an NWCO hearing. To date, only the Motu River Conservation Order has been the subject of such an inquiry, but the Rakaia River Draft Order will come under the scrutiny of the Planning Tribunal at some time in the near future.

The 1981 Amendment Act has been used only on a few occasions. Therefore the following discussion of the existing resource allocation framework relies on limited information. These information sources include the draft order for the Rakaia River and the Planning Tribunal's decision for the Motu River, in addition to the Acts.

2.2 INSTITUTIONAL MANAGEMENT OF THE RAKAIA RIVER

Three institutions are important in the management of the Rakaia River. These are the North Canterbury Catchment Board and Regional Water Board (NCCB & RWB), the National Water and Soil Conservation Authority and the Planning Tribunal. Each of these has a degree of responsibility for the management of the resource, although each operates under different rules.

The NCCB & RWB undertakes the day-to-day management of the river. For this purpose, it has conducted resource surveys and published a draft management plan.

The role of the Board is outlined in two principal Acts. Under the Soil Conservation and Rivers Control Act 1941, section 126, its main functions are to minimise the damage caused by floods and erosion and to promote soil conservation. Under the Water and Soil Conservation Act 1967, chiefly the long title and section 20, the Board is to undertake the tasks of protecting and conserving water supplies, promoting the most beneficial uses of water, recommending water levels and water quality standards, and preserving and protecting the wild, scenic and other natural characteristics of rivers, streams and lakes.

The Board must also consider the needs of farming, industry, recreation, fisheries and wildlife habitats. Under the 1981 Amendment Act, its role is to consider and make recommendations on Local Water Conservation Notice (LWCN) applications. It may make both submissions on, and objections to, a NWCO application. Once a conservation order or notice is in force, the Board must take account of it in managing the water.

The NWASCA normally has a wide ranging role, but this is

narrowed in the context of a NWCO application. The Authority, or a committee of it, is required to consider the application together with submissions and objections that it has received. It must have regard for the following matters:

> "(a) All forms of water-based recreation, fisheries, and wildlife habitats;
>
> (b) The wild, scenic, and other natural characteristics of the river, stream, or lake;
>
> (c) The needs of primary and secondary industry, and of the community; and
>
> (d) The provisions of any relevant regional planning scheme and district scheme."

(Water and Soil Conservation Amendment Act 1981, s20B(6)).

The existing legislative framework defines the NWASCA's role somewhat differently to that of the NCCB & RWB. Like the Board, the Authority may seek to resolve conflict in an equitable manner with any burden evenly shared. However, the Authority is constrained so that, in considering water resource conflicts, "the [Authority] is not as free as the Board to consider future and potential users of the resource" (NWASCA, 1984:18). While there is provision in the Act for the Authority to reconsider a NWCO if needs have changed through time (s20E), it is clear that, in comparison with the Board, the Authority is restricted to consideration of the present.

Once a hearing has been completed, the Authority must adopt one of three possible courses of action. These are to:

(1) prepare and publicly notify a draft NWCO; or,

(2) recommend to the Minister of Works and Development that a LWCN be made; or,

(3) recommend to the Minister that the application be declined.

If a NWCO is recommended, it must specify either the waters to be preserved or the outstanding features to be protected. The order may provide for: river flows and lake levels to be left untouched; certain areas where damming and the effects of dams should not be permitted; lake levels; minimum flows; and, maximum ranges of flow. The order may also impose conditions on the granting of water rights, but cannot restrict rights existing before the order is made.

Under the NWCO provisions, the Tribunal may conduct a public inquiry. The Tribunal only becomes involved in national water conservation order proceedings when a conflict exists which a NWASCA hearing cannot resolve to the satisfaction of the participants. The purpose of the inquiry is to consider objections and submissions regarding either a draft NWCO or a recommendation by NWASCA that the application be declined. The legislation is, however, unclear on the question of whether or not the Planning Tribunal should consider the original application.

On completion of the inquiry, the Planning Tribunal has three options, which are to:

(1) make a report and recommendation to the Minister of Works and Development on the draft NWCO; or

(2) direct the appropriate Board to make a LWCN; or

(3) recommend to the Minister that the application be declined.

2.3 PROBLEMS IN THE EXISTING RESOURCE ALLOCATION FRAMEWORK

2.3.1 Legislative Inadequacies

On a number of occasions, comments have been made on the inadequacy of the guidelines provided by 'planning' legislation. Judge Turner has commented:

> "A judicial tribunal operates best when the area of dispute or conflict and the scope of the matters which it is to take into account have both been clearly defined for it in advance. That clear definition does not exist at present." (Turner, 1983: 11)

In the first of the Clutha River decisions, Judge Treadwell was particularly critical of the Water and Soil Conservation Act 1967:

> "I am forced into a position of dealing with an Act which contains few guidelines. ...I am ... faced with trying to extract law from a statute which is lamentably lacking in any specific direction. I think it would be safe to say that never in the history of legislation in New Zealand has the long title to an Act been used so frequently in an attempt to find guidelines." (Annan and Others v National Water and Soil Conservation Authority and Minister of Energy, (1981), 7NZTPA: 438)

More recently, the Planning Tribunal has commented on the 1981 Amendment Act. They had difficulty in "construing the provisions of the Act" and noted that:

> "It is not unusual in the field of environmental law to find statutes passed for the first time which suffer from some deficiencies and it is to be hoped that the matters we have so far traversed will be considered by Parliament with a view to giving further clear

directions to resolve some of the anomalies." (Planning Tribunal, 1984:9)

The role of the Planning Tribunal has also been raised, particularly with regard to major resource development and government policy. Judge Turner (1983: 9) describes an unsatisfactory situation:

> "Responsibility for making (or recommending upon) decisions over major resource utilization has become vested in the Planning Tribunal by a piecemeal process of legislative enactment and statutory interpretation. In other words the jurisdiction exercised by the Tribunal to make these decisions has been conferred upon it without any clear legislative intention that that should be so, and without any precise definition by Parliament of the limits of the 'relevant considerations'".

The problem has been more clearly defined and stated by Cowper (1983: 10):

> "... it is not the role of a judicial body to determine matters of Government policy ... Accordingly the judicial body should not be called upon to evaluate such policy, unless the criteria against which that evaluation is to be performed are clearly set out." (our emphasis)

2.3.2 Conflict Resolution

In order to consider the form of guidance that would be most helpful to the Planning Tribunal, it is necessary to begin with the nature of the problem they are required to address. Quite simply, the problem is that people have conflicting opinions on what use should be made of the resource referred to as the Rakaia River. This problem has two main contributing factors. The first is that people have different perceptions of the resource to be allocated, and

the second is that people seek to put the available resource to different uses.

Resources can be defined as the elements of people's environment to which they assign utility. As such, resources are neither wholly of the physical world nor of the world of people, but the result of the interactions of the two; furthermore, resources are defined differently over time, depending on cultural values and available technology. (Adapted from Chapman, 1969.)

The boundary between those elements of the environment to which we assign 'utility' and the rest of the environment is an important one. Different interest groups will have different perceptions of where that boundary lies. Some may take a narrow view, concentrating on specific elements of a resource, while others will emphasise the ecological connections between all environmental elements and call for a much broader definition of any given resource. At the Rakaia Hearing, for example, some groups confined their case to water in the river, while others called for the inclusion of all adjoining lakes, swamps and tarns in any consideration of the Rakaia River system. There was conflict among those groups which limited their views to water in the river. Different groups wanted different minimum flows for different purposes. If the Planning Tribunal is expected to resolve conflicts in a consistent and acceptable manner it needs guidance. The comments in section 2.3.1 indicate that the guidelines in the current legislation are not adequate. A solution to this problem is offered in the next chapter.

CHAPTER 3: GUIDING PRINCIPLE

3.1 INTRODUCTION

The previous chapter highlights the deficiencies in existing legislation. In particular, authorities have noted that they have no "specific direction" (Annan and Others vs National Water and Soil Conservation Authority and Minister of Energy, (1981) 7 NZTPA), no "precise definition by Parliament of the limits of the 'relevant considerations' " (Turner, 1983), and no "criteria against which [the] evaluation is to be performed" (Cowper, 1983).

In this chapter, an attempt is made to provide the appropriate guidance. First, a guiding principle is developed, which, it is believed, can be relevant to all resource allocation decisions. This guiding principle is developed from an examination of statutes and societal expectations of resource use. Second, a number of considerations that may assist the Planning Tribunal in applying this principle in practice in water resource allocation are identified. The relevance of these considerations will depend on the case in question. Used together with the guiding principle, they should go some way towards rectifying the lack of guidance described above.

To develop the guiding principle, two conditions were set. First, the guiding principle should be both capable of implementation within the existing legislative and institutional framework, and second, unambiguous. The principle suggested, it is believed, will improve the decision-making process and will be capable of adoption by the Planning Tribunal within the existing legal framework.

3.2 DEVELOPMENT OF THE GUIDING PRINCIPLE

The Planning Tribunal should ideally make decisions in a manner that is consistent with societal expectations of resource use. To identify these expectations, their development over the past 25 years was examined. The expectations of the participants in the Rakaia NWCO hearing were then examined, this being the most recent public forum at which a wide range of relevant views were expressed. It is useful to distinguish between societal expectations of the process of resource allocation, that is, the way in which a decision is made, and expectations of the outcome of the process, that is, the allocation decision. Both types of societal expectations are considered in this section.

People's expectations of decisions in resource allocation change over time. These changes are reflected in the legislation affecting water resources, in the views expressed by various interest groups and in indicators of public opinion. Changes in the long title of the 1967 Water and Soil Conservation Act introduced by the 1981 amending legislation illustrate the increasing recognition of in-stream values. The relevant modification changed the long title from:

> "... ensuring that adequate account is taken of the needs of primary and secondary industry, water supplies of local authorities, fisheries, wildlife habitats, and all recreational uses of natural water."

to:

> "... ensuring that adequate account is taken of the needs of primary and secondary industry, community water supplies, all forms of water-based recreation, fisheries, and wildlife habitats, and of the preservation and protection of the wild, scenic, and other natural characteristics of rivers, streams, and lakes."

Changes in societal expectations are also reflected by the evolution of interest groups and by indicators of public opinion such as major petitions. In recent years, a number of interest groups concerned with environmental protection have been established, such as the Environmental Defence Society (1971), Friends of the Earth (NZ) (1975), and environment centres (since 1973).

The increasing level of public concern with water allocation issues reflects a wider recognition of the value of both in-stream and out-of-stream uses. This is illustrated by the interest in, for example, the Save Manapouri campaign in 1971 (with more than 250 000 signatures collected in support of the petition) and the recent water conservation order applications. Groups representing in-stream uses have increased and become more vocal. Such groups include the New Zealand acclimatisation societies, the New Zealand Jet Boat Association and various river rafting organisations.

Increasing recognition of in-stream values has not been accompanied by decreasing demands for water by out-of-stream users. On the contrary, most of their demands have increased. For example, water abstraction for irrigation has received widespread public support.

The increasing demand for water by out-of-stream users, accompanied by increasing recognition of in-stream values, has increased the conflict between these groups. Although water is a renewable resource, the quantity allocated is finite, and therefore use of water to satisfy the various demands is finite, use of water to satisfy any one demand often reduces the quantity available to satisfy other demands. As the demands for water increase further, the potential for conflicts between those parts of society with different expectations of water allocation will also increase. It is perhaps as a result of this increased

potential for conflict that concern has been expressed about the process by which water allocation decisions are made.

The current perception of the importance of the allocation process was evident from the expectations expressed by participants at the Rakaia River NWCO hearing. Some of these expectations were as follows:

- consideration of the principles of multiple use, dominant use and beneficial use;

- the need for a 'fair decision';

- a comprehensive coverage of all potential values and uses of the river system; and

- 'valid comparisons' between in-stream and out-of-stream uses.

Although there appears to be general agreement about these expectations, it is probable that what constitutes a 'fair decision' and 'valid comparisons' will be viewed differently by different participants. No doubt a participant's perception of what is 'fair' will be further influenced by the actual decision.

The wide range of societal expectations regarding resource allocation dictates that for a guiding principle to be useful, it must be of a general nature. If it is too specific it may favour some resource users at the expense of others, and will be unacceptable to the disadvantaged users.

Implicit in all expressed expectations for the allocation of resources is the belief that the resource should be allocated in such a way as to maximise benefits to society. The same sentiment can be found in the 1967 Water and Soil Conservation Act s14(3)(d), which lists among the functions

of the National Water and Soil Conservation Authority:

> "To co-ordinate all matters relating to natural water so as to ensure that this national asset is available to meet as many demands as possible and is used to the best advantage of the country and the region in which it exists in the course of nature."

Further, there is evidence to suggest that society is concerned for the welfare of future generations. In general, members of our present society are concerned that their children will be provided for. Presumably they in turn will have concern for the welfare of their children and so on. This continuing pattern of concern for the welfare of generations to follow suggests that society would expect decisions affecting future generations to take their interests into consideration.

Based on these common expectations, we propose a guiding principle that the Planning Tribunal could use when resolving resource-allocation conflicts:

> Resources should be allocated so as to maximise the well-being of New Zealand society over time.

This principle, although seemingly obvious, is of considerable value. The very fact that it is obvious and can be agreed on by all resource users, means that it can be used in all resource allocation decisions. The explicit use of well-being in several resource management policy statements highlights its applicability. For example, the concept of well-being is contained in section 2.1 of the Land Settlement Board High Country Policy (Land Settlement Board, 1980) and the Department of Lands and Survey's National Goals for Land Use in New Zealand (Land Use Advisory Council, 1983). However, some additional guidelines are required and these are discussed in the following section.

3.3 FACTORS CONTRIBUTING TO WELL-BEING

3.3.1 Introduction

As well-being is a key concept in the proposed guiding principle, it needs to be considered and explained. The Random House Dictionary (1967) defines well-being as:

> "A good or satisfactory condition of existence; a state characterised by health, happiness and prosperity ..."

Well-being can be thought of as the result of satisfying basic needs, and the opportunity to fulfill individual desires and aspirations. It brings together the physical, psychological and spiritual aspects of an individual's needs and wants.

Well-being, therefore, has many factors. These are recognised in a number of different statutes and policies, and although expressed individually, they collectively show that Parliament intends that they should be used to assist in decision-making. Of particular relevance are the Town and Country Planning Act 1977, the Water and Soil Conservation Act 1967, the Reserves Act 1977, the Government Policy Statement on the Use of High Mountain Resources (New Zealand Government, 1979), the Land Settlement Board's High Country Policy (Land Settlement Board, 1980), and the General Policy for National Parks (National Parks and Reserves Authority, 1983). As a further guide to the identification of these factors, the stated goals of various interest groups and non-government organisations expressed at the Rakaia NWCO Hearing were examined.

The factors identified in section 3.3.2 are not an exhaustive list. However, we believe they are representative of those which contribute to the well-being

of New Zealand society. They result in better health, increase an individual's prosperity, or are perceived by the individual as providing happiness in some form.

In addition, some important resource management practices contribute to well-being. These are not explicitly stated as societal goals and do not directly influence an individual's well-being. They are, however, important in ensuring that factors of well-being are maintained. These are discussed in section 3.3.3.

3.3.2 Components of Well-being

Standard of living

The terms 'standard of living' and 'well-being' are often thought of as synonymous. However, standard of living is but one factor of well-being. Standard of living is normally defined in economic terms and may be considered from a national or individual perspective.

Gross Domestic Product (GDP) is often used as a measure of society's standard of living. This is "... the value of the final goods and services produced in the economy during a given period of time" (Woodfield and McCann, 1982: 177). While GDP provides a convenient measure of economic output, it does not address the issue of the distribution of that output within society.

For individuals, standard of living can be measured in terms of income and accumulated material wealth, and employment; this latter element remains the major mechanism by which the national income is distributed among individuals within society. It is, therefore, important that the impact of resource use proposals on employment, and on the permanency of employment, be considered in resource allocation decision-making.

As evidenced by the existence of the welfare state, New Zealand society is concerned with ensuring that all individuals are able to maintain a reasonable standard of living. The first schedule of the Town and Country Planning Act 1977 recognises this concern, as do the provisions of the Water and Soil Conservation Act 1967 (s14(3)(a)(v) and s20B(6)(c)) and section 2.1 of the 1980 Land Settlement Board High Country Policy (Land Settlement Board, 1980). Benefits from the exploitation of nationally owned resources, such as water and minerals, should therefore be used for the good of the whole nation.

It should be noted that increased income and material wealth do not necessarily improve individual or societal well-being, as an increased standard of living may be accompanied by greater social ills (e.g., racial tension, congestion and pollution).

Employment

New Zealand as a society regards paid employment as being necessary and desirable. As a result, being employed could add significantly to an individual's self-esteem and may, therefore, contribute to or enhance their well-being.

For most people the choice of employment is an important factor of well-being. There are others, however, who neither seek nor require paid employment to boost or maintain their self-esteem. These people may seek other means such as an alternative lifestyle. Where possible then, resource allocation decisions should not restrict alternatives for employment or the option to choose a particular way of life.

Maintenance of Recreation Opportunity

Recreation is commonly regarded as a basic human need. The Town and Country Planning Act 1977 recognises this need in its First Schedule. The benefits people derive from

recreation contribute significantly to their well-being. In this context natural water, as in the Rakaia, provides a relatively accessible outdoor recreational facility which caters for a diverse range of activities and individuals. At the same time it also provides a positive visual amenity (Ditten and Goodale, 1972; Patmore, 1970).

Technological advancements have created a greater diversity of recreational activities. As society provides more opportunities to recreate, both the numbers of recreational resource uses and the frequency with which they are used, increases. It is important, therefore, to maintain this diversity of recreational activities for society as a whole. As each particular form of recreational activity involves specific demands on the resource, conflicts can arise, not only between different recreational uses, but also between the participants in a single recreational pursuit. Thus, any particular resource allocation pattern may not satisfy the needs of all recreational activities.

Traditional and Cultural Values

Resources often have symbolic or cultural significance. For those in society who perceive such significance, whether local, regional or national, a greater importance and a higher value will be attached to that resource. Sections of the Town and Country Planning Act 1977 provide for the recognition of the significance of this factor to well-being (e.g., Sections 3(1)(a) and 3(1)(g)).

Conflict develops in the absence of a common set of environmental ethics for society, as different groups tend to apply their own sets of values. Conflict may also develop between proponents of new and traditional uses, or, as New Zealand is a multi-cultural society, from differences in ethnic origin. The maintenance of cultural identity is an important factor of well-being. Traditional and cultural

values should be respected, therefore, and taken into account when resolving resource use conflicts.

Existence Value

Existence value is the satisfaction individuals gain from the knowledge of the presence of a resource they consider intrinsically valuable. Legislative recognition of existence value is allowed for in several statutes, for example in the long title of the Reserves Act 1977 and section 8 of the National Parks Policy (National Parks and Reserves Authority 1983). Thus, the knowledge that a natural system such as the Rakaia persists in an unspoiled state may contribute significantly to the well-being of some individuals. Such value exists even though individuals may not be actively involved in the use of the resource. Small components of a larger system (for example, the Wrybill Plover on the Rakaia River) can also possess an existence value. If the existence value placed on a resource or its components contributes to an individual's well-being, then it should be explicitly considered in resource allocation decisions.

Aesthetic Quality

An experience based on the aesthetic quality of a resource is another basic human value and viewing the landscape can be an important part of this experience.

Different landscapes appeal to different people, so it is necessary to retain a variety of landscape types. Protection of particular types will become more important as they become scarce, for example wild and scenic rivers, kauri forests and wilderness areas. The landscape is a composite of features in which each feature contributes to the overall aesthetic quality. In the case of the Rakaia, the braided river channel is an important landscape element, contributing to the aesthetic quality of the resource. The effect of resource uses on the landscape can therefore alter

the aesthetic quality.

Scientific Value

Ecological systems can contribute to well-being through their value to science. The scientific study of such systems (for instance, the Rakaia River) contributes to a better understanding of the functioning of the environment and natural systems. This enables more accurate prediction of the consequences of actions and so reduces the levels of uncertainty and risk associated with present patterns of resource use. In addition, scientific study may be able to contribute to well-being by identifying new possibilities for resource use, as well as broadening the frontiers of knowledge. Scientific value is recognised by the Reserves Act 1977, which provides for the designation of areas of land as scientific reserves.

The Rakaia River, as an example of a relatively unmodified braided river sytem, can make a significant scientific contribution towards underestanding why and how such systems are developed and maintained, the interaction involved between river hydrology and ecology and the implications associated with particular development proposals. Information obtained through this type of research is valuable not only to increase knowledge of braided river systems, but also to assist in the development of management regimes.

Distributional Equity

Any form of resource use will result in both costs and benefits to society. It is important to consider how those costs and benefits are distributed amongst individuals within society. Identification of the group or groups whose well-being would be affected one way or another is necessary. The decision as to whether or not the resulting distribution is equitable must be made in the light of the

existing distribution of each of the components of well-being.

3.3.3 Considerations for the Practice of Resource Management

There are a number of important management considerations in deciding resource allocation and, if not incorporated into decision-making procedures, a society's expectations for well-being are less likely to be met. These considerations, including risk and uncertainty, planning horizons, sustainability and resource use efficiency, are not generally incorporated in legislation, but are recognised by many authorities (for example, they are explicitly included in the Nature Conservation Council's proposal for Integrating Conservation and Development (Nature Conservation Council, 1981)). Government appreciation and acceptance of the value of these considerations would do much to provide the Planning Tribunal with the guidance it seeks.

Risk and Uncertainty

Uncertainty is a state arising from possession of only limited amounts of information or knowledge concerning the outcome of a decision. Risk is a term used to denote the possibility of an unfavourable outcome (Radford, 1977). In deciding between conflicting demands, it is necessary to assess the uncertainty and associated risks inherent in each of the demands. With respect to water allocation, there is some uncertainty about both the impact a given allocation may have on the natural system and the benefits accruing from water use.

The assessment of risk has two main components, risk determination (which is the identification of all the risks and estimation of the likelihood and magnitude of their occurrence) and risk evaluation (which is the measurement of

risk acceptance and risk avoidance) (Rowe, 1980). Assessment of risk acceptability must always be subjective as there are many difficulties associated with determining acceptable levels of risk arising out of differing perceptions and uncertainties in measurement.

Some degree of risk is inevitable. Examples of uncertainty and the possible risks associated with abstractive use of Rakaia River water are the effects of the different allocation rules on the various natural systems, the ecological effects of changes to the natural flow patterns, and the security of water supply for irrigation.

The important questions when examining risk are: what levels of risk are acceptable ? (and to whom?); what means exist for reducing or avoiding risk ?; and who should decide the varying degrees of risk?

Risk assessment should not of itself be the basis for decision-making, but it is a valuable tool for assessing the consequences of actions decided upon.

Planning Horizon

The guiding principle requires that well-being be maximised over time. Accordingly, an explicit planning horizon should be identified for the management of a resource. Relevant considerations include the length of time a resource development proposal will affect the resource, and any changes in those impacts over time. The planning horizon should encompass the notions of flexibility and the inter-temporal distribution of resource use.

The notion of flexibility is concerned with maintaining the capacity to make adjustments to a chosen pattern of resource use. Some resource use decisions foreclose present and future options for the use of that resource. For example,

if in the case of the Rakaia River it was decided to allow maximum extraction for irrigation, this would restrict opportunities for present and future in-stream uses. The cost to future generations should therefore be given full consideration and, where possible, flexibility in future use options should be preserved.

The notion of inter-temporal distribution focusses on the distribution, through time, of costs and benefits accruing from a resource use. Although closely related to flexibility, it is primarily concerned with the costs imposed on future generations. At present there is a tendency to give more attention to options providing short-term rather than long-term benefits. However deferred costs may, in the long term, outweigh short term benefits and should be given greater consideration.

Sustainability

Renewable (flow) resources occur in many forms, such as land, soil, water, forests and food sources. However, they all have one major characteristic in common; they are capable of existing in perpetuity, providing that any disturbance does not result in their destruction. A society which insists that all use of renewable resources is sustainable, ensures that it will benefit from these resources indefinitely.

To achieve sustained benefits, renewable resources require careful management. It follows that:

> "for renewable resources, a sustainable [management] strategy is one in which the resource is used at a rate no faster than the rate at which it is renewed" (Hunt, 1979, 12).

Resource Use Efficiency

Resource use efficiency can be defined nominally as

minimising the wastage from production and maximising the use of the resource. The benefits from efficient use of non-renewable (stock) resources are different from those of efficient flow resource use. The Rakaia River waters are generally considered a flow rather than a stock resource in the strict sense. Yet, as the number of braided river systems is fixed, the Rakaia River is undoubtedly part of a finite stock of rivers.

Careful allocation and use of stock resources by the present generation will help to ensure that adequate resources are available for future use. Efficient stock resource use contributes to the flexibility of resource allocation decisions and usually improves the inter-temporal distribution of costs and benefits. Some benefits of efficient use, such as the reduction of waste products from resource extraction and production processes, may accrue to society now.

In any resource allocation decision, consideration should be given to the efficiency with which the resource will be used in each use option. Where possible, the option providing for the most efficient use of the resource should be considered preferential.

3.4 MAXIMISING SOCIETAL WELL-BEING IN DECISION-MAKING

This chapter has developed the concept of well-being and discusses the factors which contribute to well-being. The various factors of well-being cannot be compared directly, since each will be expressed in different terms. For example, GDP, as a measure of standard of living, is expressed in monetary terms, employment in the number of jobs created and recreation in hours of use.

In developing the guiding principle, factors of well-being have been identified. Different use options proposed for a resource will allow for the provision of different combinations of these factors. The problem faced by the Planning Tribunal in allocating resources is to decide which combination or balance between the factors will best be able to maximise well-being. An outline of the process, by which the factors contributing to well-being could be weighed, is presented in chapter five.

In deciding on the emphasis to be given to the various factors of well-being, the Planning Tribunal is in part dependent upon the information presented to them. The ability to recognise differences in the quality and the type of information is important for the implementation of the guiding principle. The following chapter provides a commentary on the information presented as evidence to the Rakaia River NWCO Hearing.

CHAPTER 4:

A COMMENTARY ON THE QUALITY OF INFORMATION PRESENTED AS EVIDENCE TO THE RAKAIA RIVER NWCO HEARING

4.1 INTRODUCTION

Many different types of evidence are presented to Planning Tribunal Hearings. The sources of evidence may vary, coming from institutional or governmental agencies and special interest groups, as well as private individuals. The Tribunal must determine which parts of the evidence are useful and relevant to the case being heard. In this chapter we comment on the evidence presented to the Rakaia River NWCO hearing. From this critique, general comment will be made about the manner in which evidence could be viewed by a Planning Tribunal.

Four major types of evidence have been identified.

(1) scientific research;
(2) economic analysis;
(3) sociological research; and,
(4) opinion.

Figure 4.1 lists participants in the NWCO hearing whose evidence we examined and the type of evidence presented by each. Each type of evidence is described in more detail in the following discussion. There is also a short critique of some of the specific methods used to obtain the evidence. This critique is then used as the basis for a more general discussion on how the quality of the four types of evidence can be judged.

It should be noted that whilst the discussion in Appendix D on the nature of scientific evidence refers specifically to physical and biological research, much of it is applicable to economic analysis and sociological research.

FIGURE 4.1: A summary of approaches used and the users at the National Water Conservation Order Hearing

APPROACH / USER OF APPROACH	PHYSICAL AND BIOLOGICAL RESEARCH		ECONOMIC ANALYSES	SOCIOLOGICAL RESEARCH	OPINION			
	RESEARCH	INTERPRETATION			INDIVIDUAL			REPRESENTATIVE
					PERSONAL	EXPERT ACADEMIC	EXPERT, PERSONAL EXPERIENCE	
INSTITUTIONAL								
Canterbury United Council					X	X		
Commission for the Environment		X	X		X	X		
Dept of Internal Affairs (Wildlife Division)	X	X	X		X			
M.A.F. (Agricultural Research Division)	X	X	X		X	X	X	
M.A.F. (Fisheries Research Division)	X	X				X	X	
Ministry of Works and Development	X	X	X			X		
Ministry of Energy (Electricity Division)						X		
North Canterbury Catchment Board	X	X		X		X		
INTEREST GROUPS								
Acclimatisation Societies								X
Canterbury Chamber of Commerce					X			
Environment Defence Society			X		X		X	X
Federated Farmers					X	X	X	X
N.Z. Jet Boat Assoc.			X	X			X	X
N.Z. Salmon Anglers Assoc.				X				X
N.Z. Salmon Company		X					X	
Rakaia River Association					X			X
Royal Forest and Bird Protection Society								X
INDIVIDUALS								
Citizen					X	X	X	
Technical		X				X		

FIGURE 4.1: A summary of approaches used and the users at the National Water Conservation Order Hearing

4.2 EXAMPLES OF PHYSICAL AND BIOLOGICAL RESEARCH FROM THE RAKAIA RIVER NWCO HEARING

The evidence presented in the NWCO Hearing provides examples of the stages of scientific investigation discussed in Appendix A. The resource surveys (both ecological and sociological) represent observation stages, while other evidence includes hypothesis formulation and testing. Evidence has been considered under the broad headings of classical scientific investigation and simulation models. Major examples are briefly described. One example of each category is discussed in detail to provide illustrations of the nature of the scientific investigation.

4.2.1 Classical Scientific Investigation

(1) Wildlife Service, Fauna Survey Unit

A nationwide inventory of sites of special wildlife interest ("Habitats of Note") was provided. The areas were described, the range and number of species assessed and the areas given a subjective rating for their value as wildlife habitat. Included in the inventory were the braided river habitats of Canterbury and the Upper Waitaki Basin. The designation of an area as a "Habitat of Note" was done on the basis of the degree of modification of the habitat from its natural state (O'Donnell and Moore, 1983).

(2) MAF Fisheries Research Division (FRD)

Investigations were conducted into the biology and ecology of the Rakaia freshwater fisheries. These involved study of the fish stocks, their distribution and habitat. One particular study, described in the evidence of Glova (1983) is an investigation of the effects of flow on the quantity and quality of food and space available to fish.

(3) MWD Water and Soil Division

The research by Mosley (1982) provides a good illustration of classical scientific investigation. Mosley developed two relationships between minimum passage depth and total river discharge in Canterbury rivers. Since these relationships were the basis of important evidence in five submissions to the NWCO hearing, the research deserves close scrutiny. A full critique of this research is given in Appendix B, the main points being summarised below.

The relationships developed by Mosley are dependent on two major assumptions. These are that riffles in different rivers have similar characteristics, and that data from four Canterbury rivers can be meaningfully analysed together. We believe that these assumptions may not be correct. They are not necessarily supported by the data presented in the 1982 paper or by the conclusions of further research by the same author (Mosley, 1983). Therefore, we believe results obtained from relationships that employ either of these assumptions may not be scientifically defensible. We believe that these relationships should not be used for predicting the total river discharge required for a minimum passage depth.

The dependence of scientific results and conclusions on the underlying assumptions of the investigation is illustrated in Appendix B by the use of new assumptions in deriving the relationships between minimum passage depth and total river discharge. While the assumptions used by Mosley (1982) are applied to all Canterbury rivers, the new assumptions are relevant only to the Rakaia River. Based on the two relationships developed by Mosley, the predicted total river discharges required to provide a minimum passage depth of 0.25 m are 68 and 38 $m^3.s^{-1}$. Recalculation of the required discharges for the same depth based on the new assumptions gives values of 77 and 53 $m^3\ s^{-1}$ respectively. While in

hydrological terms these differences of 11 and 15 m^3 s^{-1} are not very large, they are significant in the context of the Rakaia River NWCO Hearing where the minimum flows specified in the different flow regimes differed by as little as 5 m^3 s^{-1}.

Although the results based on the new assumptions are not necessarily any more correct than those they replace, they do indicate how results can be very sensitive to changes in the assumptions on which they are based.. Similarly, where results are based on few data points, the results may be very sensitive to small changes in those data. Since assumptions are not proven and data points always have associated errors, results should be expressed either as a range or with confidence intervals. If this is not possible, it should be made clear that the precision of the results is unknown.

Appendix C summarises the way in which each of the five major participants in the Rakaia River NWCO Hearing has interpreted and used Mosley's work in their calculation of minimum required river discharges. It can be seen that all the participants who used his work made mistakes in their interpretation of the methodology. The most common error was in the way that groundwater and underflow losses were incorporated into total discharge calculations. People using the results of scientific work have a responsibility to ensure that the methodology is clearly understood and correctly applied.

Three of the five submissions chose to use only one of the two methods developed by Mosley, to predict total river discharge for different minimum passage depths in the Rakaia River. While there may have been valid reasons for this choice, no explanations were given. Furthermore, none of the participants questioned the assumptions which formed the

basis of the relationships derived by Mosley.

4.2.2 Predictive Simulation Models

Computer simulation models are often used to predict the behaviour of complex systems. They contain variables related to each other in specific ways and expressed in mathematical terms. Each variable may be manipulated to explore the effect it has on the overall system.

(1) MAF Agricultural Research Division (ARD)

A daily water-balance demand model was used by the MAF to simulate growth of crops and pasture under various irrigation regimes. Using 24 years of climatic data, the model was used to predict irrigation requirements, the flow available for irrigation, the likely irrigation deficits and crop and pasture yields.

Comparisons were made of the probable irrigation water deficits under different water allocation rules. In using the model to determine water demand for irrigation from the Rakaia River, MAF incorporated a number of assumptions based largely on experience. Some of these are discussed below.

The assumptions made about land use and irrigation area were very rigid. Only a single value was used in the MAF model to represent the area of land to be irrigated by river water. However, there is a large degree of uncertainty surrounding this value due to incomplete knowledge of groundwater supplies, changing pumping technology and variations in the costs associated with the use of groundwater for irrigation. Thus the actual area irrigated could differ considerably from that estimated. Furthermore, only one ratio of crop area to pasture area was tested for each soil class. As the character of water demand for pasture is significantly different than that for crops, changes in this ratio could affect demand significantly.

Assumptions about irrigation are untested. For each soil and land use group, only one time period between irrigations was considered. A range of irrigation cycles should have been evaluated as the overall efficiency may depend on soil type, wind, slope, temperature, crop cover and root distribution. Any one of these variables may differ over the scheme area and should be tested to determine how such a variation might affect the model's results.

The model considered one type of response by farmers to uncertainty of water supply. In reality, response to uncertainty is likely to vary depending on the personality, experience and other characteristics of the farmers involved. Alternative responses should have been tested. There was also an assumption of "good" farm management (i.e., that management capable of producing plateau yields) over the entire scheme area. This is unlikely, so levels of production are probably overestimated by the model.

The preceding discussion shows that the assumptions made by MAF about land area, land use, irrigation efficiency and farm management are all subject to variability. Where a complex model, such as this one, has a number of variables, an examination of the sensitivity of the whole model to changes in each variable should be included. The MAF evidence does not provide such sensitivity analyses. While the model itself may be based upon objectively determined relationships between variables, the conclusions from its use are entirely subjective unless all relevant combinations of variables are explored and reported.

4.3 ECONOMIC ANALYSES

4.3.1 Introduction

This section will examine the various economic analyses used by participants at the NWCO hearing on the Rakaia River. Three types of economic analysis have been identified: cost/benefit analysis; budgeting; and, the use of multipliers. The theory of each of the three methodologies, including the rationale for their use and an account of their assumptions and limitations, is discussed in Appendix D.

This section examines the studies done in preparation for the NWCO Hearing. Economic information was provided by the Ministry of Agriculture and Fisheries, New Zealand Salmon Anglers Asosociation, New Zealand Salmon Company, New Zealand Jet Boat Association and the Commission for the Environment. The information varied from economic analyses which attempted to derive a net benefit, to attempts at quantifying only some of the benefits and costs. For each of the economic studies, section 4.3.2 contains a description of their major omissions and weaknesses. Finally, there is a discussion comparing the methods of economic analyses.

4.3.2 Economic Studies Used for the Rakaia River NWCO Hearing

(1) MAF Agricultural Research Division Farm Budgeting

Evidence presented by MAF gave some weight to the deteriorating profitability of dryland farming in Canterbury and to the likely benefits that might accrue to the farmers from irrigation under a range of river allocation rules. There appeared to be three main reasons for examining the impact to individual farmers:

(a) There is an assumption that increased profitability at the farm level will translate to increased benefits to the nation.

(b) It is assumed that the likely benefits to farmers will be a major determinant of their acceptance of an irrigation scheme.

(c) There is a concern for the welfare of farmers.

In relation to the first assumption, it cannot always be assumed that a scheme providing positive net benefits to the farmer will be of benefit to the nation. Farmers have widely varying cost structures; in particular their level of debt servicing is extremely variable. Although these costs may have a major impact on farm profit, they are transfer payments within the New Zealand economy and as such they will not directly influence the net benefits of a scheme from the national perspective. Also, the pricing used in farm budgeting includes subsidies on input and output prices, and on capital items for development. It cannot be assumed that the subsidy schemes currently in place will provide an efficient allocation of resources from a national standpoint in all cases where major development programmes are considered.

With regard to the second assumption it is possible that a scheme may technically provide increased production possibilities. However, farmers are wary because of the risks and stresses associated with shortfalls in irrigation water supply. Brown (MAF), in his submission to the NWCO hearing, stated: "farmers are generally risk averse and are therefore unwilling to invest in developments which have uncertain prospects".

The budgeting analysis carried out by MAF did not include

any sensitivity analyses on the many technical pricing and management assumptions incorporated in the work. When dealing with small profit increases, which was the case for some of the more restrictive water management rules, changes in these variables may be important.

(2) MAF Economics Division Multiplier Studies

Evidence was presented at the hearing that recognised the follow-on effects of irrigation development. All of the theoretical assumptions and limitations of the use of multipliers, which are outlined in Appendix D, apply to the MAF evidence. Also, the figure obtained must be examined in the context of present regional trends, particularly when concerned with regional employment. In reviewing studies of irrigation schemes currently in operation, Leathers et al (1983) found that in some cases farmers have not employed extra labour units on irrigated farms.

(3) MAF Economics Division Cost/Benefit Analysis

The Ministry of Agriculture and Fisheries claim to have used this method to assess the national net benefits that might accrue from the use of Rakaia River water for irrigation. In addition, they have attempted to assess the cost to the nation, in terms of production foregone, of restricting irrigation water supply under the NWCO rule. There are a number of weaknesses apparent in their analysis:

(a) At the time of the NWCO hearing, only the Lower Rakaia Irrigation Scheme (LRIS), with an irrigable area of 22,010 hectares, had been the subject of a CBA. In estimating the national benefits from the much larger total scheme area (96,600 hectares), there was an implicit assumption that the rest of the scheme area would produce a similar rate of return as the LRIS.

(b) No sensitivity analyses were carried out on any of the variables within their analysis. The following are the significant variables that may alter the net return to the country.

(i) The values ascribed to the technical parameters associated with this analysis are not precise. As outlined in Appendix D there may be considerable variation in these values. This fact has not been mentioned in their analysis.

(ii) Recent events in New Zealand show that changes in the on and off-farm capital costs may seriously alter the scheme's viability.

(iii) There was an assumption about the rate of development of the scheme, and therefore when benefit and cost streams will occur. There may be variability in this factor due to delays in construction or the adoption rates of irrigation by farmers may not be as forecasted.

(iv) Product prices may be uncertain as a result of the changing world markets for our primary products.

(v) Production levels were based on plateau yields. Although these are below those technically possible, they represent the 'likely' yield, under 'good' management, given the vagaries of weather, pests and disease and management uncertainties.

(c) A CBA from a national stance should explicitly exclude input and output subsidies for farm production. While it may be inferred that the MAF

analysis did exclude subsidies, it was not made clear.

(d) There are likely to be benefits and costs for which no market price exists. In this category there are in-stream values of the Rakaia such as fishing, jetboating, canoeing, wildlife and other natural values. In their CBA the Ministry of Agriculture and Fisheries assumed the opportunity cost of these in-stream values to be zero on the basis that the 1974 North Canterbury Catchment Board allocation rule would not detrimentally affect these values. In so doing, they avoided the problem of valuation. Given the uncertainty surrounding the likely impacts on in-stream uses, in-stream values should not be so readily dismissed.

(4) Other Economic Studies

The New Zealand Salmon Company, the New Zealand Salmon Anglers' Association and the New Zealand Jet Boat Association all provided information of an economic nature. All were attempts to quantify the in-stream value of Rakaia River water.

The New Zealand Salmon Company estimated gross returns from the sale of salmon eggs to place a dollar value on the water, for the purposes of salmon ranching. However, there was no indication as to how much this would be reduced, or even if it would be reduced, should irrigation go ahead. Therefore the benefits from salmon ranching cannot be regarded as an opportunity cost of irrigation until it is proved that they are mutually exclusive uses.

The New Zealand Salmon Anglers' Association attempted to quantify the recreational fishing value of the Rakaia. This was achieved by observing and valuing the boats, fishing

gear, vehicles and caravans at the mouth of the Rakaia on an unspecified day in March. However, there was no discussion of methodology, or how this relates to the actual fishing value of the river. Also, there was no attempt to separate the value of the portion of equipment used in other activities. It was assumed, in effect, that cars and other equipment were purchased exclusively for fishing the Rakaia River.

The New Zealand Jet Boat Association used data derived from a survey of their members to determine a gross expenditure on jet boating, thus valuing the river's recreational value. Again, no attempt was made to separate that portion of equipment value and expenditure associated with jet-boating on rivers other than the Rakaia. This could considerably over-value the jet boating opportunities of the Rakaia.

The New Zealand Jet Boat Association also attempted to identify the secondary benefits of their recreational activity. No values were given, but it was stated that "benefits [to] accommodation, service stations and food stores can be quite considerable [for] the local community from jet boating on the Rakaia" (NZ Jet Boat Association, 1983). On its own, this statement does not provide any verifiable data, but it does present a possibility for further research. Regional or employment multipliers could be developed to estimate the secondary benefits of jet boating.

Dr Ken Leathers (for the Commission for the Environment) presented a review of the available information relating to the economic, social and environmental issues from irrigation development. It was emphasised that "no formal cost-benefit analysis of the issue in question at this hearing (i.e., the NWCO) has been undertaken" (Leathers, for the Commission for the Environment) (our emphasis).

However, the work to date on the instream benefits attributable to the Rakaia is discussed, and it was concluded that "the estimates are indicative only of what the Rakaia fishery and amenity resource might be worth in economic terms to the region" (Leathers et al, 1983).

4.3.3 Comparison of Results from Economic Analyses

Given the previous discussion of the theory and use of the various economic analyses, it is possible to comment on the comparability of the outcomes. Even though the results of analysis of various use options were expressed in dollar terms, they cannot always be directly compared. There are tpwo main areas where difficulties in comparison arise.

(1) The stance of the analyses

The stance taken in an economic analysis has a major bearing on the identification of costs and benefits. From an individual standpoint, the analysis will be concerned with identifying costs and benefits accruing directly to the individual. The costs and benefits associated with that enterprise may be quite different to the national costs and benefits. It is possible that a factor may be regarded as a cost from one stance and a benefit from another. For example, a government subsidy on an input to a venture would be regarded as a benefit to the firm, but as a cost to the nation. Therefore it is not possible to compare the net benefits of various ventures if different stances have been used to estimate those benefits.

At the Rakaia River NWCO hearing, economic information was presented from the individual, local, regional and national stances. It is important to consider which stance was appropriate for this hearing. As a NWCO was being sought, rather than a LWCN, it was appropriate that the national accounting stance be used in the first instance. The individual, local and regional stances are useful to

determine whether individuals or regions would incur disproportionate costs from the institution of a NWCO.

(2) The estimation of benefits and costs

The methodologies available for the estimation of non-market values have not yet been sufficiently tested to provide reliable results. The results of analyses using such values and those relying on market pricing cannot be compared with any degree of confidence.

None of the analyses used made any attempt to recognise risks or uncertainties associated with the various projects. For example, the benefits accruing from salmon ranching may be highly unpredictable given the risk of disease or market uncertainties, while the returns from irrigated agriculture may be more predictable. There are methodologies available for the incorporation of risk and uncertainty within a CBA framework (see Bell, 1977; Irwin, 1978). However, these are not widely used.

The necessary assumptions within any economic analysis and the problems of obtaining accurate estimates of benefits and costs, mean that clear comparisons of projects cannot always be made. The results can only provide approximate comparisons and then only where similar stances are taken.

4.4 SOCIOLOGICAL RESEARCH

4.4.1 Introduction

The philosophy of social science is similar to that of the physical sciences, but its focus is the behaviour of human beings.

The primary difference between social and physical sciences is that a large body of social science deals with people's verbal reports of their behaviour, rather than direct observation by the researcher of the behaviour itself. Much of the information obtained by social science is therefore qualitative in nature, and does not lend itself to measurement and replication.

However, measurement and replication are simply the techniques used by the physical sciences to validate the information they produce. Because these techniques cannot often be applied in social science, a number of well worked and sophisticated methods for validating qualitative information have been developed (see, for example, Hughes, 1976). These include methodological diversity and cross-validation of information obtained from different sources.

4.4.2 Examples of Sociological Research

(1) NCCB & RWB Rakaia River On-Site Recreational Survey

This reported the results of a survey of recreational use of the Rakaia (see Bowden, 1983; Saville-Smith, 1983). A variety of methods were used to obtain the results, including:

(a) two surveys of users, one on-site, one at home;
(b) interviews with key informants;
(c) site inventories;
(d) aerial survey counts of recreators; and
(e) fishability experiments.

(2) The New Zealand Jet Boat Association

A questionnaire was sent to all members in an attempt to obtain data about the use of the river. Members were also asked for intormation about the amount of money they spent on the sport so that an economic evaluation of the Rakaia's value as a recreational jet-boating resource could be made.

(3) MAF Fisheries Research Division (National River Angling Survey

This was an attempt to assess the relative importance of New Zealand's rivers and streams to recreational anglers. It was a national survey, conducted using a sample of licensed anglers from each acclimatisation district. The anglers were asked to list the rivers they fished and rate the importance of each river to them on a scale of 1-5. Respondents were also asked to assess the rivers they listed on the basis of qualities believed to be attributes of good river fisheries. An evaluation of responses to the questionnaire resulted in a list of fishing rivers of national importance.

Two features of this survey, in particular, contribute to its usefulness as a qualitative assessment of the fishing value of different rivers. First, the assumptions and methods used to gather the information are clearly stated. This enables the reader to assess the validity of the results and conclusions drawn from them. Second, it was a national rather than regional survey and thus should provide a comparison of practically all fishing rivers in New Zealand.

However, the survey did have a number of limitations. To enable relative values to be assigned, the results from different rivers must be comparable. In this survey the seven fishery attributes were designed to provide the basis for comparison between different rivers but, despite the

inclusion of attribute definitions in the questionnaire, the results showed that anglers' interpretations of each attribute varied. Thus, the information obtained is useful only as a general indication of the importance of each river, and not as a direct comparison between rivers.

Other limitations of the survey were:

(a) As only adult whole-season licence-holders were polled, the information obtained is not fully representative of the whole angling population.

(b) Questionnaire response rates were low (40-60% depending on the region).

(c) No discussion was included on the levels of confidence of the results. (This has been included, more recently, in Regional Reports sent to each acclimatisation society (Davis, FRD: pers. comm.))

(d) When the conclusions were drawn, although reference was made to the limitations identified previously, no implications of these limitations were discussed.

These points illustrate the difficulties associated with interpreting the results of much sociological research, and the need to specify precisely what is being surveyed and the bounds of a particular survey design. However, surveys are only one method of obtaining information and feedback on issues. Opinion represents another method where the public have an opportunity to have a say on particular matters of interest and/or concern.

4.5 OPINION

4.5.1 Introduction

This section discusses information presented as opinion. An opinion is an expression of beliefs, values and attitudes. A distinction may be made between representative opinion and individual opinion. Representative opinion is when a spokesperson expresses the collective view of a group, even though some individual members may disagree with the group statement. Conversely, individual opinion is an independent statement made by one person. Individual opinion can be divided into:

(1) Personal opinion, where the person speaks on the basis of individually held beliefs and values; and

(2) Expert opinion, where the person expresses an opinion on a matter in either their own specialist field of research (i.e. expert academic opinion), or as a result of long standing experience or knowledge (i.e. expert experiential opinion).

The expression of an individual's or group's opinion is one of the few opportunities for the public to participate in decisions regarding water resource allocation. At present, there is an increased interest in public participation in resource allocation. This pressure for increased participation is based on both philosophical and pragmatic considerations. There is a general belief that in democratic societies, individuals have the right to be informed and consulted, and to express views on matters which affect them personally. More pragmatically, the demand for more participation stems from distrust in the ability of the decision-makers to adequately gauge public preferences. Thorn (1984) further outlines some aspects of public participation at the Rakaia River NWCO Hearing.

4.5.2 Examples of Opinion from the Rakaia River NWCO Hearing

The participants at the Hearing identified a range of natural system and existence values. Within the diversity of expressed public, private and institutional concern, the following categories were identified:

(1) ecological values
(2) braided river values
(3) value to science
(4) aesthetic values
(5) wild and scenic values
(6) amenity value

Although these categories were often discussed separately by participants at the hearing, it should be recognised that they are closely inter-related, that is the perception of quality of life values are reliant on the existence of natural systems values. The 'obligations' of the participant (whether institutional, interest group, technical witness or citizen) tended to determine the range of values they addressed. Institutional (i.e. governmental) agencies referenced a wider range of natural system values, whereas the individual citizen appeared to be more specific in their area of concern.

This illustrates one of the conflicts the Tribunal may have to resolve - which information has the greater relevance to the issue in question? For example, a person who has been fishing the Rakaia River all their life (basing their expertise on 'personal experience') may agree that from observing river characteristics, such as mouth closure or fish passage up shallow minor braids, a specific low flow may have little or no effect. The person who bases their opinion on 'academic experience', however, may argue that the same low flow will cause the river mouth to close or restrict fish passage up the channel braids. There is

difficulty in deciding which proposition is more correct on the basis of the information presented. The 'academic expert' may be drawing their information from a wider understanding of the characteristics of the natural system as a whole, whereas the 'personal experience expert' may be presenting information that is based on site-specific experience. Thus, the Tribunal needs to decide whether the issue is best addressed by either the wider or the more site-specific approach.

4.5.3 Commentary on Information Presented as Opinion

In any inquiry into NWCOs, the Tribunal is likely to be confronted by a wide variety of opinion about the values, uses and qualities of a particular river. Deliberations and decisions will require balancing of information presented.

Two common elements concerning information presented as opinion are content and presentation.

Content

Opinion is distinguished from other approaches since it is an expression of one's thoughts and feelings. Subjectivity, therefore, is an inherent feature of opinion. The values and vested interests of participants may be reflected in their presentation and may bias the focus of their submission. Participants should make their biases clear and not attempt to present subjective opinion as objective fact. However, subjectivity does not invalidate an opinion. No opinion should be entirely disregarded, although opinions expressed by a number of participants may have more weight than those expressed by a single individual.

Presentation

This can be subdivided into written submissions and oral presentations.

In deliberating its decision, a Tribunal will undoubtably refer to the written submission. Therefore, it is important that the Tribunal is satisfied the information contained in a submission is accurate and that any interpretation of that information is valid. For example, in the Rakaia River NWCO hearing, the evidence of 'expert' witnesses on behalf of Federated Farmers was based on case-studies of individual farmers. The evidence, however, was neither co-ordinated nor presented in a manner which complemented the case-study format.

Similarly, the Wildlife Service did not show the validity of their system which rated the Rakaia as an "outstanding" wildlife habitat. What on the surface is discussed as scientific evidence appears in fact to be the opinion of Wildlife Service officers. It is their interpretation of the inventory. The Tribunal should seek to separate the elements of opinion from the discussion of scientific evidence.

There are two means by which the validity of information presented as opinion can be assessed. First, by examining its basis. For example, it may be based on long experience, academic expertise or strong feeling. Second, it can be validated by corroboration, when the same or similar opinion is expressed by a number of participants.

4.6 CONCLUSION

It has been shown in this chapter that the information presented to a resource-allocation hearing can be of varying types and qualities. Critical evaluation of the validity of the information is required at the initial stages of proceedings. The Planning Tribunal or any other decision-making body must be aware of the limitations of any evidence presented and this cannot always be left to other hearing participants to provide.

Although it is important to assess the quality of information, another important aspect of information presented involves comparability of similar values or results. Simply because two values are expressed in a common numeraire (e.g. dollars) does not mean they can be directly compared. The manner in which the information was derived, as well as the values it purports to represent, must be carefully assessed. Valid comparisons of information can only be made where the validity of the information is established and the information represents similar values.

The general commentary about the four major types of information (scientific, sociological, opinion and economic) has critically examined the methods used and highlighted deficiencies in the information they produce. When assessing specific pieces of information, the following set of criteria are useful for identifying their short-comings.

1. Has the objective of the investigation or analysis been clearly stated (e.g. a hypothesis)?

2. Have the underlying assumptions been stated and are they justified?

3. Has a full description been given of any specific methods used to obtain or analyse data?

4. Are the methods relevant to the stated objective of the investigation or analysis?

5. Are the conclusions drawn valid and relevant to the problem or issue addressed?

6. What confidence can be placed in results or conclusions? That is, are error values or limits of confidence stated?

7. Have the full implications of the results and conclusions presented been discussed in an objective manner?

It is essential that major resource allocation decisions are made using reliable information. Where obvious gaps are apparent in information presented, the tribunal should endeavour to determine the significance of the omission. Occasionally it may be necessary for the tribunal to seek additional advice.

CHAPTER 5: THE PROCESS OF RESOLVING CONFLICT IN RESOURCE ALLOCATION

5.1 INTRODUCTION

In Chapter 3, a guiding principle for resolving resource allocation conflicts was developed which proposes that:

> Resources should be allocated so as to maximise the well-being of New Zealand society over time.

This guiding principle was then further developed by the identification of a number of factors essential to the well-being of New Zealand society. In addition, resource management considerations that help to ensure the maintenance of well-being over time were discussed.

In the resolution of resource allocation conflicts, two processes of appraisal are necessary. The first is the assessment of information for its validity and relevance. In Chapter 4, a commentary was presented on the nature of information introduced as evidence at the Rakaia River NWCO Hearing. From this commentary, a set of criteria was developed which will enable the validity of such information to be assessed. The second appraisal process involves the comparison of different use options in terms of the guiding principle and factors described in Chapter 3. A process within which these two aspects might be integrated is outlined in this chapter. Although presented as a sequential process, in practice it is likely to be more iterative.

5.2 THE ASSESSMENT OF INFORMATION

The initial stage in the process is the identification of resource use options. This requires a clear and careful description of the various proposals for the management of the resource in question.

The next stage involves an assessment of the information available about each resource use option. This appraisal will have two aspects. First, the validity of the information needs to be assessed. The criteria presented in Chapter 4 provide a means by which it is possible to determine whether a sufficient standard of rigour was applied in obtaining the information. The Planning Tribunal, by considering each piece of evidence in terms of these criteria, can assess its quality as information. Second, the Planning Tribunal needs to consider the relevance and completeness of the set of information. Information is needed about each use option in terms of each of the factors contributing to well-being and considerations for the practice of resource management presented in Chapter 3. However, we consider the list of factors we have presented to be a minimum requirement. Some resource allocation conflicts may require additional factors to be taken into account.

In this stage of the process, then, the members of the Planning Tribunal need to satisfy themselves as to the validity, relevance and completeness of the set of information available to them. If the validity or completeness of the information is questionable, then the Planning Tribunal should exercise its power to delay making a decision until more satisfactory information is available. On some occasions a trade-off may have to be made depending on the urgency of a decision, the availability of information, the relative importance of the unsatisfactory

or missing information and the consequent risks involved in making a decision without it.

5.3 THE COMPARISON OF RESOURCE USE OPTIONS

The next task is to assess the different use options in terms of their ability to contribute to the well-being of New Zealand society. This involves explicit consideration of how well each resource use option will provide for each of the factors contributing to well-being. The Planning Tribunal also needs to assess how well each resource use option would perform in terms of the considerations for the practice of resource management. This stage involves consideration of the uncertainties and risks involved in each use of the resource, and who is bearing the risks, the sustainability of each resource use, the planning horizon involved and the overall efficiency of each resource use.

One useful technique for ordering this information could be to set up a matrix of the kind shown in Figure 5.1. Obviously, much of the information involved will be qualitative in nature. We consider that it is highly improbable that any sort of quantitative scoring or ranking is likely to be either possible or meaningful in this situation. What would be entered in each column, therefore, would be a summary of the effects of the proposed resource use on each of the factors contributing to well-being, and of the resource management considerations involved in such a proposal. The matrix can then serve two purposes: firstly, as a checklist to ensure that all the factors have been considered and secondly, as a means of summarising and comparing the information about the proposed resource uses. However, while it is a useful tool, a matrix cannot be a substitute for careful evaluation of the detailed evidence.

This step should provide the Planning Tribunal with a clear picture of the effects which different use options are likely to have, both now and in the future.

FIGURE 5.1: Information Matrix

		RESOURCE USE OPTIONS		
		PROPOSAL A	PROPOSAL B	PROPOSAL C
FACTORS CONTRIBUTING TO WELL-BEING	Standard of living			
	Employment			
	Recreational opportunity			
	Traditional and cultural value			
	Existence value			
	Aesthetic quality			
	Scientific value			
	Distributional equity			
RESOURCE MANAGEMENT CONSIDERATIONS	Risk and uncertainty			
	Planning horizon			
	Sustainability			
	Resource use efficiency			

5.4 THE CHOICE OF RESOURCE USE

The task of deciding which is the most preferable use of the resource requires the exercise of judgement, and must give regard to both societal preferences at the time of the decision and resource management practices that will enable society to cater for changes in its preferences in the future. This judgement will require the Planning Tribunal to decide which factors should be given more or less emphasis in any resource allocation decision.

The emphasis accorded to each factor will depend in part on existing patterns of resource use. The contribution of a resource use to a factor will be more important if other satisfactory means of contributing to that factor are scarce or non-existent. For example, in a situation of high unemployment, the ability of a resource use to provide a significant number of suitable jobs may be very important. Similarly, the scientific or existence value of a relatively unmodified natural system may be highly significant if all comparable natural systems have already been extensively modified as a result of previous use choices.

The relative importance of the factors will be different for each situation, and the task of assigning priorities will therefore need to be undertaken for each new decision. When conflicts arise between matters of local, regional or national importance, the appropriate planning legislation may give guidance about which stance should be accorded priority. If not, then all these stances should be explicitly considered when assessing the effects of each option on each factor.

This stage of the process, in summary, is for the Planning Tribunal to consider the set of consequences that each resource use option has for societal well-being, and appraise the relative importance of those consequences. It

must then decide which set of consequences will contribute most to the well-being of New Zealand society over time.

5.5 CONCLUDING COMMENT: THE ROLE OF THIS STUDY

The decisions involved in the process we have described demand sound judgement rather than accurate calculation. This is the role of the Planning Tribunal. The task of the analysts and proponents of the various resource use options is to provide the Planning Tribunal with the best possible information on which to base its judgement.

The role which we believe our work fulfils is to make explicit the factors which must be considered, both in the assessment of information for its validity and usefulness, and in the evaluation of resource use options for their ability to contribute to societal well-being. Although these issues may be addressed implicitly in decision-making at present, we consider that there is real value in making them explicit.

We believe that if a decision process such as the one that we have suggested was adopted, it would enable people to see that consistent standards were being applied to each resource allocation decision. Furthermore, if the concerns that we have discussed were given specific reference by the Planning Tribunal in publishing its decisions, it would enable people to observe the relative significance accorded to different factors in reaching the decision. The public would then be able to decide whether these priorities were acceptable and whether they accord with the direction in which people wish to see society evolve. Without an explicit set of standards it would be difficult to be consistent across the range of resource allocation decisions. Inconsistency could result in society unwittingly foreclosing options and limiting the range of alternatives available to it. We believe that if the guidance we have suggested is endorsed, it will assist the resource allocation process for the benefit of society.

The guidance that we have provided is designed for the existing legislative and institutional framework. We believe that its application does not conflict with any of the Planning Tribunal's existing legal responsibilities. However, we consider that it would be appropriate for such guidance to be given formal recognition. Furthermore, it should be noted that the conflicts which the Planning Tribunal is called upon to resolve arise during earlier stages in the resource allocation process. We believe therefore, that the guidance we have provided should be used at all levels of the planning and decision-making process.

CHAPTER 6: SUMMARY

Resource use has always been an integral part of economic growth and development in New Zealand. Increasing concern for the conservation of resources, together with a wide range of demands for the use of available resources, has inevitably created conflict.

The Planning Tribunal has the responsibility under the Water and Soil Conservation Act 1967 and the 1981 Amendment Act to make decisions when conflicts in water resource allocation cannot be resolved by other methods.

This study was motivated by two problems that have to be addressed by the Planning Tribunal when making resource allocation decisions. Firstly, the guidance provided by legislation is inadequate and secondly, evidence supporting a range of resource uses must be evaluated and compared by the Tribunal. To resolve these problems, the Rakaia River NWCO hearing has been used as a focus for this study. Two objectives were defined:

(1) To develop a guiding principle that could assist the Planning Tribunal when considering resolution of conflicts in resource allocation; and,

(2) To provide a commentary that could assist the Planning Tribunal in its interpretation of evidence and to make valid comparisons between different proposals for resource use.

We recognise that if the Planning Tribunal is to be assisted in its present role, any guidance should be capable of implementation within the existing legislative framework. Our approach to this study, therefore, began with a review of the legal and institutional context within which National

Water Conservation Order decisions are made. We then characterised resource allocation conflict with particular reference to the Rakaia River. This conflict was identified as resulting from different opinions about the nature of the resource and how it should be used.

Societal expectations for the management of resources were examined. These included expectations for the way in which a decision is made, and expectations for the outcome of the allocation process. We found these expectations to be in statutes, political debates, petitions, the goals of interest groups and in submissions to the Rakaia River NWCO Hearing. Our examination revealed a common desire to maximise benefits accruing to society through resource allocation, and provided the basis for our guiding principle that:

> Resources should be allocated so as to maximise the well-being of New Zealand society over time.

The key concept of this principle is well-being, which encompasses the notions of health, happiness and prosperity. To provide a better understanding of this concept, we sought to identify factors of well-being, drawing on legislation and statements by interest groups. The factors we identified were:

(1) Standard of living
(2) Employment
(3) Maintenance of recreational opportunity
(4) Traditional and cultural values
(5) Existence values
(6) Aesthetic quality
(7) Scientific value
(8) Distributional equity

In addition, there are considerations for the practice of resource management which indirectly contribute to well-being. These are:

(1) risk and uncertainty;
(2) planning horizon;
(3) sustainability; and
(4) resource use efficiency.

We note that the Planning Tribunal must make decisions on the basis of the information presented to them. The Planning Tribunal is presented with a wide range of evidence of varied type and quality. It must determine the usefulness and relevance of this evidence to the problem of resource allocation under dispute. To assist the Planning Tribunal in this task we have provided a critique of the methods used to obtain the evidence presented at the Rakaia River NWCO hearing, and a commentary on the use of these methods by the participants at that hearing. For convenience, the evidence was grouped into four main categories; scientific research, economic analysis, sociological research and opinion. Examples were selected from each category for more detailed discussion.

The main conclusion drawn from the critique of scientific evidence is that the assumptions on which the evidence is based must be justified and clearly stated. We found that this requirement was not always met in the presentation of scientific evidence by participants at the Rakaia NWCO Hearing. Different assumptions or small changes in the assumptions can cause marked changes in the results of the study and the conclusions drawn from these results.

Where economic analyses are performed it is important that the standpoint of the analyses are made clear. A weakness of much of the economic evidence presented at the hearing was that the stances of the analyses were not explicitly stated.

Valid comparisons between results of economic analyses cannot be made if the standpoints of the analyses differ. Economic analyses performed from a national standpoint, therefore, are not directly comparable with those made from a regional or local standpoint.

Information presented in the form of opinion should be scrutinised for its relevance and validity. The validity of opinion can be assessed by examining its basis or by corroboration.

Overall, from these methods of generating information, a number of conclusions can be made about the relevance and validity of that information. They are the following:

- The objectives of the research or analysis should clearly be stated along with the reasons for choosing a particular method.

- All assumptions used in obtaining information must be made explicit. Where required, the assumptions should be tested and validated.

- A clear statement of the methods used to generate information is needed. This will enable an examination of the validity of the methods, and ensure that they have been correctly applied.

- Confidence limits should be placed on the results obtained.

On the basis of these four points it will be possible to determine whether the evidence is relevant and whether the conclusions drawn from the work are valid.

We suggest a process which provides a means of applying the guiding principle and the criteria for the assessment of

information to the resolution of resource allocation conflicts. This process can be summarised by the following five steps:

(1) Identification of resource use options.

(2) Assessment of information:
- for validity (in terms of the criteria in Chapter 4 and Appendices A and D);
- for relevance and completeness (with respect to the factors and considerations in Chapter 3).

(3) Use of the information to identify the consequences of each resource use option (in terms of the factors and considerations in Chapter 3).

(4) Determination of the relative significance of each factor in the situation under consideration.

(5) Judgement as to which set of consequences will contribute most to the well-being of New Zealand society over time.

We see a number of advantages in the adoption of this process. It makes explicit the basis on which resource allocation decisions are made and provides for consistency across the range of such decisions. It also allows for the reassessment of priorities, by both the public and decision-makers, as societal preferences change over time. It can, therefore, enable the resource allocation process to be more responsive to society's wishes. We believe that there would be considerable benefit in the application of this process at all levels of the planning and decision-making process.

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APPENDIX A: THE NATURE OF SCIENTIFIC INVESTIGATION

The purpose of scientific investigation is to gain a greater understanding of a system. The system may be natural or man-made. An investigation should accurately describe the nature of a system or allow predictions to be made about its behaviour. In the context of the Rakaia River, investigations were carried out to gain a greater understanding of the river ecosystem and its different uses. The information obtained was used to predict the impact of various management regimes on the river system and on in-stream and abstractive uses.

To know with certainty how a system will respond to a specific set of conditions, one must impose these conditions and observe the result. However, it is usually impractical to test every part of a system, thus only parts of it are tested and the results are assumed to be representative of the whole system.

Scientific investigation involves use of a specific investigative format (Popper, 1959). On the basis of observations, a prediction or hypothesis is proposed and then tested by means of further observations or by various experimental methods. The hypothesis is rejected or modified if any observation or experimental result is not in agreement with those predicted by the hypothesis. Except where it is very simple, a hypothesis cannot be proved correct. However, the greater the number of observations and results which agree with those predicted, the greater the confidence one can place in the hypothesis.

In reality, scientific investigation tends not to be this rigorous. Instead, observation, hypothesis formulation and hypothesis testing occur more or less simultaneously and may influence each other considerably. Furthermore, there is

scope for the investigator's own beliefs and expectations to influence all stages of the investigation.

Once an hypothesis has been used for some time it can become entrenched. Thus, when observations and results which are not consistent with the hypothesis are noted, the observations and results are considered anomalous, rather than the hypothesis being rejected. Only when there are sufficient anomalies is the hypothesis rejected. The more firmly entrenched the hypothesis, the more anomalies are required before its validity becomes suspect.

Aims and Objectives

The aims of scientific research are broad statements of interest. The aim may not be attainable but provides direction to the study, and should therefore be explicit at the beginning of any scientific investigation. The objectives of the study should be derived from the aim. They provide explicit proposals of what is to be accomplished by the investigation and should be capable of both attainment and measurement. The statement of aim[s] and objectives allows the reader to check that the assumptions, methods and conclusions are both relevant to and fulfilled by the research.

Assumptions

Assumptions are points taken to be true for the purpose of the argument or action. All scientific investigations contain assumptions, the most common being that the part of the system tested is representative of the whole system. Other assumptions will depend on the nature of the investigation. An example from the evidence of Glova (MOWD) is "that the suitability of habitat for a particular species [of fish] can be described by measuring the water depth, velocity, and substrate composition of the sites occupied by fish".

In any piece of scientific work, assumptions should be clearly stated. They provide the boundaries or framework within which the scientific investigation is made, and as such they are not usually tested during the investigation. It is important, therefore, that the assumptions used in an investigation are consistent with what is already known about the system and with the methods and techniques used in the investigation. The assumptions behind all scientific work should be questioned and, if necessary, tested, to ensure that they are reasonable. Without this, the value of scientific work is limited.

A clear statement of the assumptions used allows readers of scientific work to determine whether they agree with those assumptions, and whether the results are internally consistent; that is, they are reasonable in light of the assumptions made, regardless of whether the assumptions are valid.

Methods

The methods used in an investigation must be appropriate for the type of results required, and must be clearly explained. Inappropriate methods may give results which, although technically correct, are misleading in that the method has not tested the hypothesis. For example, when calculating the degree of farmer acceptance of irrigation, it would be inappropriate to use a method based on farmers' profits if, in reality, farmer acceptance was related only to the farmers' perception of risk avoidance, and not to profits.

In the same way that assumptions must be clearly stated, the methods used in an investigation must be clearly explained. This allows the reader to determine whether the methods used are appropriate and allows meaningful comparisons to be made with other scientific work. Careful description of methods facilitates further analysis of the results by the reader

and should allow the work to be repeated.

Accuracy of Results

The objective of all investigation is to produce results from which conclusions can be drawn and predictions made. Results are never completely precise and it is necessary to describe the level of accuracy or the magnitude of possible error involved. This is usually done by statistical analysis, which requires that investigations be designed and conducted in accordance with principles of experimental design (Steel and Torrie, 1980).

The accuracy of results is expressed in the form of the result plus or minus the associated error. This describes the range of values in which the result will probably be found. For example, a result of 150 plus or minus 10 with a 95% probability, means that there is a 95% chance of the correct value lying between 140 and 160.

Sensitivity analysis is another technique used to determine the accuracy of results. It assesses the effect on the system, or part of the system, of a change in one variable. Thus the variables to which the system is most sensitive can be identified.

Conclusions in Scientific Investigations

It is important, when drawing conclusions from a scientific investigation, that all the results of the investigation are taken into account. A conclusion drawn from only selected results may give a misleading view of the system under consideration. Furthermore, conclusions must be relevant to the purpose of the investigation.

When research conclusions are quoted to support a particular viewpoint, it is important that they are used in the context of the original research. Conclusions can only be

considered valid in the context of the system within which they were derived, and under assumptions made about that system. If they are used under another set of assumptions, or in another system, then this must be clearly stated.

APPENDIX B: A CRITICAL EXAMINATION OF SCIENTIFIC EVIDENCE

The two methods developed by Mosley (1982) to relate minimum depths to river discharges are important in the context of the Rakaia River investigation. All participants at the NWCO hearing who requested minimum river discharges used these methods to predict required total river discharge for various minimum passage depths. This paper has been critically examined to illustrate some of the features of scientific investigation.

The first method involved the development of two relationships; the minimum passage depth on any riffle at a given discharge (equation 1), and the proportion of total discharge carried by the main channel (Q_m/Q_t) at a given discharge (equation 2). By combining the equations for the two relationships, the minimum passage depth in the main channel of a river was established for any total discharge (equation 3).

In Method 1, data is interpreted on the basis of two assumptions. The first is that "there is no reason to suppose that the riffles on the [different] rivers do not conform to the same relationship". This assumption appears justified for the data set presented in Figure 3 (Mosley, 1982) as the points for the three rivers (Ashley, Hurunui and Rakaia) fall within the 95% confidence interval around a single regression equation. Equation 1 is derived from the lower envelope of this data set and is used to represent minimum depths at different flows.

The second assumption is used to determine the relationship between Q_m/Q_t and total discharge (equation 2). Mosley assumes that the rivers have the same characteristics and that combining data from different rivers is warranted (Figure 1).

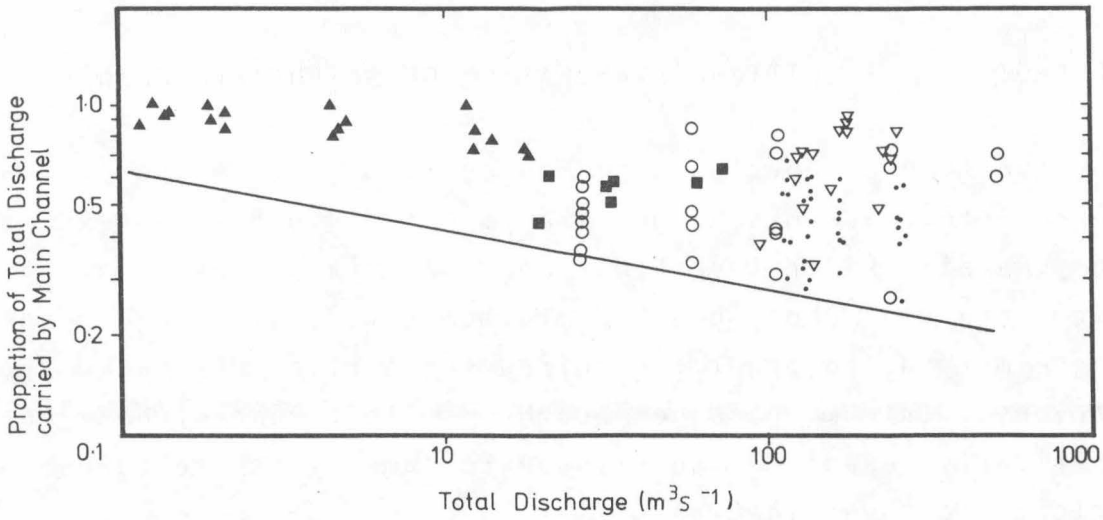

Figure 1: Relationship between the proportion of total discharge carried by the main channel Q_m/Q_1 and total discharge Q_1 for the Ashley (▲), Hurunui (■), Ohau (○), and Rakaia (▽, measured; •, estimated from aerial photographs) rivers. The solid line is the lower envelope with the equation $Q_m/Q_1 = 0.65Q_1^{-0.2}$ (From Mosley, 1982).

However, in a second paper (Mosley (1983), he presents the same data set (with the exception of a few low Q_m/Q_t values) and concludes that combining data from different rivers to develop a flow relationship is inappropriate. In his discussion of this data, he states the following:

> "There is a weak tendency for the proportion of flow in the largest channel to decline as total flow increases (Figure 24), but this may be because the data are drawn from several rivers, each covering different flow range. Again, the scatter is so great that the relationship has little predictive value."
> (Our emphasis)

Although the relationship referred to in the 1983 paper is a regression rather than a lower envelope equation, we believe that the conclusion drawn from the data in the 1983 paper is correct. The consequence of this conclusion is that the relationship between Q_m/Q_t and total discharge developed by Mosley (1982) does not hold. Therefore equation 2 should not be used in the derivation of a relationship to predict the discharge required to maintain a specified minimum

passage depth in Canterbury rivers (equation 3). We believe that a more conservative assumption on which to base the second relationship is justified. This assumption should deal with data from each river separately, and since the major use of Mosley's work has been by participants in the Rakaia NWCO hearing, we have chosen to reinterpret only the Rakaia River data set.

There are two options for the new assumption. The first is to draw a lower envelope for the Rakaia River data alone. Considering the variability of data for Q_m/Q_t at any given discharge, too few data points are available over too narrow a range in river discharges to provide a reliable lower envelope. Therefore we will not use this assumption. The second option is to assume a single minimum value for Q_m/Q_t for the Rakaia River. This means that Q_m/Q_t is assumed not to alter with changing total discharge over the range of discharges presented. Accepting that a predictive relationship based on data from different rivers is not valid, then for the Rakaia River data set the assumption that Q_m/Q_t is constant, is justified.

The derivation of Mosley's equation 3 has been reworked using the assumption that $Q_m/Q_t = 0.25$, the minimum depth value for the Rakaia River (Mosley, 1982).

equation 1	D_{min}	$= 0.092\ Q^{0.34}$
2	Q_m/Q_t	$= 0.65\ Q_t^{-0.2}$
2'	Q_m/Q_t	$= 0.25\ Q_t$
3'	D_{min}	$= 0.057\ Q_t^{0.34}$
4	D_{min}	$= 0.14\ Q_t^{0.16}$
4'	D_{min}	$= 0.53\ Q^{0.39}$

Figure 2 shows the relationship between minimum passage depth and total river discharge using equations 3 and 3'. It can be seen from Figure 2 that changing the underlying assumption used in deriving the relationship alters

predictions of minimum passage depths using Method 1. A comparison of results from equations 3 and 3' is given in Table 1. While in hydrological terms a difference of 9.4 $m^3.s^{-1}$ (for 0.25 m depth) is not large, it was significant in the context of the Rakaia River NWCO Hearing.

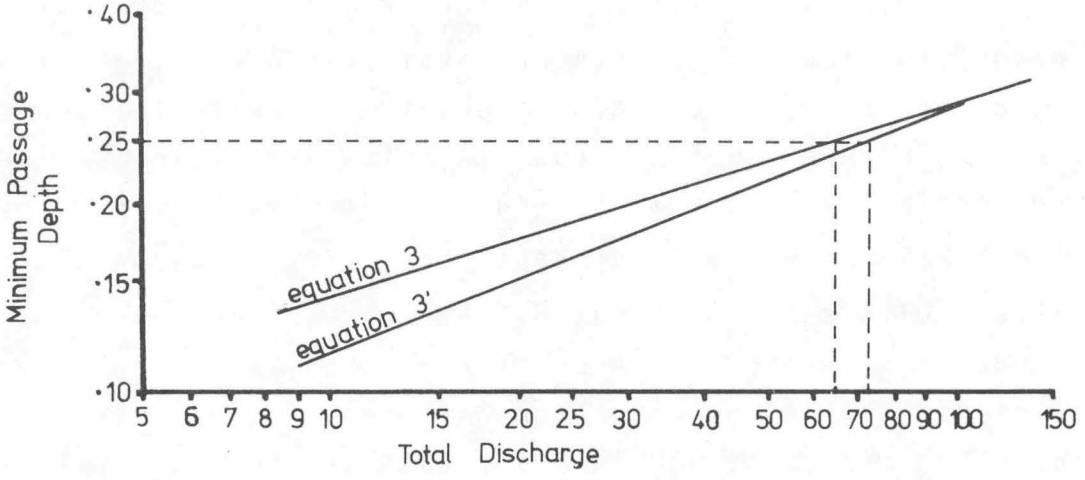

FIGURE 2: Minimum passage depth vs total discharge (from equations 3 and 3')

TABLE 1: Predicted total discharges for Rakaia River using equations 3 and 3'

Required Depth	Minimum Total Discharge ($m^3.s^{-1}$) Equation 3	Equation 3'
0.12	4.5	8.9
0.23	49.8	60.4
0.25	67.8	77.2
0.30	133.0	132.0

The second method developed by Mosley (1982), to relate total river discharge to minimum passage depths, was based on field measurements of minimum riffle depths in the main channel of the Ashley, Hurunui and Rakaia Rivers. Minimum riffle depths were plotted against total river discharges and a lower envelope line was fitted to the data set to derive equation 4. This method depends on Mosley's first assumption (that "there is no reason to suppose that the riffles on the [different] rivers do not conform to the same relationship".) In the context of Method 1, this assumption appeared justified for the reasons stated above. When applied in the context of Method 2, however, there are two reasons why this assumption is unjustified.

First, in his 1983 paper, Mosley invalidates the assumption. He examined "the effects of changing discharge upon channel characteristics that are of relevance to environmental impact investigations". Data was collected "at randomly chosen cross-sections in braided reaches of the Ashley, Hurunui, Rakaia and Ahuriri Rivers." He concluded the following from his 1983 research:

> "Although general qualitative relationships exist between discharge and channel characteristics, variability is so great that the relationships have little predictive value. Scientifically defensible, quantitative prediction of the impact of discharge

change on the ecologically significant aspects of a given braided river cannot be made using:

(a) relationships of the regime equation type;

(b) extrapolation of knowledge from another river having discharges in the range for which prediction is required; or

(c) extrapolation of trends in the target river measured at discharges other than those for which prediction is required."

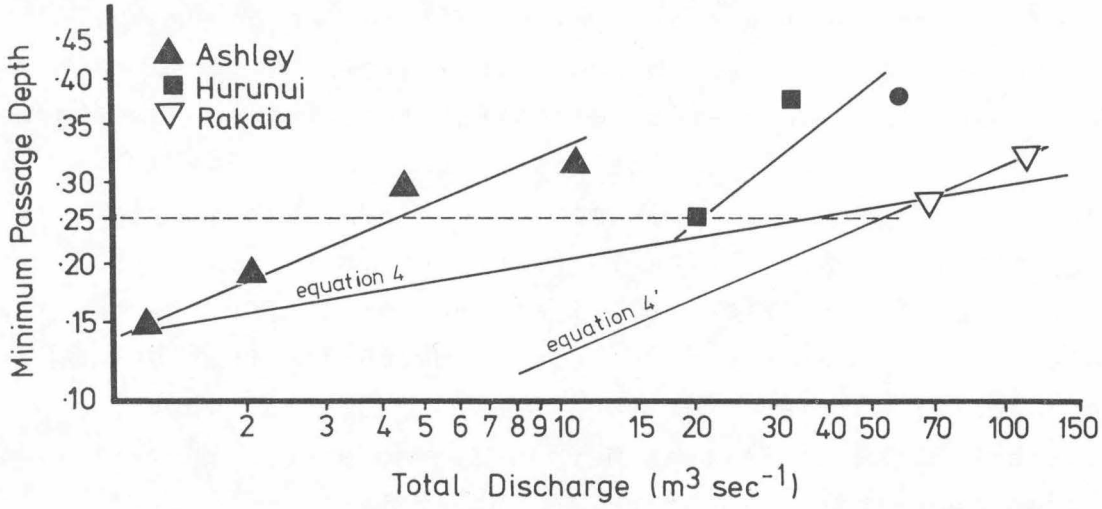

FIGURE 3: Relationship between observed minimum passage depth D_{min} and discharge Q_1 for selected reaches of the Ashley (▲), Hurunui (■) and Rakaia (▽) Rivers. The solid line is equation 4, the envelope curve fitted to the data points for the three rivers. Equation 4' is the line fitted to the Rakaia data alone.

Second, the assumption does not appear to us to provide a reasonable basis for interpreting the data set presented in Figure 3. We believe a more reasonable interpretation of Mosley's 1982 data set can be obtained by treating the three rivers as discrete systems. In Figure 3, best-fit lines have been drawn (by eye) for each of the three data sets.

The effect of changing this assumption is to markedly alter the river discharges predicted using Method 2. Table 2

shows predictions for the three rivers of the discharges required to give a minimum passage depth of 0.25 m (an approximate minimum depth for fish and boats). Discharges shown in column one are based on Mosley's assumption and were calculated using the lower envelope of the combined data (equation 4 in Mosley, 1982). The second column shows discharges calculated from the individual best-fit lines.

TABLE 2: Predicted total discharges to give minimum passage depth of 0.25 m.

River	Predicted Total Discharge ($m^3.s^{-1}$)	
	Using Combined Lower Envelope	Using Individual Best Fit Lines[a]
Ashley	37.5	4.2
Hurunui	37.5	20.0
Rakaia	37.5	53.0

a: approximate only

The predictions based on the individual best-fit lines for the Ashley and Hurunui Rivers are 'interpolations', and are from 'same-river' data. They are therefore consistent with Mosley's (1983) conclusions (quoted above) and therefore have greater predictive capabilities than Mosley's original interpretation (equation 4). However, it is important to note that the small number of data points for each river mean that the predictions are only approximate.

Predictions based on the Rakaia data set are less reliable since a data base comprising two points is completely inadequate for predictive purposes. Furthermore, Mosley's (1983) conclusion (as above) implies that predictions cannot be made outside of the data range (65-110 $m^3.s^{-1}$). Bearing these limitations in mind, we calculated the equation

(equation 4') of the best- fit line for the Rakaia River data points, and used it to predict the total discharge required for various minimum passage depths. These predictions are shown in Table 3 together with predictions calculated from Mosley's combined river data lower envelope equation (equation 4).

We do not suggest that the predictions in Tables 2 and 3 are correct, but rather present them to illustrate the effect of reasonable changes to the assumptions underlying this scientific investigation.

TABLE 3: Predicted total discharges for Rakaia River using Equations 4 and 4'

	Minimum Total Discharge ($m^3.s^{-1}$)	
Required Depth	Equation 4	Equation 4'
0.12	0.4	8.1
0.23	22.3	42.8
0.25	37.5	53.0
0.30	117.1	84.6

Equation 4

$D_{min} = 0.14\ Qt^{0.16}$

Equation 4'

$D_{min} = 0.53\ Q^{0.39}$

It has been shown here that the predicted total discharges are highly dependent on the assumptions used in interpreting the data. The assumption that riffles in different rivers behave the same (Mosley, 1982) has been questioned both by the analysis presented here, and we believe, by Mosley in his 1983 paper. Therefore results obtained by any method employing this assumption, such as Method 2 above, are not scientifically defensible. These methods ought not to be used for predicting the total river discharges required for minimum passage depths.

The major conclusion emerging from this analysis is that there are, at present, no adequate data for the Rakaia River from which relationships between river discharge and minimum passage depth can be determined with any specified level of confidence. Water allocation decisions based on predictions from such relationships involve considerable risk unless they are based upon the highest value of the range of predicted flows.

APPENDIX C: Use of evidence from Mosley (1982) in the Rakaia River NWCO hearing (to be read with appendix B).

	USE OF METHOD 1 (equation 3)[A]	USE OF METHOD 2 (equation 4)[B]	METHOD OF ACCOUNTING FOR GROUNDWATER AND UNDERFLOW	UNDERLYING ASSUMPTIONS OF METHOD 1 AND 2
M.W.D.	Accepted method Averaged results from two methods for minimum depth of 0.25 m ($68\ m^3s^{-1}$ and $38\ m^3s^{-1}$), resulting in a predicted discharge of $53\ m^3s^{-1}$.	Accepted method	Subtracted $20\ m^3s^{-1}$ from prediction derived from equation 1 and 2 to determine minimum flow that could be expected at Great Island area (Locality expected to have greatest water loss in the river).	Not questioned
N.C.C.B.	Accepted method Used predictions of discharge from both methods for 0.25 m as one input to final discharge recommendation.	Accepted method	Added estimated groundwater and underflow loss to results of method 1 and 2.	Not questioned
F.R.D.	Accepted method Used 0.25 m depth, predicted $68\ m^3s^{-1}$ minimum discharge as that necessary to maintain fish passage for salmon.	Ignored method No explanation given	Did not incorporate. Assumed incorrectly that method 1 gave predictions for discharges at the gorge.	Not questioned
Salmon Anglers Association	Accepted method Used prediction of $68\ m^3s^{-1}$ (0.25 m depth) to form basis of minimum discharge requirement for migrating salmon.	Ignored method No explanation given	Added maximum estimates of loss given by N.C.C.B. Resource Survey (Vol 2) to prediction given by method 1 (i.e. $68 + 13 + 25\ m^3s^{-1}$).	Not questioned
Jetboat	Accepted method Used equation to determine predicted minimum discharge for 0.30 m depth. Calculated minimum discharge incorrectly to be $125\ m^3s^{-1}$, actually $133\ m^3s^{-1}$.	Ignored method No explanation given	Did not incorporate into minimum total discharge calculations.	Not questioned

A Total discharges derived from equation 3 are predictions of discharge at study sites (P. Mosley pers. comm.)

B Total discharges derived from equation 4 are predictions of gorge discharges (P. Mosley pers. comm.)

APPENDIX D: THEORY OF THE ECONOMIC METHODOLOGIES

Budgeting

A budgeting exercise endeavours to quantify the costs and benefits of a particular proposal to an individual or a firm over a fixed period, usually one year All costs and benefits are expressed in dollars of the day. The net result will be an indication of profitability to that individual or firm and cannot be viewed in terms of benefit to the nation. Therefore a budgeting exercise does not, and is not intended to, account for the distribution of commodities among groups in society.

Multipliers

A multiplier is described in Hubbard and Brown (1979) as "a measure of the total impact on an economy generated by an initial expenditure injection". The rationale for this is that an industry, into which the capital injection is made, has strong linkages with the regional and national economics via the goods and services it demands and produces.

Hubbard and Brown state that successive rounds of output, income and employment created by the indirect and induced effects can be measured using output, income and employment multipliers. The size of these multipliers, and hence the secondary effects, is determined by 'leakages' from the economy through savings, taxes and imports. The greater these leakages, the smaller the multiplier effects will be.

Generally, when multipliers are used, the following assumptions are made:

- Multipliers may be constructed using local, regional, national or world data bases. It is important that the multiplier used has been constructed from the appropriate data base, i.e., if the indirect effects on the regional economy are being estimated, then regional input/output tables should be used. If, for example, national input/output tables are used, it is assumed that the regional economy is a miniature of the national economy.

- All sectors in the economy are assumed to be fully utilising their equipment and resources.

- Any additional resources used by local firms to meet local demands have a zero opportunity cost.

- Changes in output do not alter the structure of the economy.

There are some limitations in the use of multipliers:

- The data required to obtain multipliers is extensive and detailed. As such it is published years in arrears and as the multiplier analysis relates only to a single year, discrepancies may occur.

- It is not possible to estimate the time horizon over which the multiplier effects will operate. This has implications for both planning and development.

- Multipliers are more likely to be over-stated than under-stated. In the absence of a detailed analysis, an employment multiplier is often averaged at 2.0 (meaning that for every job created in the agriculture or construction sector, one further job is created in the associated service or processing industries).

The use of multipliers can lead to approximations of employment and regional economic effects, but it must be remembered that these are only estimates and as such are indicative of the probable order of magnitude of development impacts. They provide no information on the distribution of development impacts.

Cost/Benefit Analysis

Cost/Benefit analysis (CBA) is an analytical tool used to determine the economic efficiency of a proposal from a national stance. The methodology compares the present day value of future benefits and costs generated over the life of a project. The results, in the form of a net present value and an internal rate of return, allow ready comparison with results of other CBAs. The methodology can also allow the inclusion of shadow weights on cost or benefit streams to reflect specific policy decisions. An example of weighting is the extra value attached to foreign exchange transactions.

Government projects are evaluated by CBA. This is done for two main reasons. First, the methodology serves as a means of rationing scarce government funds. In New Zealand this is achieved by a requirement for a 10% internal rate of return on public sector investment. The second reason is that CBA offers a means of ranking projects, by comparing their internal rates of return and net present values.

CBA can be seen to have several limitations:

(1) It does not provide any information on the distribution of benefits and costs among groups in society. The implications for the welfare of different groups in the population must be described in a separate exercise and placed before the decision-maker, alongside the results of a CBA.

(2) It can accommodate non-market values where these have been expressed quantitatively. In some instances, social values can be approximated in monetary terms by inferring what consumers would be willing to pay for the product or service[1]. In this way, the Agricultural Economics Research Unit at Lincoln College gave imputed valuations to recreation values by using travel cost as a proxy and also by using the contingent valuation method. The wide discrepancy in the results obtained suggest that these methods have not been sufficiently well developed to provide accurate results (Kerr, 1984, pers. comm.). Therefore, it may be questioned whether it is appropriate to include such figures in a CBA. It may be argued that all valuations in a CBA have a degree of uncertainty. However, in most cases recognised market valuations appear to be more reliable than the imputed valuations for natural values and recreation. Therefore, it may be appropriate not to include non-market priced values within a CBA framework, but rather to express them separately in written form as opportunities foregone.

(3) As there is no recognised means of determining a social rate of time preference for use as a discount rate, project analysts have used the opportunity cost of capital in the private sector as a proxy. However, there is disagreement about the validity of this approach. In particular, there is the belief that inadequate provision is made for the interests of future generations, as the relatively high discount rate suggested by the opportunity cost of capital favours benefits in

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1 Alternative values are consumer surplus and consumer's willingness to accept compensation.

the short term as opposed to the long, and excessively discounts the deferred costs and benefits.

Whether provision is made for the interests of future generations within the CBA framework by adjustments to the discount rate, or whether this issue is dealt with within the wider decision-making framework, is not the central issue. What is important is that future interests be addressed explicitly.

APPENDIX E: PARTICIPANTS' EVIDENCE AT THE RAKAIA RIVER NWCO HEARING EXAMINED IN THIS REPORT

The review of the evidence presented to the Rakaia River National Water Conservation Order Hearing focussed on the following participants and their respective witnesses:

Canterbury Chamber of Commerce
Canterbury United Council
Commission for the Environment
Environmental Defence Society
Federated Farmers of New Zealand Inc.
Malvern County Council
Ministry of Agriculture and Fisheries
- Fisheries Research Division
- Agricultural Research Division
- Economics Division

Ministry of Energy
- Electricity Division

Department of Internal Affairs
- Wildlife Division

Ministry of Works and Development
New Zealand Acclimatisation Societies
New Zealand Jet Boat Association
New Zealand Salmon Anglers' Asosociation
North Canterbury Catchment Board
Rakaia River Association
Royal Forest and Bird Protection Society
- Canterbury Branch

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ABBREVIATIONS

CBA	Cost Benefit Analysis
FRD	Fisheries Research Division, Ministry of Agriculture and Fisheries
GDP	Gross Domestic Product
LRIS	Lower Rakaia Irrigation Scheme
LWCN	Local Water Conservation Notice
MAF	Ministry of Agriculture and Fisheries
MWD	Ministry of Works and Development
NCCB and RWB	North Canterbury Catchment Board and Regional Water Board
NWASCA	National Water and Soil Conservation Authority
NWCO	National Water Conservation Order

GLOSSARY

Internal rate of return:	The interest rate by which the benefit and cost streams would need to be discounted to produce a zero net present value.
Leakages:	Flows of goods, services or money beyond the boundaries of the economy under consideration, e.g. regional or national economics.
Net present value:	The net value of future benefit and cost streams discounted by the chosen discount rate to present day values.
Numeraire:	A commodity by which all other commodities can be valued, as a benchmark or a yardstick, e.g. dollars.
Opportunity cost:	The return that might might be expected from the next best alternative use of the resource in question.
Plateau yields:	These represent the maximum potential yield of a given crop when one agricultural input, e.g. water, ceases to be limiting in any way. The assumption that all other inputs will be managed as carefully as possible is central to the notion of plateau yield.

Shadow weights:	These are weights attached to costs and benefits in an analysis to reflect more clearly the societal value placed on a good policy or to reflect government policy.
Social rate of time preference:	This expresses the value society places on future costs and benefits.

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