

Snowy Water Inquiry

Final Report

Submitted to the Governments of New South Wales and Victoria

Commissioner: The Hon Robert Webster

23 October 1998

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New South Wales

23 October 1998

The Hon M R Egan MLC
Treasurer
Minister for State Development
Leader of the Government in the Legislative Council and
Vice-President of the Executive Council
Governor Macquarie Tower
1 Farrer Place
SYDNEY NSW 2000



Dear Treasurer

Pursuant to my appointment as Commissioner I now have the honour to present you with the Final Report of the Snowy Water Inquiry in accordance with its Terms of Reference.

I draw your attention to the provisions of section 21(2) of the Snowy Hydro Corporatisation Act 1997 which require the report to be made public.

Yours faithfully

The Hon Robert Webster
Commissioner

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Inquiry Publications

This is the third set of documents produced by the Inquiry. At the outset of the Inquiry an *Issues Paper*, outlining the key issues facing the Inquiry under its Terms of Reference, and a *Guide to the Inquiry*, to facilitate maximum public participation, were circulated to all relevant stakeholders and those who had shown an interest in the Inquiry.

On 11 September 1998, a *Draft Options Paper for Discussion* and an *Appendix of Resource Materials* were circulated for public comment. The *Appendix of Resource Materials* contained a vast amount of the information, studies and analysis conducted by and on behalf of the Inquiry. Because this information was automatically provided to all who had participated or shown an interest in the Inquiry, this document has not been reproduced as part of the *Final Report*.

However, references are made to sections in this document and are identified with an A prefix (eg, see Section A3.4). Copies of the previous documents are available on the Inquiry's internet site:

<http://www.snowywaterinquiry.org.au>

Between the *Draft Options for Discussion Paper* and this *Final Report*, submissions were received and figures refined. Consequently the *Final Report* is based on the latest information available to the Inquiry which may present as minor variations between the two documents. (Sections which have changed significantly are included as supplementary material in Appendix 1 of this document.) The *Final Report* therefore addresses relevant public comment on the *Draft Options for Discussion Paper* and provides the results of further analysis or studies conducted following its release.

Front Cover

Top: Talbingo reservoir and pressure pipelines feeding Tumut 3 power station

Photo: Snowy Mountains Hydro-Electric Authority

Centre: Snowy River downstream of Kara Creek, June 1998

Photo: Snowy Water Inquiry

Bottom: Irrigated agriculture at Mildura

Photo: Murray-Darling Basin Commission

Terms of Reference

1. The Snowy Water Inquiry must:

- (1) examine environmental issues arising from the current pattern of water flows caused by the operation of the Snowy Mountains Hydro-electric Scheme ("Scheme") in rivers and streams in the Snowy water catchment (as defined in the Act), the course of the Snowy River flowing from that catchment to Marlo and the course of the rivers and streams flowing from that catchment to Lake Hume, Blowering Reservoir or Burrinjuck Reservoir ("designated area of inquiry");
 - (2) develop and submit to the Governments a range of comprehensive, fully costed options to address those environmental issues;
 - (3) consider the environmental, economic, agricultural, social, heritage and other impacts of the options. Agricultural impacts include the impact of changed water flows on agricultural industries that are dependent on irrigation. Environmental impacts include, but are not restricted to, the impact of releases of water from storage that provide environmental flows, being flows in rivers and streams which mimic natural seasonal flows and which restore and maintain the ecology of those rivers and streams;
 - (4) for the purposes of reporting on the impacts of the options, address the impacts on areas other than the designated area of inquiry including the Murray and Murrumbidgee valleys and the State of South Australia;
 - (5) identify costs and benefits of each option, so far as is practicable, in terms of currently available information. The Snowy Water Inquiry may conduct further investigations, including scientific investigations, within the time frame allowed for the Inquiry, if considered necessary to assess fully the options;
 - (6) consider the full range of options available to address the environmental issues, including:
 - (a) environmental flows in all the rivers and streams within the designated area of inquiry and accessed by the Scheme;
 - (b) altered catchment management practices within and adjacent to the designated area of inquiry; and
 - (c) river remediation works within and adjacent to the designated area of the Inquiry;
 - (7) for each option, include a proposed level for the initial release of water to the Snowy River for environmental reasons on the issue of the Snowy water licence to Snowy Hydro Limited, and a proposed maximum level for any increased amount of such releases following the first review of the Snowy water licence that will not give Snowy Hydro Limited an entitlement to compensation under the Act; and
 - (8) identify the environmental management objectives of each option, in particular for variation in flow regimes and alternative means of meeting the environmental objectives inherent in these objectives.
- ### 2. In developing the options, the Snowy Water Inquiry must have regard to the continuing viability of the Scheme, where:
- (1) the major physical permanent works and structures comprising the Scheme will remain in place and will continue to divert, collect, store and release water; and
 - (2) the Scheme is an ongoing commercial electricity business entity.
- ### 3. In developing the options, the Snowy Water Inquiry must:
- (1) have regard to:
 - (a) the environmental and water management legislation of the Commonwealth, New South Wales and Victoria;
 - (b) the policies of the New South Wales, Victorian and Commonwealth Governments in relation to streams and rivers affected by the operations of the Scheme;
 - (c) the Murray-Darling Basin Agreement and Ministerial Council policies; and
 - (d) the Act, the *Snowy Hydro Corporatisation Act 1997 (Vic)*, and the *Snowy Hydro Corporatisation Act 1997 (Cwlth)*; and
 - (2) ensure that the options are consistent with:
 - (a) the relevant commitments contained in the Council of Australian Governments principles for water reform; and
 - (b) the ARMCANZ/ANZECC principles for the allocation of water.

2 April 1998

Commissioner's Analysis and Conclusions

When Australians are told that the Snowy River is presently flowing at only 1% of its original flow below Lake Jindabyne, and that an increased flow is required to restore the river's environmental, economic, social, and heritage values, they understandably react positively to the suggestion of increasing flows.

However, when they realise that increasing flows into the Snowy may impact on the viability of the Snowy Mountains Hydro-Electric Scheme and the irrigation areas to the west, as well as the social and economic values of the broader communities which rely on them, they begin to realise how challenging it is to find a solution for the Snowy River.

This challenge has been the task before the Snowy Water Inquiry – to provide Governments with a basis on which they can analyse and balance the needs and interests of three Australian icons: the Snowy River, the Snowy-Hydro-Electric Scheme, and the Murray and Murrumbidgee irrigation areas.

The Snowy River is the most obvious icon, rich in Australian history and immortalised by the Banjo Patterson poem. The Snowy Mountains' rivers are unique amongst Australian rivers because their source is Australia's major alpine region. The fact that the Snowy River flows east from the mountains, coupled with a call to irrigate Australia's dry inland in the wake of a series of droughts, led to proposals to redirect the Snowy's waters west as early as the 1880s. When the potential for electricity generation was examined, visionary engineers and politicians had the opportunity to create an engineering and construction miracle — the second icon we know as the Snowy Mountains Hydro-Electric Scheme. The simple concept was to trap the snow melt in the upper reaches of the Snowy River, divert it west through a series of dams and tunnels to the Murray and Murrumbidgee River systems for irrigation, and use the energy created as the water falls to generate electricity.

The result of water being diverted to the west is equally significant and important to many Australians. With the waters of the Snowy providing security to the Murray and Murrumbidgee, especially in times of drought, irrigated agricultural areas expanded dramatically. These irrigated lands are the third icon. They stretch from the western foothills along the two

rivers in New South Wales and Victoria to the South Australian border and beyond. They have transformed local economies and added billions of dollars to Australia's economic output.



The Framework

The Terms of Reference for the Snowy Water Inquiry encapsulated the challenge before the Inquiry and set down the specific parameters for the Inquiry's investigations.

In essence, the Terms of Reference required the Inquiry to provide the New South Wales and Victorian Governments with fully costed options for the restoration of the environments of the Snowy and its associated rivers as well as other rivers and streams flowing from the Snowy River to Lake Hume, Blowering Reservoir and Burrinjuck Reservoir. The Inquiry was required to assess the environmental, economic, social, and heritage impacts of those options.

Importantly, we were also required to pay due consideration to various Federal and State agreements and environmental water legislation and policies across three States and the Commonwealth, not to mention the Snowy Hydro Corporatisation Act, 1997.

Our Approach

With the Terms of Reference as the framework for the Inquiry's investigations, we undertook to establish the approach the Inquiry would take.

It could be argued that the Terms of Reference were almost contradictory in the way they required the Inquiry to identify the environmental issues arising from the operation of the Scheme and then provide a range of fully-costed options to deal with these issues while balancing the needs of competing users of water. I therefore took the view that the only way we could succeed in providing Governments with tangible options was to deal transparently with each of the areas of consideration without any bias towards any particular partisan position or stakeholder viewpoint.

At the same time, we determined not to replicate existing research but rather to add to and develop our understanding of the issues for the Snowy

and associated rivers and for water resource management in Australia in general.

With that in mind, we closely reviewed all existing research about the Snowy and associated rivers, together with work in progress on other river systems in Australia. We identified existing research methodologies which could assist our investigations including areas which required further development. We produced an analytical framework which specifically addressed the issues relating to the designated area and the requirement to assess any associated economic, social and heritage impacts.

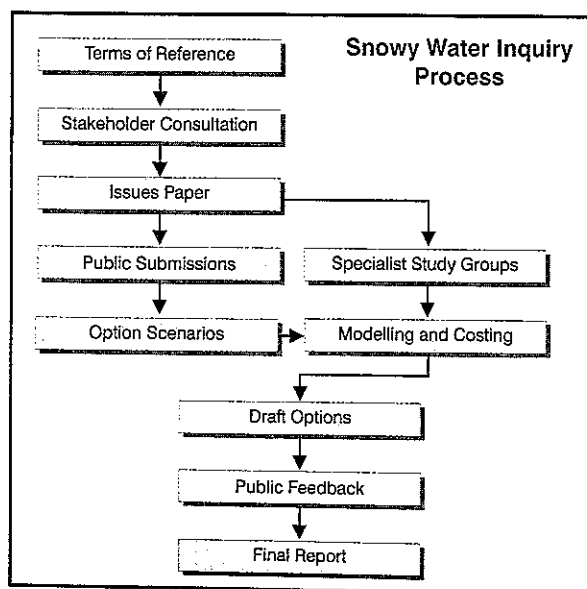
Given the six-month timeframe for the Inquiry, we also made the decision to use outside expert consultants coupled with the considerable expertise contained within the Inquiry staff and relevant government departments and agencies. This assisted with the analysis and option development process.

In addition, it was apparent from the outset that, because of the broad range of communities with an interest in the Inquiry and its investigations, the opportunity for the community to contribute to the Inquiry's investigations and deliberations should be maximised at every step.

We have outlined the Inquiry's approach to its investigations in the chart below.

The Results

Extensive community consultation and expert analysis underpinned the Inquiry's investigations and considerations throughout its course. The



Inquiry achieved unprecedented public participation in its processes and a scientific methodology evolved which is at the cutting edge in its thinking and application.

In doing so, I believe we have set a benchmark for future public inquiries and scientific and economic studies into the nature of water allocation and river system management in Australia and internationally. We have received commendation from many individuals and organisations involved in the public consultation aspect of the Inquiry. Our analytical framework and scientific approach to the issues at hand have also been widely praised.

I believe the accumulated knowledge now before the Inquiry, together with the analysis and expert investigation, means that we are ideally positioned to present Governments with a range of packages of options, or Composite Options, as well as a framework for implementation.

In fact, the unique nature of the Inquiry, combined with the collective knowledge and experience that is at its most potent while the Inquiry is still functioning, has prompted me to go further than the requirements laid down in the Terms of Reference and nominate a preferred Composite Option for Governments to consider.

The Inquiry's Terms of Reference make it clear that the Snowy Scheme and its functions are to remain in place. At the end of the day the rivers and streams will remain modified but it is my view that they should be healthier and have an ecological diversity and function which better satisfies a combination of environmental and social needs.

Fundamentally, in my deliberations I sought to answer the question: how can the ecological and social functions of a group of modified rivers be improved to the fullest extent, taking into account the interests of other users and beneficiaries?

This question, which calls for an assessment of the community's values (environmental, economic, social and heritage), is far broader than a question of improving this group of rivers to achieve only the "best" ecological benefit, important as that is.

The outcomes of the Inquiry's investigations and my analysis of those investigations have led me to conclude that the following key factors must be

taken into account when determining a solution for the Snowy and associated rivers and streams:

- Significant environmental gain for the river systems must be achieved
- Significant reduction of water wastage in irrigation areas must be addressed
- The cost impact on agriculture must be minimal because of its significant economic contribution to the community (apart from the opportunity cost of potential growth of industry)
- The impact on the hydro-electricity generator must be manageable
- The capital cost impact on the Governments must be reasonable in terms of the return benefits to the environment and the community.

As a result, I have nominated Option D as my preferred Composite Option for implementation by the Governments. Option D achieves the key guiding factors I have outlined above.

Finally, how the Governments manage implementation will be critical to the success of any agreed option, both in terms of realising the expected benefits and for continuing to assess the progress of restoration. It will certainly be several years before impacts can be properly assessed.

For that reason, the Inquiry has strongly recommended that the Governments put in place a structure to facilitate implementation and which bridges interstate, inter-regional and local systems and issues. A 3-5 year implementation program plus a 5 year monitoring period, as measures take effect, is also recommended prior to any subsequent review of water allocations.

Commissioner's Overview of the Inquiry

Current Issues

Modified Rivers

The rivers and streams of the Snowy Mountains have been regulated and modified for the past 50 years. In a land with scarce water resources, they have made a significant contribution to the economic and social life of a large number of rural and urban Australians.

As with many of our rivers today, we are finding that this contribution from the Snowy River has a price. The ecological function of the rivers and streams has deteriorated, due in part to the Scheme but also to a long history of poor natural resources management — of the Snowy catchment in particular.

The community's concerns for the riverine environment have focused on the Snowy River, in particular that part of the river below Jindabyne Dam. However, the construction and operation of the Scheme has also modified the environments of the upper Snowy, upper Murrumbidgee, Tooma, Geehi, Swampy Plain, Murray, Tumut and Eucumbene Rivers, together with other streams controlled by weirs and aqueducts. The current environmental condition of the rivers in the Inquiry's designated area and associated issues are summarised in Appendix 2 of this report, following on from Section A2 in the *Appendix of Resource Material*.

Immediately below each diversion point virtually all natural flow in the river has ceased, although small quantities are released for stock and domestic uses from Jindabyne and Tantangara Dams. Other dams such as Guthega, Island Bend and Khancoban have spill releases but these do not mimic the natural variability of flows over an annual cycle.

The modified rivers have responded in different ways to the changed flow conditions, depending on local climate and geography, and the physical characteristics of river reaches.

Environmental issues in these rivers include but are not limited to low flows and modified flow patterns (diurnal and seasonal), shallower depths of flow and slower rates of flow, and poorer water quality including greater water temperature variations. Other physical issues include changes to the river channel structure, contraction of the river channel, poor lateral connectivity and gradual filling-in of the river bed substratum.

Artificial and natural barriers disrupt the longitudinal connectivity of sediment, nutrients, fish and other fauna.

The poorer aquatic habitat has led to further issues of lower ecological integrity and, in instances, changes in types of macro-invertebrates, fish and aquatic vegetation which occur. Introduced fish species often dominate, placing native fish under stress.

Further downstream below the dams, the rivers gradually recover in flow and size due to tributary inflows. However, the flows are still of reduced size and changed pattern compared to pre-Scheme.

In adapting to flow and other changes, the physical structure of each river and its ecology has also changed. These long-term impacts are compounded in some instances by other catchment changes such as agricultural development and the intrusion of weed species such as willow, poplar, blackberry and broom. The reduced flow in the Snowy and other rivers has allowed weeds to establish and spread within the river corridor.

In the lower reaches of the Snowy River, environmental issues include, but are not limited to, increased sediment infilling of pools, loss of aquatic habitat and migration of the salt-water wedge upstream.

However, not all sections of rivers in the Inquiry area are heavily modified when compared to pre-Scheme conditions — the Snowy River from the Delegate River to the Buchan River is one such example.

In addition, many smaller tributary rivers and streams have their flows partially or completely diverted, with similar environmental issues to those already described downstream of the offtake structures and aqueducts.

Community Impacts

Communities along the Snowy River which were established before the Scheme feel aggrieved by the loss of opportunity to develop irrigated agriculture and new eco-tourism industries that could help their towns adjust to the changing circumstances faced by most rural communities. Understandably, they want to improve the economic health of their communities and restore their lost affinity with the river to what it was pre-Scheme.

These communities point to overuse of water in the irrigation areas as potential sources of waste and land degradation that, if reduced, could improve land management in the west and return water to the Snowy.

Communities that have expanded and prospered along the western rivers have invested and developed on the basis of Snowy water being available in the long term. They have had to adjust to and accommodate limits on the availability of water for diversions as the Murray-Darling Basin Cap (MDBC) Cap takes effect and environmental provisions for their local rivers are determined. Both these factors have had the effect of substantially reducing established water allocation expectations. A further loss of water from the Snowy River has the potential to affect the level and reliability of irrigated agriculture. This is the main industry of many areas. Understandably, people want to protect their income and communities.

Electricity

The electricity industry is no longer controlled by state-owned monopolies determining the type and capacity of generators and how much is produced. Snowy Hydro Trader now competes in wholesale markets to sell its generation capacity. Its major competitors are thermal power stations with relatively higher marginal costs of production but which are more suited to supply steady predictable levels of demand. They also produce greenhouse emissions as a by-product. Hydro power stations have lower marginal costs. Their large storages and high turbine capacity enable generators like Snowy Hydro Trader to respond quickly to fluctuations in market demand or supply and so provide a continuing and valuable service to the community.

The Terms of Reference required me to have regard to the financial viability of the proposed Snowy Hydro Ltd business. There are two aspects to this task.

First, given that the Scheme has large storage capacity, a reliable and renewable source of water and very low marginal costs, the continuing requirements of the irrigation industry for water, an increasing trend towards clean energy, and the growing demand for electricity in the long term, the assets of Snowy Hydro will clearly remain viable as a significant source of electricity generation.

Second, in financially structuring the business, the shareholders have to consider the impact of the adopted environmental flows, the new and dynamic nature of the electricity market, new entrant behaviour, the opportunities and risks Snowy Hydro has in dispatching generation and in earning price premiums, the rate at which surplus generating capacity is absorbed, and the long term price path.

However, in creating a financially viable company, the shareholders will need to review their equity contributions and their level of debt exposure in the light of current and projected market conditions. These matters should be considered and negotiated at the time by the shareholder Governments.

For the last twenty years, there has been a growing world trend of concern with global warming and the greenhouse effect. Thermal power generators are a major source of greenhouse gases but there is an argument that the energy consumed in creating dams plus the gases produced by the decay of inundated vegetation mean that hydro power stations also contribute to greenhouse emissions. For a mature hydro scheme such as the Snowy, these original construction related emissions are effectively a sunk cost. The rate of decay of vegetation also declines to a negligible level after about 5-10 years. Any reduction in the generation of hydro electricity from the Scheme is likely to be replaced by thermal generation, thus increasing the difficulty Australia will have in meeting greenhouse emission targets recently agreed to at Kyoto.

Consultation

Community Participation

At the outset it was my view that, because of the broad range of communities with an intense interest in the Inquiry, and the passionate positions taken by the various stakeholders, the opportunity for the public to participate in the process should be maximised.

First, the Inquiry undertook to meet with key stakeholders with an interest in the Snowy and the Inquiry, prior to the release of the Terms of Reference. The purpose of these meetings was to establish a rapport between the Inquiry and stakeholder and community groups, as well as an understanding of community attitudes and expectations of the Inquiry. Because of the relatively short period of six months set down for

the Inquiry, an *Issues Paper* was published as soon as possible after the official commencement of the Inquiry. This was done in early April and it started a continuous dialogue between the stakeholders and the Inquiry. There were 489 responses to the Issues Paper which were published on the Inquiry website and this process enabled points of view to be exchanged and commented on quickly. Importantly, submissions stated the values the community placed on the Snowy and other rivers: these included not only environmental but also economic, social, and heritage values.

The Inquiry's public hearings were held in the regional centres of Orbost, Cooma, Cobram, Deniliquin and Griffith. Stakeholders, community representatives and individuals all had the opportunity to make presentations to the Inquiry, ask questions and exchange views in an informal yet structured setting. I was determined that the Inquiry would be objective and prepared to listen to the community's views in the regional areas covered by the Terms of Reference. Judging by the feedback received after the hearings, I believe we were successful in achieving this objective.

The passion displayed by the individual communities was an indication of their valid concern for the issues they considered had to be addressed when Governments adopted an outcome.

The release of the *Draft Options for Discussion* paper in September was the culmination of nearly five months of hard work by the Inquiry. The paper objectively set out a range of options together with an *Appendix of Resource Material* for public comment. Stakeholder briefing sessions, held in Sydney and Melbourne immediately following the release of these documents, were designed to assist interested parties in understanding the paper and facilitating their responses.

Members of the Inquiry and I have also had numerous meetings and briefing sessions with interested parties ranging from government agencies, Aboriginal representatives, Members of Parliament and stakeholder group representatives.

Despite the relatively short duration of the Inquiry and the immense amount of work that needed to be done, I am confident we were able to maximise public participation in the process.

Expert Analysis

In addition to the public process, the Inquiry worked with a number of expert consultants and scientific groups to develop an appropriate analytic framework, carry out in-depth assessments and put together the *Draft Options for Discussion* paper for community comment in the lead up to the preparation of this *Final Report* to the Governments.

A Scientific Reference Panel (SRP) was established to assess the environmental condition of rivers resulting from the operation of the Snowy Scheme and the benefits and costs that would be derived from a range of additional flow options. The Panel also took a total catchment management approach which involved more than just looking at water flows. This meant that the impact river and land management actions can have on river conditions, when combined with changed water flows, was also assessed.

The Panel, managed by Dr Bill Young, Senior Research Scientist with the CSIRO, is made up of the following members (their area of expertise is shown in brackets):

Dr Wayne Erskine (geomorphology), Senior Research Scientist with NSW State Forests and formerly Senior Lecturer, School of Geography, University of NSW

Dr Bruce Chessman (macro-invertebrate ecology), Senior Biologist, NSW Department of Land and Water Conservation

Tarmo Raadik (fish ecology), Senior Ecologist, Victorian Marine and Freshwater Resources Institute

Dane Wimbush (vegetation), consultant, formerly with CSIRO

Ian Varley (hydrology), Manager Water Resources NSW for the Snowy Mountains Engineering Corporation

John Tilleard (catchment management), an independent consultant and principal of Moroka Pty Ltd

Prof Tony Jakeman (environmental modelling), Director of the Integrated Catchment Assessment and Management Centre, Australian National University

The task of the SRP was different to that of the three expert panels which have examined the

Snowy and other rivers over the past three years. In short, the SRP described, predicted and prescribed a number of long term, sustainable environmental conditions for various flow and other management inputs, whereas the expert panels developed a single flow regime based on thresholds for ecological function (as discussed in Sections A3.1 and A3.6).

At the same time, the Inquiry engaged ACIL Consulting Pty Ltd to advise on the benefits and costs of each option for environmental releases to the various rivers in the Inquiry area. ACIL was supported by Hassall & Associates Pty Ltd and A C Neilsen, who provided analysis of agricultural and social impacts along the Murray and Murrumbidgee Rivers, and Ord Minnett, who provided an assessment of the financial assets of the Snowy Scheme.

ANU's Integrated Catchment Assessment and Management Centre (ICAM) was engaged to assess the agricultural, tourism, social, community, heritage and cultural issues in the Snowy region.

To help assess the impacts of various water release options to the Snowy and other rivers, the Inquiry linked a series of operating models. These models included a simulated operation of the electricity market, Snowy Hydro's management of water releases, and various models of irrigation water management and agronomy used by the Murray-Darling Basin Commission, the Department of Land and Water Conservation, the Department of Natural Resources and Environment, and the NSW Department of Agriculture.

A panel was also established to assess the environmental effects of options on the Murray and Murrumbidgee rivers downstream of the Scheme.

Together with the public submissions and ongoing comment received by the Inquiry, these studies have guided the development and refinement of firm options for presentation to the Governments.

Developing the Options

The Issues of Balance and Trade-off

The Inquiry's Terms of Reference made it clear that the Snowy Scheme and its functions will remain in place. A key issue before the Inquiry then was how to restore environmental and social condition to the rivers and streams, while bearing in mind that those rivers and streams would remain modified.

The Inquiry was faced with a range of environmental, economic, social and heritage issues that represent fundamental trade-offs between:

- Flows for the Snowy River environment and the impact on irrigation and generation
- Flows for the environment of other streams and rivers and the impact on generation
- Improving the riverine environment and the impact on the atmosphere from the substitution of fossil fuel using thermal generators compared to the use of clean renewable fuel sources of generation
- The economic and social benefits from additional flows in the Snowy and the impact of increased salinity or reduced environmental condition for the down stream users of the Murray River as far away as Adelaide.

Basic Propositions

The underlying task for the Inquiry was to establish the extent of, and to separate the compounding impacts of, pre-Scheme catchment activities and issues from Scheme-related flow and structures outcomes. The task was then to establish the extent to which these compounding impacts, particularly related to the Scheme, could be reduced to achieve desired environmental outcomes.

Based on this approach, the Inquiry developed a number of propositions on which its analysis was based. These included:

- The environmental condition of the rivers and streams reviewed would continue to deteriorate without action to sustain or improve their current condition
- The Snowy and other rivers could be restored to provide different sets of environmental, economic, social and heritage values, depending on community priority values and on the amount of additional flow and other catchment and river management measures
- Additional water for the Snowy River below Jindabyne would result in reduced water releases to the west
- All releases on other rivers and on the Snowy River above Jindabyne would impact on electricity generation rather than flows in the western rivers

- Savings of up to 135 GL in the western water distribution systems could be made and returned to the Snowy without affecting the environmental condition of either the Murray or Murrumbidgee rivers, or irrigation diversions. The precise feasibility and cost of recovering this water would need detailed assessment and it may take several years to implement the savings
- Competition for the savings will be intense, with strong efforts made to keep the water to the west in order to ease the pressure to reduce diversions to meet environmental needs or to expand irrigation developments. If this pressure is acceded to and Governments choose to allocate water to the Snowy River, this water would then have to come from reduced diversions
- All allocations to the Snowy River over and above a 15% additional flow would require an offsetting reduction in irrigation diversions.

Environmental Considerations

To improve the Inquiry's environmental assessment process, the Inquiry grouped the large number of environmental issues against the following criteria. These provide a basis for developing options and Composite Options aimed at improving environmental condition:

Flows

- Critical flow components such as minimum habitat utilisation, flushing and channel maintenance flows; and diurnal, seasonal and other flow requirements, to provide environmental, economic, social and heritage values

Connectivity

- Connectivity of main rivers with tributary streams and catchments
- Longitudinal connectivity of upland and lowland rivers, and the river estuary
- Longitudinal and lateral connectivity of sediments; organic carbon, nitrogen, phosphorus, and other nutrients; biota including algae, macro-invertebrates, fish and aquatic and riparian vegetation

Conservation

- Sustain and restore upland montane rivers
- Enhance value of rivers within national parks
- Aid recovery of threatened and vulnerable species

Sustainable Environmental Condition

The expected environmental outcomes for each option and composite option were described by using eight environmental indices: hydraulics (instream flow condition), geomorphology, water quality, barriers, riparian vegetation, macro-invertebrates, fish and aquatic vegetation which are described in Section 5, Environmental Condition Assessment. These indices are composed of 31 sub-indices, all of which have been assessed by the Inquiry's Scientific Reference Panel. Descriptions of environmental condition are summarised in each option statement and are detailed in Section A3.3, based on the Panel's assessments in Section A3.4, of the *Appendix of Resource Materials*.

The Panel also developed an Environmental Condition Index (ECI) which was a tool combining the index scores (described in Section A3.2). The ECI values for river reaches and river sections are included in the option and Composite Option statements to indicate in summary form the extent and direction of change in environmental condition from one option to the next.

Other Considerations

Community Values and Assessment

Following initial investigations, it became apparent to the Inquiry that a measure of general community attitudes and values towards the Snowy and associated rivers and streams would be critical to the outcome of the Inquiry.

By simply providing Governments with an economic analysis of a range of options along with the views of those with an interest in the Inquiry, Governments would not be aware of broader community attitudes associated with the choices and potential trade-offs involved.

As a result, the Inquiry engaged expert consultants to conduct social research aimed at gaining an understanding of the community's awareness of, and attitudes to, the environmental concerns and about the possible trade-offs and costs involved.

What this research established quite clearly was that while the community was very supportive of initiatives to improve the environmental condition of the rivers, they perceived the Murray and Murrumbidgee river system as having a higher priority compared to the Snowy. The question of whether water should be diverted back into the

Snowy was viewed generally as being a difficult trade-off when having regard to the importance of agriculture, the "clean energy" values of the Snowy Scheme and general concern about the environmental health of the Murray and Murrumbidgee systems.

Economic Values and Assessment

From an economic point of view, the Inquiry sought to establish a benefit/cost analysis of various trade-offs involved in the Inquiry's deliberation, including:

- Improving irrigation system efficiency versus the potential costs (including opportunity costs) to the agricultural communities
- Improving business opportunities along the Snowy through increased flows versus the loss of water to the Snowy Hydro-Electric Scheme
- Loss of water to the Snowy Hydro-Electric Scheme and the resulting impact on a reduction in generation capacity and potential increase in greenhouse effects

These economic values were then compared with community values which were also under assessment by the Inquiry.

- Working from the basis that 135 GL of water could be provided to the Snowy River by investing in efficiency measures on the Murray and Murrumbidgee River delivery systems, the Inquiry found that an estimated \$42 million would be required to implement the efficiency measures. At the same time, the redirected water represented a loss of opportunity for irrigators and western river environmental managers to either adjust to local pressures or expand their businesses. However, the investment would defer reducing irrigator diversions until environmental flows exceeded this figure. In addition, if the 135 GL was not achieved and irrigation diversions were reduced as part of any solution adopted by Governments, then the economic impact on irrigated agriculture would be approximately \$25m per 50GL
- The Inquiry found that any option that causes water to bypass the Snowy Scheme generators will have an impact on the community. Electricity has little price responsiveness, consequently any reduction in

Snowy generation will be replaced with higher cost, greenhouse polluting thermal generators. In an age where there is widespread concern about global warming and containing greenhouse effects, reducing Snowy hydro-generation should be carefully considered

- The Inquiry found that if flows were increased on the Snowy and Murrumbidgee rivers in particular, active use of the rivers, predominately through fishing and canoeing, could increase, at best in terms of more visitors and consumer satisfaction.

The Inquiry has presented the estimated "economic surplus" for the benefits and impacts of various environmental flow options in a consistent framework. The "non-use" passive values have not been measured, as the methods bring added difficulty to an already complicated assignment. However, the method of tabulating the results in Table 1 highlights that there are environmental and social values which need to be considered in making a final choice.

Options Development

The 23 options presented and described in more detail in Section 8 were developed by the Inquiry to address two or more of the environmental criteria. The options were developed within the framework of various government policies and principles.

Of particular importance were the ANZECC *National Principles for the Provision of Water for Ecosystems* which state that one of the goals of providing water for the environment is "to sustain and where necessary restore ecological processes and biodiversity of water dependent ecosystems ...

"The objective is not to return all rivers to pristine condition but rather to ensure that the needs of the water dependent ecosystems are considered and catered for in allocation decisions. In general, the aim is to protect and sustain current environmental values. The exception will be those cases where there is a community decision to provide further water for the restoration or enhancement of their aquatic ecosystem."¹

The Inquiry was also guided by the NSW *Guiding Principles for the Proposed River Flow and Water Quality Objectives*².

¹ ARMCANZ and ANZECC National Principles for the Provision of Water for Eco Systems, occasional paper SWR No 3, July 1996, p5

² New South Wales Government, NSW Water Reform Implementation, published by NSW Department of Land and Water Conservation, March 1998

The principles include adaptive management; catchment focus; social and economic impacts; water access and use, and existing rights; community involvement; natural flow regime; protection of less affected rivers; rehabilitation; interactions between groundwater and surface waters; and environmental assessment.

The Composite Options

All the rivers in the Inquiry Area are highly modified, both by pre-Scheme settlement and the impact of reduced flows. The Scientific Reference Panel found that the rivers, in general, were not fully adapted to the changes and will continue to deteriorate unless action is taken to sustain or improve their current condition. It also found that the rivers could not practically be returned to completely natural conditions.

As the options were developed to address two or more of the environmental criteria, the increment between successive options on the same river highlights the improvement in environmental condition, in other non-use values, and in quantified use values such as canoeing, rafting and fishing. The increment between options also highlights the cost of the resources required.

The Inquiry assembled seven Composite Options by combining various of the Options 1 to 23, and variations of those. Composite Options have been assembled within a hierarchy developed from the environmental criteria described above.

The seven Composite Options and their environmental objectives are:

Composite Option A: To sustain the current environmental condition of all rivers and streams in the Inquiry area in the long term. This option includes a range of management measures; increased flow (in the Snowy and upper Murrumbidgee Rivers), catchment, riverine and structures management measures.

Composite Option B: To build on Composite Option A by improving environmental conditions in rivers downstream of the Scheme (Snowy River below Jindabyne and upper Murrumbidgee River). To aid the recovery of threatened fish species in the upper Murrumbidgee River.

Composite Option C: To build on Composite Option B by further improving environmental conditions in rivers downstream of the Scheme. To strengthen the recovery of threatened fish species in the upper Murrumbidgee River.

Composite Option D: To build on Composite Option B by improving conservation values including the environment of high montane rivers (Geehi and upper Snowy Rivers and their tributaries). To aid the recovery of threatened fish, frog and plant species.

Composite Option E: To build on Composite Option D by further improving conservation values, extending the area of high montane rivers (Tooma River and tributaries, and more flows in the upper Murrumbidgee). To aid the recovery of threatened fish, frog and plant species.

Composite Option F: To build on Composite Options C and E by improving the pool habitats in the Snowy River between Sandy Point and Marlo. To aid the recovery of additional threatened species.

Composite Option G: To build on Composite Option B and incrementally improve the environmental condition of all rivers and streams in the Inquiry area.

My preference is for Option D because:

- It achieves significant environmental gain for the river systems in the Inquiry area
- It has minimal cost to agriculture (apart from the lost opportunity cost of potential growth of industry)
- The impact on the hydro-electricity generator is manageable
- The capital cost impact on the Governments is reasonable in terms of the return benefits to the environment and the community.

Implementation

Interstate, inter-regional and local issues can affect the successful implementation of any agreed option. There is also a clear need to ensure that measures associated with the option are coordinated. The Inquiry therefore believes that the Governments should establish a process to implement their decision.

At the same time, implementation is likely to take several years and the various measures will need time to take effect before their impacts can be assessed. The Inquiry considers that a 3-5 year implementation program plus a five year monitoring period, as measures take effect, would not be unreasonable before a review of the Snowy water licence that may trigger increased release provisions without compensation to Snowy Hydro Ltd.

Coordination Function

An interstate commission was considered by the Inquiry; however, this would require legislation being passed in both New South Wales and Victoria. It would either overlap or strip powers and functions from existing organisations. This would be difficult to justify to the affected organisations and communities and may detract from their overall capacity to perform their wider roles. It may also set a poor precedent for land and water management across the States. Agreeing to a form of legislation and carrying it through two Parliaments would be time-consuming and have a low probability of success.

At the other extreme, leaving existing organisations on both the west and east of the Snowy Mountains and on both sides of the border to identify and implement their obligations as they see fit does not produce the right incentives to negotiate and implement a joint program of activities in a timely manner.

Ultimately State-based Ministers will agree on an option and determine the resources to implement it. The line of accountability should be as short, direct and simple as possible. The structure should have sufficient flexibility to negotiate interstate, inter-regional and local community issues within the decision framework given by the Ministers. After a maximum of five years the important issues should be resolved, leaving an on-going task focused on the Snowy region. As part of the five year review, the Ministers should review the implementation organisation and establish whether a further body or another mechanism is required to coordinate regional cross border issues.

Because this project is part of the activities necessary to implement electricity reform, the Ministers responsible for the larger project should also be accountable for this implementation stage.

Project Director

The Inquiry proposes the two Governments consider entering into an agreement to appoint a Project Director to implement their decision. The features of this agreement would be:

- Agreement as to the total contribution to the program by the participating Governments.
- The operation of a trust account established under the NSW Public Account into which New South Wales, Victoria and the

Commonwealth would make periodic deposits that, in total over five years, matched a sum agreed to at the time of determining the preferred option. There would be a variation process to allow for the benefit of more precise information similar to that applied when development projects move from feasibility to approval.

- The joint appointment of the Project Director who would report directly to the New South Wales and Victorian Ministers responsible for electricity reform.

The powers of the Director to enter and enforce contracts would be to those of a Departmental Secretary under NSW public administration powers.

There would be provision in the agreement for the Director to employ and second a small number of key staff from government agencies to obtain access to necessary skills and knowledge.

The Director would operate in a customer supplier manner, negotiating the programs to be provided and then purchasing them from existing organisations or local communities

The Project Director's role is primarily a coordinating one to ensure that the two Governments' decision is implemented efficiently. It will not replace the role of established land, water or catchment management authorities and their relationship with their community.

The Director would be accountable for the expenditure of funds. An Advisory Board would be appointed to assist the Director. It would consist of:

- Chair Person of the Snowy Genoa Catchment Committee
- Chair Person of the East Gippsland Catchment Management Committee
- Chair Person Upper Murrumbidgee Catchment Committee
- Executive Director DNRE
- Executive Director DLWC
- CEO of Snowy Hydro Ltd
- An Environmental Scientist

This Board would also report independently to the joint Ministers regarding the effectiveness of the implementation project and level of community involvement.

The duties of the Director and Advisory Board would be to:

- Negotiate interstate, inter-regional and local project plans with the relevant existing authorities and to fund projects on behalf of the Governments. This would cover both projects to the west of the Scheme and within the Inquiry's reference area. The focus would be on the actions necessary to implement the agreed option and its expected outcomes.
- Satisfy themselves that community involvement had been encouraged and is reflected in the plans and activities, and that a wide range of community funding had been sourced for activities necessary to deal with non Scheme related environmental concerns. If necessary, the committee would support local advocacy from funding agencies.
- Consult with the Snowy Scientific Committee and establish an agreed flow release management program to mimic natural flows. Within such a program, there should be a flexible capacity to manage release to obtain the best environmental impact over the full length of the river. Snowy Hydro should not be responsible for release decisions. The Director would have to establish a decision protocol and monitoring process in conjunction with the Water Administration Ministerial Corporation and Snowy Scientific Committee.
- Develop a comprehensive integrated rolling 5-year works/financial plan, supported by annual detail plans, upon which funds would be allocated. Through this integrated plan, specific programs would be developed, modified and adapted in the light of improved information that should become progressively available from the catchment, riverine and flow management measures used to obtain environmental responses.
- Establish the monitoring program reflecting the Water Administration Ministerial Corporation requirements under the Snowy Water licence. The Director would then contract to have the program implemented.
- Report six monthly to the Ministers on progress in implementing the plan. It would then contract to have the program implemented.

- Produce an annual report.
- Become a repository for the accumulation of management information that would contribute to the later environmental evaluation as to whether additional flows should be released.

The program of works and efficiency saving could largely be achieved within five years and subsequent coordination would then only relate to Snowy region issues.

Coincident with a review of progress in five years time, consideration should be given to the form and role of any future cross-border coordinating role.

Conclusion

The Inquiry has proposed a series of options that address the needs of the Snowy community for a river with restored ecological function and improved opportunities for recreational and local amenity values.

Simultaneously, the south-eastern Australian community at large will be called upon to bear a small increase in the cost of producing thermal electricity and its associated pollution, while having the satisfaction that positive effort has been made to restore one of many rivers.

The Governments have been challenged to implement a difficult but achievable level of water efficiency savings or impose a cost of lost production on the irrigation sector by reducing its diversion entitlements.

As shareholders of the Snowy Hydro Scheme, the Governments are called on to carry the cost of a smaller, more environmentally responsible generating business and to cover the cost of restoring the catchment to the extent attributable to the Scheme they originally endorsed. I believe Governments can find the appropriate balance in the options I have presented.



The Hon Robert Webster
Commissioner

23 October 1998

Commissioner's Acknowledgements

On behalf of the Inquiry I would like to thank all those individuals and organisations who have made submissions, presented at hearings, or otherwise assisted through the course of the Inquiry. The Inquiry particularly acknowledges the enormous effort and detail that many people put into their submissions, as well as the time many people set aside to meet with the Inquiry over the course of its deliberations.

I must also acknowledge the professionalism and integrity of the members of the Inquiry

Inquiry Team

Executive Officer, Mr Jim Jolley

NSW Department of Health

Project Officer, Mr Charles Jago BA

NSW Department of Public Works and Services

Administrative Officer, Ms Carla Passeggio

The Inquiry's internal consultants were managed by the Operations Manager, Mr Geoffrey Chambers, BCom, MBA, FCPA, Project Manager Department of Treasury and Finance Victoria.

His team consisted of:

Mr Graeme Turner, DipCE, EWS, Manager Surface Water Allocation and Management, Department of Natural Resources and Environment, Victoria

Mr John Verhoeven, BE(Hons1), MEngSc, MIEAust, CPEng, Executive Director Integrated Policy and Planning, Department of Land and Water Conservation, NSW

Mr Stephen Tantala BEc, LLB, Adviser Snowy Corporatisation Unit, Commonwealth Department of Primary Industries and Energy

Mr Derek Rutherford, BNatRes, Principal Project Officer Water Reform, Western Regions, Environment Protection Authority, NSW

Mr Peter Mueller, BAgEc(Hons), Research Officer

In addition, Mrs Gabrielle Kibble AO, BA, DipT&CP, FRAPI acted as consultant to the Commissioner.

Scientific Reference Panel

In respect of its environmental analysis of the rivers and streams impacted by the Scheme the Inquiry acknowledges the work of the Scientific Reference Panel, managed by Dr Bill Young, BE(Ag)(Hons1) Canterbury, PhD Lincoln, Senior Research Scientist with CSIRO Land and Water. The Panel comprised:

Dr Wayne Erskine, BA(Hons) UNSW, PhD UNSW, Senior Research Scientist NSW State Forests, formerly Senior Lecturer School of Geography, University of NSW

Dr Bruce Chessman, BSc Monash, PhD Monash, Senior Biologist, NSW Department of Land and Water Conservation

Mr Tarmo Raadik, BSc(Hons), Senior Ecologist, Victorian Marine and Freshwater Resources Institute

Mr Dane Wimbush, MSc (Sydney), Consultant and formerly with CSIRO

Mr Ian Varley, BE(Hons) UNSW, MEngSc UNSW, Manager Water Resources NSW for the Snowy Mountains Engineering Corporation Pty Ltd

Mr John Tilleard, BE(Hons) Melbourne, MSc Colorado, Principal of Moroka Pty Ltd, Chairman ID&A Pty Ltd, Director Southern Rural Water

Professor Tony Jakeman BSc(Hons) Sydney, PhD ANU, Director of the Integrated Catchment Assessment and Management Centre, ANU

Critiques of the environmental assessment method were provided by:

Dr Peter Davies PhD, BSc, Research Fellow University of Tasmania, Department of Zoology; Director, Fresh Water Systems Pty Ltd, National Coordinator of the National River Health Program

Professor Tony Jakeman

Professor Bob Wasson, BGeography(Hons1) Sydney, PhD Macquarie, Professor and Head of Department of Geography, School of Resource Management and Environmental Science, ANU; formerly Assistant Chief CSIRO

Supporting Consultants

The Inquiry engaged a number of other consultants to assist in its deliberations of the other costs, benefits and impacts. ACIL Consulting Pty Ltd advised on the costs and benefits of each option for environmental releases to the various rivers in the study set.

ACIL provided valuable input and expertise in providing the Inquiry with meaningful data through which impacts outlined in the Terms of Reference could be addressed.

The ACIL team consisted of:

Mr David Campbell, Director, BSc(Hons)

Mr Paul Breslin, Director, BSc(Hons) Salford, BEc ANU

Dr David Adam, Principal Analyst, PhD ANU, BSc(Hons) Queensland

Ms Nadira Barkatullah, Principal Economist, PhD Sydney, MSc Carnegie Mellon

Mr Rod McInnes, BAgEc, DipEd

Mr Barry Nicholls, Principal Consultant, MA(Cantab)

Ms Brigid Wheeler, Research Assistant

Hassall & Associates Pty Ltd supported ACIL in relation to agricultural and social impacts along the Murray and Murrumbidgee Rivers:

Mr Michael Clarke, Manager Economics, BAgEc (Sydney)

Mr Adrian Taylor, Consultant Economist, BAgEc (Sydney)

Mr Peter Brown, Director and Senior Consultant, BAgSc (Sydney)

Ord Minnett provided a review of the financial model proposed by the Snowy Hydro Corporation:

Mr Stuart Ulhorn, Director, BEc, DipFinMgt, FCPA

The ANU's Integrated Catchment Assessment and Management centre was engaged to assess the agricultural, tourism, social, community, heritage and cultural issues in the Snowy region. The ICAM team consisted of:

Professor Tony Jakeman

Mr Chris Buller, BSc(Hons) London, BA ANU

Dr Andrew Walker, BSc(Hons) Sydney, PhD ANU

Ms Michelle Scoccimarro, BEc(Hons) Qld

Mr William Watson, BAgEc(Hons) UNE, MSc Davis

Dr Segei Schreider, PhD ANU

Water Studies Pty Ltd performed an independent review of the SMA model including input data changes:

Dr Chris Joy, BE, MEng Sc, PhD UBC Canada

Scientists who provided advice on environmental impacts in the Murray and Murrumbidgee Rivers included:

Mr Paul Brown, BSc(Hons), Master of Philosophy, MPh, Senior Scientist, Freshwater Fisheries Research and Assessment, Marine and Freshwater Resources Institute, Victoria

Mr Paul Lloyd, BSc(Hons), MNatRes, Project Officer, NSW Murray Wetlands Working Group

Mr Phil Green, BSc, DipEd, GradDipNatRes, Resource Officer, Environmental Management Murrumbidgee Region, Department of Land and Water Conservation

Valuable comment on Murray River impacts was also provided by Ms Julia Reed, Environmental Flow Officer, Department of Natural Resources and Environment, Victoria.

HECEC Australia Pty Ltd prepared cost estimates of structural upgrades requirements for the environmental release cases:

Mr Simon Krohn, Principal Engineer, Water Resources HEC

Mr Bram Knoop, Senior Investigations Engineer HEC

Bewsher Consulting Pty Ltd advised on efficiency improvements for Menindee Lakes and the River Murray:

Mr Andrew Bewsher, BE(Hons), MSc, FIEAust, CPEng, Past Chairman, Western Sydney Water Engineering Panel, Institution of Engineers Australia

AC Nielsen conducted a body of social research through a survey for ACIL to determine community awareness and attitudes to the issues facing the Inquiry:

Ms Jennifer Kelly, Executive Director, Social and Government Research, BSc (Psychology) UNSW BEc (Hon) Sydney

Ms Robin Dowson, BA

Dr David James, BA(Hons), MA, PhD Bristol, of Ecoservices Pty Ltd independently reviewed the work of ACIL, the incorporation of the AC Nielsen survey and ICAM's Economic and Social report.

I further wish to acknowledge the assistance given by the Murray Darling Basin Commission, the Department of Natural Resources and Energy (Victoria), Department of Land and Water Conservation (NSW), NSW Department of Agriculture, the Snowy Mountains Hydro-Electric Authority, and the Power Systems Evaluation Department of VPX in respect of the supply of necessary data and requisite modelling work. In particular the following team leaders are acknowledged:

MDBC - Mr Andrew Close, Mr Pradeep Sharma

SMHEA - Mr Barry Dunn, Mr Geoff Adams,

Mr Tony Chun

DNRE - Mr Gary Stoneham, Mr Jason Barker

DLWC - Mr Paul Pendlebury, Mr Ian Milward-Brown, Mr Chris Ribbons, Mr Andrew Davidson, Mr Tissa Yatawarra

Department of Agriculture (NSW) - Mr Jason Crean

VPX - Mr Graham Kipp

Further, Gavin Anderson and Kortlang acted as media and community relations consultants for the Inquiry. Mr Brian Tyson and Ms Suzanne Mercer were the consultants on the project.

The editor for the Inquiry was Mr Richard Venus, BTech, BA, of Digital Ink.

Composite Options

The Snowy Water Inquiry has developed a number of Composite Options which are largely derived from the options described in the *Draft Options for Discussion* paper. These options have been further refined and included as Section 7. They were the building blocks for the Composite Options summarised below. They remain available for the Governments to consider. These Composite Options are explained in detail in this section.

Option A: Sustain current environmental condition of all rivers in the Inquiry area

This requires some management intervention to prevent further deterioration including flows in the Snowy below Jindabyne and in the upper Murrumbidgee Rivers.

Option B: Improve environmental conditions in rivers downstream of the Scheme

This requires both management and flow measures and combines Composite Option A with Option 3 for the Snowy River and Option 14 for the Upper Murrumbidgee River.

Option C: Further improve environmental conditions in rivers downstream of the Scheme

This combines Option B with Option 4 for the Snowy River and an increase in flows down the Upper Murrumbidgee River to 15%.

Option D: Improve conservation values including the environment of high montane rivers

This combines Option B with Option 18 for the Geehi/Swampy Plain Rivers, an increase in flows down the Upper Murrumbidgee River to 15%, and Option 10 (either the upper Snowy or Gungahlin Rivers).

Option E: Further improve conservation values, extending the area of high montane rivers

This combines Composite Option D with Option 15 for the Upper Murrumbidgee River and Option 22 for the Tooma River.

Option F: Restore pools in the Snowy floodplain reaches

This combines Composite Option E with Option 5 for the Snowy River.

Option G: Maintain and restore the environmental condition of all the rivers in the Inquiry area

This combines Options 3 (Snowy) and 9 (upper Snowy), a 10% increase in flows down the Eucumbene, Options 14 (Upper Murrumbidgee) and 18 (Geehi/Swampy Plain Rivers), a 10% increase in flows down the Tumut and Tooma Rivers, and Option 23 for the lower Swampy Plain/Upper Murray Rivers.

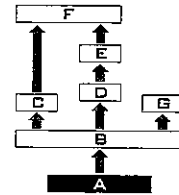
Table 1: Summary of Composite Options

Composite Option	A	B	C	D	E	F	G
Flows							
Within Scheme (GL/yr)	15	30	44	96	152	152	169
Out of Scheme (GL/yr)	38	140	198	140	140	256	140
Provision for max flow (GL/yr)	8	20	40	20	140	51	140
Costs – Water (\$m)							
Catchment works	23	23	24	24	24	32	23
Water efficiency investment	9	42	42	42	42	42	42
Costs – Electricity (\$m)							
Greenhouse abatement	6	23	35	41	53	70	49
Fuel substitution	6	36	54	54	67	98	64
Outlet works	1	22	32	27	27	38	27
Costs – Economic (\$m)							
Salinity	0	3	3	3	3	3	3
Agriculture	0	3	27	3	10	60	6
Cost – maximum flows (\$m)							
Total Quantified Costs (\$m)	45	152	217	194	226	343	214
Benefits – Use Values (\$m)							
Canoeing and rafting	0	3	3	3	3	4	3
Fishing	0	23	30	45	46	57	23
Total Quantified Benefits (\$m)	0	26	33	48	49	61	26
Net Threshold Cost (\$m)	45	126	184	146	177	282	188
Net addnl cost - max flow (\$m)	5	17	38	22	22	45	21
Environment/Social Values (\$m)¹							
Impact on Snowy Hydro (\$m)	28	83	119	108	130	188	121
Addnl impact of max flow (\$m)	0	1	3	1	1	4	1

Note 1: This row represents a range of values not quantified. Readers are provided with a substantial body of information in this report to enable them to make their own value judgements.

Note 2: Figures in this table and throughout the report are rounded and may not always add.

Composite Option A: Sustain Current Environmental Conditions in Rivers in the Inquiry Area



1. Description

The aim of this option is to sustain the current modified condition of the rivers in the Inquiry area. Its purpose is to demonstrate the nature and range of activities necessary to prevent further deterioration of the environmental condition due to the impacts of the Snowy Scheme and the modification of the riverine environment.

It acknowledges that the Scheme and other land use activities have changed the condition of the rivers and streams and that the process of ecological decline will continue to a lesser environmental condition unless positive action is taken to hold the current condition. It sets out a base in the Inquiry area from which judgements can be made about improving the current condition of individual or groups of rivers.

2. Environmental Objective

To sustain, in the long term, the current environmental conditions of the rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 8, 11, 13, 17, 19, 21 and 23.

Estimated cost \$22m

3.2 Flow Management

- Additional flows of 38 GL/annum, from decommissioning the Mowamba aqueduct, would provide the necessary flow for the Snowy River below Jindabyne. See Option 1 for more detail.

This volume would be sourced from "above target" water and would need to be offset by efficiency savings in the western rivers to avoid impacts on the irrigation industry.

- Additional flows of 15 GL/annum from Tantangara Dam would provide the necessary flow for the upper Murrumbidgee River. See Option 13 for more detail.
- Current flow in all other rivers and streams.

3.3 Proposed Maximum Flow

As described in Option 1, the proposed maximum level for releases in the Snowy River below Jindabyne Dam, following the first review of the Snowy water licence, is 46 GL, if needed. This represents an additional 8 GL above the 38 GL initial release, for additional minimum habitat utilisation flow.

Estimated economic cost \$1m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 21 and 23.

4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

Current environmental condition is improved in the lower Swampy Plain and Murray Rivers and sustained in the rivers and streams in the Inquiry area, as described in detail in Options 1, 8, 11, 13, 17, 19, 21 and 23.

4.2 Socio/Economic Benefits

No benefits from this option.

5. Effects west of the Inquiry Area

5.1 Water Management Effects

Delivery system efficiency measures to offset reductions in releases to the west (see Option 1 for more detail).

Water savings not fully provided in severe droughts, estimated to occur 4 years in 100.

Estimated cost \$9.0m

5.2 Other Effects

No salinity, agriculture, or environmental impacts from this option.

6. Electricity Effects

The impacts would be the same as for Option 1.

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$6m

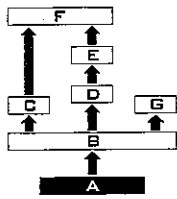
Greenhouse abatement.

Estimated cost \$6m

6.2 Outlet Works

Decommissioning Mowamba River aqueduct and works at Tantangara Dam to modify outlet gate.

Estimated cost \$1.6m



Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	0
Total estimated quantified benefit	0
Costs within the Inquiry Area	
Catchment and river measures	23
Costs west of the Inquiry Area	
Water efficiency measures	9
Salinity	-
Agriculture	-
Electricity	
Greenhouse abatement	6
Fuel and capital	6
Outlet works	1
Total estimated quantified cost	45

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro Business

Impact of reduced revenue, higher operating costs and modifying structures.

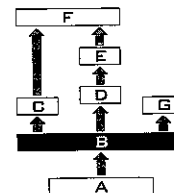
Estimated loss of asset value \$28m

7.2 Sensitivity Issues

If efficiency savings works were not undertaken in the western river system, irrigation diversions would be reduced and there would be a small agricultural impact.

Environmental flows below Jindabyne would be reduced in severe droughts, estimated to occur 4 years in 100.

Composite Option B: Improve Environmental Conditions in Rivers Downstream of the Scheme



1. Description

This option builds on the current sustainable condition for all rivers in Composite Option A. Additional flows, catchment and riverine works and measures are provided to the Snowy River below Jindabyne (Option 3) and the upper Murrumbidgee River (Option 14).

2. Environmental Objectives

To improve the environmental condition of the Snowy River below Jindabyne Dam by providing minimum habitat utilisation, flushing and channel maintenance flows.

To improve the environmental condition in the upper Murrumbidgee River and aid the recovery of threatened fish species by providing minimum habitat utilisation and flushing flows.

To sustain, in the long term, current environmental conditions of all other rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 8, 11, 13, 14, 17, 19, 21 and 23.

Estimated cost \$23m

3.2 Flow Management

- An additional release to the Snowy River of 102 GL above Composite Option A (for a total additional release of 140 GL) from Jindabyne Dam, with releases mimicking natural seasonal patterns. Flow at the dam would increase to 10% of ANF and flow in Jindabyne Gorge would increase to 15% of ANF with the Mowamba River and Cobbon Creek contributing 5% of ANF. Flow would increase to 60% of ANF in the Orbost Reach.
- An additional release of 15 GL to the upper Murrumbidgee River above Composite Option A (for a total additional release of 30 GL) from Tantangara Dam. Total flow is 10% of ANF at the dam, increasing to 16% of ANF in the river reach below the dam, and to 78% of ANF in the river reach above Burrinjuck Reservoir.
- Current flows in all other rivers and streams.

3.3 Proposed Maximum Flow

As described in Option 3, the proposed maximum level for releases in the Snowy River below Jindabyne Dam following the first review of the Snowy water licence is 168 GL, if needed. This represents an additional 28 GL above the 140 GL initial release, for additional minimum habitat utilisation flows or a flushing flow.

Diversions to the west would be reduced by the impact of this maximum provision.

Estimated economic cost \$5m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 19, 21 and 23.

4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

In the Snowy River below Jindabyne Dam, habitat condition is expected to improve to approximate a moderately modified condition in seven of the eight reaches. Refer to Option 3 for a detailed description of river habitat and biota conditions and their expected improvements for the Snowy River, and for the Mowamba River and Cobbon Creek (two tributaries currently diverted by the Mowamba aqueduct).

In the upper Murrumbidgee River, environmental condition is expected to improve to that of a moderately modified river. The habitat for native fish species, including the threatened trout cod and Macquarie perch, is improved, and as a result total and native fish species abundance, and native fish species richness are expected to improve in various river reaches. Refer to Option 14 for a detailed description of river habitat and biota conditions and their expected improvements.

Current environmental condition is improved in the lower Swampy Plain and Murray Rivers and sustained in the other rivers and streams in the Inquiry area, as described in detail in Options 8, 11, 17, 21 and 23.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.

Estimated consumer surplus \$26m

5. Effects west of the Inquiry Area

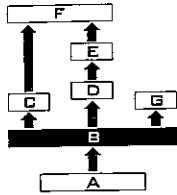
5.1 Water Management Effects

Water security to the west need not be significantly reduced by this option, provided the commitment to saving 135 GL is made. Water savings would not be fully provided in severe droughts, estimated to occur 4 years in 100. Refer to Option 3 for a detailed description.

Murrumbidgee average supplies (farm offtakes) would be reduced by 5 GL.

Water released through Tantangara would be stored in Burrinjuck for use as environmental and irrigation releases.

Estimated additional water efficiency costs \$42m



5.2 Agricultural Effects

Estimated reduction in agricultural producer surplus \$3m

5.3 Salinity Effects

Estimated salinity costs \$3m

5.4 Other Effects

No environmental impacts from this option.

6. Electricity Effects

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$36m

Greenhouse abatement.

Estimated cost \$23m

6.2 Outlet Works

Outlet works at Jindabyne Dam are estimated to cost \$21.0m (see Option 3).

No additional outlet works are required at Tantangara Dam.

Estimated cost \$22m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

Impact of reduced revenue, higher operating costs and modifying structures.

Estimated cost \$83m

7.2 Sensitivity Issues

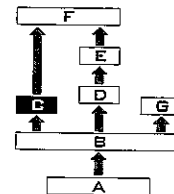
If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 5.

Environmental flows below Jindabyne would be reduced in severe droughts, estimated to occur 4 years in 100.

Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	26
Total estimated quantified benefit	26
Costs within the Inquiry Area	
Catchment and river measures	23
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	3
Electricity	
Fuel and capital	36
Greenhouse abatement	23
Outlet works	22
Total estimated quantified cost	152

Composite Option C: Further Improve Environmental Conditions in Rivers Downstream of the Scheme



1. Description

This option builds on Composite Options A and B. Additional flows are provided to the Snowy River below Jindabyne (Option 4) and the upper Murrumbidgee River (15% of ANF).

2. Environmental Objectives

To further improve the environmental condition of the Snowy River below Jindabyne Dam by providing minimum habitat utilisation and additional flushing and channel maintenance flows.

To further improve the environmental condition in the upper Murrumbidgee River and aid the recovery of threatened fish species by providing minimum habitat utilisation and additional flushing flows.

To sustain, in the long term, current environmental conditions of all other rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 8, 11, 13, 14, 17, 19, 21 and 23.

Estimated cost \$24m

3.2 Flow Management

- An additional release to the Snowy River of 160 GL above Composite Option A (for a total additional release of 198 GL) from Jindabyne Dam, with releases mimicking natural seasonal patterns. The Mowamba Aqueduct would be retained because it becomes economically viable to install a small power station on the dam outlet. Flows in the Jindabyne Gorge would increase to 20% of ANF with flow at the dam increasing to 18% of ANF. Flow would increase to 63% of ANF in the Orbost Reach.
- An additional release of 14 GL to the upper Murrumbidgee River above Composite Option B (for a total additional release of 44 GL) from Tantangara Dam. Total flow is 15% of ANF at the dam, increasing to 21% of ANF in the river reach below the dam, and to 79% of ANF in the river reach above Burrinjuck Reservoir.
- Current flows in all other rivers and streams.

3.3 Proposed Maximum Flow

As described in Option 4, the proposed maximum level for releases in the Snowy River below Jindabyne Dam following the first review of the Snowy water licence is 238 GL, if needed. This

represents an additional 40 GL above the 198 GL initial release, for additional minimum habitat utilisation flows or a flushing flow.

Estimated additional economic cost \$7m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 19, 21 and 23.

4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

In the Snowy River below Jindabyne Dam, environmental condition is expected to improve to approximate a moderately modified condition in seven of the eight reaches. Refer to Option 4 for a detailed description of river habitat and biota conditions and their expected improvements for the Snowy River.

In the upper Murrumbidgee River, environmental condition is expected to further improve as a moderately modified river above Composite Option B. The habitat for native fish species, including the threatened trout cod and Macquarie perch, is further improved and, as a result, total and native fish species abundance, and native fish species richness are expected to improve in various river reaches.

Current environmental condition is improved in the lower Swampy Plain and Murray Rivers and sustained in the other rivers and streams in the Inquiry area, as described in detail in Options 8, 11, 17, 21 and 23.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.

Estimated consumer surplus \$33m

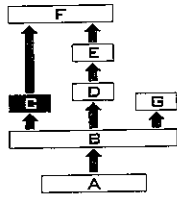
5. Effects west of the Inquiry Area

5.1 Water Management Effects

NSW Murray average usage (farm offtakes) would be reduced by approximately 19 GL/year. Impact would be felt in low allocation years: these occur in approximately 10% of years.

Victorian Murray average usage (farm offtakes) would be reduced by approximately 19 GL/year. Security would be virtually unaffected for allocations of 140% of water right (WR) or less. Sales allocations above this level would be reduced by 10% WR in approximately 50% of years.

Murrumbidgee average supplies (farm offtakes) would be reduced by approximately 23 GL. Allocations below 90% of authorised volume



(AV) occurring in 40% of years would be reduced by up to 15% of AV.

There would be a reduction in the level of assured water releases to the MDBC and DLWC storages. Capital expenditure would be needed to recover water. Water savings would not be fully available in severe drought years.

Irrigation diversions would be further reduced, with the impact similar to Option 5, if the maximum flow provision was required.

Estimated economic cost \$42m

5.2 Agriculture Effects

Estimated reduction in agricultural producer surplus \$27m

5.3 Other Effects

No significant environmental impacts or additional salinity impacts from this option.

6. Electricity Effects

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$54m

Greenhouse abatement.

Estimated cost \$35m

6.2 Outlet Works

Outlet works as in Composite Option B plus small hydro power station at Jindabyne Dam.

Estimated cost \$32m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

Impact of reduced revenue, higher operating costs and modifying structures \$119m

7.2 Sensitivity Issues

If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 6.

Environmental flows below Jindabyne would be reduced in severe droughts, estimated to occur 4 years in 100.

It may be possible to retain the Mowamba connectivity described in Composite Options A and B and defer the installation of the small power station.

The direction of some water down the Mowamba River rather than through a generator would marginally increase the economic cost of generation.

Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	33
Total estimated quantified benefit	33
Costs in the Inquiry Area	
Catchment and river measures	24
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	27
Electricity	
Fuel and capital	54
Greenhouse abatement	35
Outlet works	32
Total estimated quantified cost	217

Composite Option D: Improve Conservation Values including the Environment of High Montane Rivers

1. Description

This option builds on Composite Option B. Additional flows, catchment and riverine works and measures are provided to the upper Murrumbidgee River (15% ANF flow), the Geehi River (Option 18) and the upper Snowy River (Option 10).

2. Environmental Objectives

To improve the environmental condition of the Snowy River below Jindabyne Dam by providing minimum habitat utilisation, flushing and channel maintenance flows.

To further improve the environmental condition in the upper Murrumbidgee River by providing minimum habitat utilisation and additional flushing flows.

To sustain and improve the environmental condition of key upland montane rivers and streams.

To provide the potential to aid the recovery of a number of threatened species including trout cod and Macquarie perch, leafy anchor plant, corroboree frog and spotted tree frog.

To sustain, in the long term, current environmental conditions of all other rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 8, 9, 11, 13, 14, 17, 18, 19, 21 and 23.

Estimated cost \$24m

3.2 Flow Management

- Snowy River releases remain the same as Composite Option B (for a total additional release of 140 GL) from Jindabyne Dam, with releases mimicking natural seasonal patterns. Flow at the dam would increase to 10% of ANF and flow in Jindabyne Gorge would increase to 15% ANF with the Mowamba River and Cobbon Creek contributing 5% of ANF. Flow would increase to 60% of ANF in the Orbost Reach.
- An additional release of 14 GL to the upper Murrumbidgee River above Composite Option B (for a total additional release of 44 GL) from Tantangara Dam. Total flow is 15% of ANF at the dam, increasing to 21% of ANF in the river reach below the dam and to 79% of ANF in the river reach above Burrinjuck Reservoir.

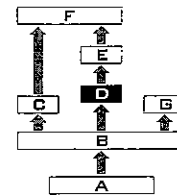
- An additional release of 20 GL (10% of ANF) from Geehi Dam or the aqueducts that divert tributary flows to the reservoir, to restore connection to the high montane catchments (such as Lady Northcotes Creek or Three Rocks Creek). Flow in the Geehi River (Reach 7.1) would be 19% of ANF, and in the upper Swampy Plain River (Reach 7.2) 50% of ANF.
- For the upper Snowy River above Jindabyne Dam, add 32 GL to the current flow condition in Reach 1.1 and 82 GL to Reach 1.3, and change the flow regime in Reach 1.2. It includes:
 - 24% ANF in Reach 1.1 comprising the current 10% spills plus 14% additional flow from either Guthega Dam or aqueducts. There are a number of choices for improving connectivity, including to decommission or modify aqueducts to restore significant tributaries such as Munyang River or Perisher Creek. The Inquiry reviewed the connectivity to the Snowy headwaters. Given the small length (6 km) of this river reach, these alternatives could also be restored as headwaters.
 - 100% flow in Reach 1.2 but with Guthega Power Station operating as a run-of-river power station, thereby changing the flow regime of the Snowy River.
 - 13% ANF in Reach 1.3 comprising 6% spills and 20% releases at Island Bend Dam representing 26% of ANF through the dam. Alternatively, Gungarlin aqueduct could be decommissioned, delivering 108 GL in Reach 1.3 and fully restoring high montane sub-catchment connectivity.
- Current flows in all other rivers and streams.

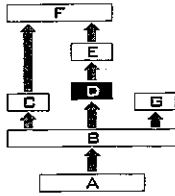
3.3 Proposed Maximum Flow

As described in Option 3, the proposed maximum level for releases in the Snowy River below Jindabyne Dam following the first review of the Snowy water licence is 168 GL, if needed. This is an additional 28 GL above the 140 GL initial release, for additional minimum habitat utilisation flows or a flushing flow.

The proposed maximum level for releases for Reach 1.1 following the first review of the Snowy water licence is 38 GL, if needed. This represents an additional 6 GL above the 32 GL initial release, for additional to minimum habitat utilisation, flushing or channel maintenance flows.

The proposed maximum level for releases for Reach 1.3 following the first review of the Snowy water licence is 98 GL, if needed. This





represents an additional 16 GL above the 82 GL initial release, for additional minimum habitat utilisation, flushing and channel maintenance flows. If the flows are provided from the decommissioned Gungarlin Aqueduct no additional flow is required as it would already be delivered as part of the 108 GL flow from the Gungarlin River.

Estimated additional economic cost of increment of flow \$5m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 21 and 23.

4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

In the Snowy River below Jindabyne Dam, habitat condition is expected to improve to approximate a moderately modified condition in seven of the eight reaches. Refer to Option 3 for a detailed description of river habitat and biota conditions and their expected improvements for the Snowy River, and for the Mowamba River and Cobbon Creek (two tributaries currently diverted by the Mowamba aqueduct).

In the upper Murrumbidgee River, environmental condition is expected to further improve as a moderately modified river above Composite Option B. The habitat for native fish species, including the threatened trout cod and Macquarie perch, is further improved, and as a result total and native fish species abundance, and native fish species richness are expected to improve in various river reaches.

In the Geehi River below Geehi Dam, environmental condition is expected to improve to that of a moderately modified river. In the upper Swampy Plain River reach, sub-index values range from moderately modified to natural condition. Refer to Option 18 for a detailed description of river habitat and biota conditions and their expected improvements for the Geehi and upper Swampy Plain Rivers above Khancoban, and for tributary streams such as Lady Northcotes Creek, Three Rocks Creek, and other creeks diverted by the Geehi River and Middle Creek Aqueducts (Options 17, 18). The improved environmental condition provides the potential to aid the recovery of threatened species including trout cod, Macquarie perch and the spotted tree frog.

In the upper Snowy River, environmental condition is expected to improve to that of a

moderately modified river in Reaches 1.1 and 1.3, and to a moderately modified to near-natural river in Reach 1.2. Refer to Option 10 for a detailed description of river habitat and biota conditions and their expected improvements for the upper Snowy River, and for tributary streams such as Munyang River, Perisher Creek, Piper Creek and Gungarlin River diverted by various aqueducts and offtake structures (Options 8, 9 and 10). The improved environmental condition provides the potential to aid the recovery of threatened species including the corroboree frog (if the Perisher Range aqueduct is decommissioned) and the leafy anchor plant.

Current environmental condition is improved in the lower Swampy Plain and Murray Rivers and sustained in the other rivers and streams in the Inquiry area, as described in detail in Options 11, 19, 21 and 23.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.

Estimated consumer surplus \$48m

5. Effects west of the Inquiry Area

5.1 Water Management Effects

Water security to the west need not be significantly reduced by this option, provided a commitment to the savings level of 135 GL is made. Refer to Option 3 for a detailed description.

Water savings would not be fully available in severe drought years. This would occur in 4 years in 100.

Water released through Tantangara would be stored in Burrinjuck for use as environmental and irrigation releases.

Geehi and Guthega releases would have no impact on water security to the west. Releases below Island Bend would have no impact on water security as these flows are pumped back from Jindabyne.

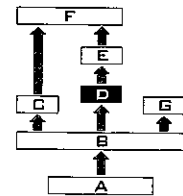
Estimated water efficiency costs \$42m

5.2 Salinity Effects

Estimated salinity costs \$3m

5.3 Other Effects

No environmental impacts from this option. Agriculture may be impacted if the maximum flows are required. The cost is incorporated in the estimate for 3.3 above.



6. Electricity Effects

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$54m

Greenhouse abatement.

Estimated cost \$41m

6.2 Outlet Works

No additional outlet works at Jindabyne Dam.

High level gate outlet works at Guthega and Island Bend (Option 10), outlet gate modifications to Geehi Dam (Option 18), and increased outlet gate capacity at Tantangara Dam.

Estimated cost \$27m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

Impact of reduced revenue, higher operating costs and modifying structures

Estimated cost \$108m

7.2 Sensitivity Issues

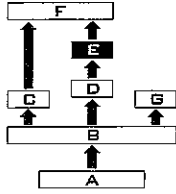
If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 6.

Environmental flows below Jindabyne would be reduced in severe droughts, estimated to occur 4 years in 100.

The choices of improving connectivity from the upper Snowy River to tributaries such as Mungyang River, Perisher and Piper Creeks or Gungahlin River, instead of the upper length of the Snowy River above these tributaries, could be made through negotiation with the NSW National Parks and Wildlife Service. The impact on economic costs would be minor but there would be potential savings of dam outlet works.

Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	48
Total estimated quantified benefit	48
Costs in the Inquiry Area	
Catchment and river measures	24
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	3
Electricity	
Fuel and capital	54
Greenhouse abatement	41
Outlet works	27
Total estimated quantified cost	194



Composite Option E: Further Improve Conservation Values, Extending the Area of High Montane Rivers

1. Description

This option builds on Composite Option D which includes the Snowy River below Jindabyne (15% of ANF), the upper Murrumbidgee River (15% of ANF), the Geehi River (10% of ANF), and the upper Snowy River. Additional flows and catchment and riverine works and measures are provided to the upper Murrumbidgee River (Option 15) and the Tooma River (Option 22).

2. Environmental Objectives

To improve the environmental condition of the Snowy River below Jindabyne Dam, and the upper Murrumbidgee River below Tantangara Dam, by providing minimum habitat utilisation, flushing and channel maintenance flows.

To sustain and improve the environmental condition of upland montane rivers and streams.

To provide the potential to aid the recovery of a number of threatened species including trout cod, Macquarie perch, leafy anchor plant, corroboree frog and spotted tree frog.

To sustain, in the long term, current environmental conditions of all other rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 8, 9, 11, 13, 14, 17, 18, 19, 21, 22 and 23.

Estimated cost \$24m

3.2 Flow Management

- Snowy River releases from Jindabyne Dam remain the same as Composite Option D (for a total additional release of 140 GL), with releases mimicking natural seasonal patterns. Flow at the dam would increase to 10% of ANF and flow in Jindabyne Gorge would increase to 15% of ANF with the Mowamba River and Cobbon Creek contributing 5% of ANF. Flow would increase to 60% of ANF in the Orbost Reach.
- An additional release of 13 GL to the upper Murrumbidgee River above Composite Option D (for a total additional release of 57 GL) from Tantangara Dam. Total flow is 20% of ANF at the dam, increasing to 26% ANF in the river reach below the dam and to 80% of ANF in the river reach above Burrinjuck Reservoir.
- No additional release to the Geehi River above Composite Option D. Flow in the Geehi River

(Reach 7.1) would be 19% of ANF, and in the upper Swampy Plain River (Reach 7.2) 50% of ANF.

- No additional release to the upper Snowy River above Jindabyne Dam above Composite Option D. Flow in the upper Snowy River includes:
 - 24% ANF in Reach 1.1 comprising the current 10% spills plus 14% additional flow from either Guthega Dam or tributaries at present diverted by offtake structures and aqueducts.
 - 100% flow in Reach 1.2 but with Guthega Power Station operating as a run-of-river power station, thereby changing the flow regime of the upper Snowy River.
 - 13% ANF in Reach 1.3 comprising 6% spills and 20% releases at Island Bend Dam representing 26% of ANF through the dam, or alternatively from the Gungarlin River.
- Additional flows of 43 GL which are a release of 20% of ANF from Tooma Dam, or from the aqueducts that divert tributary flows to the reservoir (to restore connectivity to catchments such as Outstation Creek, Ogilvies Creek or Deep Creek). Flows of 25% ANF, 36% ANF and greater than 80% ANF would occur in reaches 6.1, 6.2 and 6.3 respectively. Releases are for the purpose of minimum habitat utilisation, flushing and channel maintenance flows.
- Current flows in all other rivers and streams.

3.3 Proposed Maximum Flow

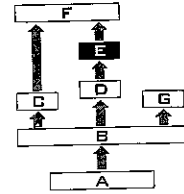
The proposed maximum level for releases in the Snowy River below Jindabyne Dam following the first review of the Snowy water licence is 168 GL, if needed. This is an additional 28 GL above the 140 GL initial release, for additional minimum habitat utilisation flows or a flushing flow.

The proposed maximum level for releases for Reach 1.1 following the first review of the Snowy water licence is 38 GL, if needed. This represents an additional 6 GL above the 32 GL initial release, for additional to minimum habitat utilisation, flushing or channel maintenance flows.

Estimated additional economic cost \$5m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 21 and 23.



4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

In the Snowy River below Jindabyne Dam, habitat condition is expected to improve to approximate a moderately modified condition in seven of the eight reaches. Refer to Option 3 for a detailed description of river habitat and biota conditions and their expected improvements for the Snowy River and the Mowamba River and Cobbon Creek (two tributaries currently diverted by the Mowamba Aqueduct).

In the upper Murrumbidgee River, environmental condition is expected to improve above that for Composite Option D, particularly from Tantangara Dam to the Numeralla River. Habitat indices range from moderately modified to near-natural to natural condition. As the habitat for native fish species, including the threatened trout cod and Macquarie perch, is further improved, total and native fish species abundance and native fish species richness are expected to improve in various river reaches. Total fish abundance increases above that for Composite Option D in the first three river reaches, considerably so in Reach 5.1 (Option 15).

In the Geehi River below Geehi Dam, environmental condition is expected to improve to that of a moderately modified river. In the upper Swampy Plain River Reach, sub-index values range from moderately modified to natural condition. Refer to Option 18 for a detailed description of river habitat and biota conditions and their expected improvements for the Geehi and upper Swampy Plain Rivers above Khancoban, and for tributary streams such as Lady Northcotes Creek, Three Rocks Creek, and other creeks diverted by the Geehi River and Middle Creek Aqueducts (Options 17, 18). The improved environmental condition provides the potential to aid the recovery of threatened species including trout cod, Macquarie perch and the spotted tree frog.

In the upper Snowy River, environmental condition is expected to improve to that of a moderately modified river in Reaches 1.1 and 1.3, and to a moderately modified to near-natural river in Reach 1.2. Refer to Option 10 for a detailed description of river habitat and biota conditions and their expected improvements for the upper Snowy River, and for tributary streams such as Mulyang River, Perisher Creek, Piper Creek and Gungarlin River diverted by various aqueducts and offtake structures (Options 8, 9 and 10). The improved environmental condition

provides the potential to aid the recovery of threatened species including the corroboree frog (if the Perisher Range aqueduct is decommissioned) and the leafy anchor plant.

In the Tooma River below Tooma Dam, environmental condition is expected to improve to that of a moderately modified river, with individual sub-index values ranging from substantially modified to natural condition. Refer to Option 22 for a detailed description of river habitat and biota conditions and their expected improvements for the Tooma River, and for tributary streams such as Outstation, Ogilvies and Deep Creeks diverted by aqueducts and offtake structures.

Current environmental condition is improved in the lower Swampy Plain and Murray Rivers (Option 23) and sustained in the other rivers and streams in the Inquiry area, as described in detail in Options 11 and 19.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.
Estimated consumer surplus \$49m

5. Effects west of the Inquiry Area

5.1 Water Management Effects

No reduction to Murray water security would occur provided a commitment to achieve the savings of 135 GL is made.

Murrumbidgee average supplies would be reduced by a further 14 GL as the consequence of increased flows from Tooma Dam. Water sharing arrangements between the Tumut and Murray Developments are adjusted to partially offset the impact of increased Tooma flows.

Water savings would not be fully provided in severe droughts, estimated to occur 4 years in 100.

Water released through Tantangara would be stored in Burrinjuck for environmental and irrigation releases.

Geehi and Guthega releases would have no impact on water security to the west. Releases below Island Bend would have no impact on water security if they are pumped from Jindabyne.

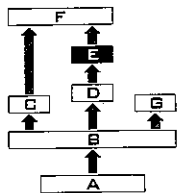
Estimated water efficiency costs \$42m

5.2 Salinity Effects

Estimated salinity costs \$3m

5.3 Agricultural Effects

Estimated reduction in producer surplus \$10m



5.4 Environmental Effects

No environmental impact to the west. Some minor benefit may occur as a result of less flow in the Tumut River below Blowering and the changed flow regime of the upper Murray River.

6. Electricity Effects

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated additional cost \$67m

Greenhouse abatement.

Estimated cost \$53m

6.2 Outlet Works

No additional outlet works at Jindabyne Dam.

High level gate outlet works at Guthega and Island Bend (Option 10), outlet gate modifications to Geehi Dam (Option 18), and increased outlet gate capacity at Tantangara Dam.

Assumes taking flows from Tooma River aqueduct and releasing these at the dam to provide connectivity (13 GL), releasing flows from Outstation Creek (3 GL) and modifying Ogilvies Creek intake.

Estimated cost \$27m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

Impact of reduced reserves, higher operating costs and modifying structures

Estimated cost \$130m

7.2 Sensitivity Issues

If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 6.

Environmental flows below Jindabyne would be reduced in severe droughts, estimated to occur 4 years in 100.

The Option assumes Tooma flows are accounted equally under the water sharing arrangements between the Tumut and Murray Developments. Alternative sharing arrangements may be negotiated which would alter the distribution of impacts between the Murrumbidgee and Murray irrigation systems.

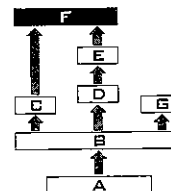
Benefit Cost Summary

Benefits in the Inquiry Area	Est.\$m
Fishing, canoeing, rafting	49
Total estimated quantified benefit	49
Costs in the Inquiry Area	
Catchment and river measures	24
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	10
Electricity	
Fuel and capital	67
Greenhouse abatement	53
Outlet works	27
Total estimated quantified cost	226

The choices of improving connectivity from the upper Snowy River to tributaries such as Mungyang River, Perisher and Piper Creeks or Gungahlin River instead of the upper length of the Snowy River above these tributaries could be made through negotiation with the NPWS. The impact on economic costs would be minor, but have potential savings of dam outlet works.

Similarly, there are choices of improving connectivity from the Geehi River to tributaries such as Lady Northcotes Creek, instead of the Geehi River above these tributaries, and of improving connectivity from the Tooma River to tributaries such as Outstation, Ogilvies and Deep Creeks instead of the Tooma River above these tributaries. These choices could be made through negotiation with the NPWS. The economic input would remain similar to those already described in this option.

Composite Option F: Extend the Conservation Area of High Montane Rivers and Restore Pools in the Lower Snowy River



1. Description

This option builds on Composite Option E. Additional channel maintenance flows and physical in-stream works in the Orbost Reach are provided to the Snowy River (Option 5).

2. Environmental Objectives

To improve the environmental condition of the Snowy River below Jindabyne Dam, and the upper Murrumbidgee River below Tantangara Dam, by providing minimum habitat utilisation, flushing and channel maintenance flows.

To improve the river pool habitats in the Snowy River between Sandy Point and Marlo.

To sustain and improve the environmental condition of upland montane rivers and streams.

To provide the potential to aid the recovery of a number of threatened and vulnerable fish, plant and frog species.

To sustain, in the long term, current environmental conditions of all other rivers and streams in the Inquiry area.

3. Management Measures

3.1 Catchment and River Measures

The range of catchment and river management measures are set out in Options 1, 5, 8, 9, 11, 13, 14, 17, 18, 19, 21, 22 and 23.

Estimated cost \$32m

3.2 Flow Management

- For the Snowy River, this option builds on Composite Option B. It requires an additional release of 116 GL. Flows in Jindabyne Gorge rise to 25% of ANF at Jindabyne, with the flow at the dam increasing to 23% of ANF. Releases would mimic seasonal patterns based on natural flows at Jindabyne and would include channel maintenance flow requirements. The Mowamba aqueduct would be retained because it is viable to install a small generator on the dam outlet. Flows in Reach 4.2 would increase to 65% of ANF.
- No additional release to the upper Murrumbidgee River above Composite Option D. Total flow is 20% of ANF at Tantangara Dam, increased to 26% of ANF in the reach below the dam and to 80% of ANF in the reach above Burrinjuck Reservoir.
- No additional release to the Geehi River above Composite Option D. Flow in the Geehi River (Reach 7.1) would be 19% of ANF, and in the upper Swampy Plain River (Reach 7.2) 50% of ANF.

- No additional release to the upper Snowy River above Jindabyne Dam above Composite Option D. Flow in the upper Snowy River includes:

- 24% ANF in Reach 1.1 comprising the current 10% spills plus 14% additional flow from either Guthega Dam or tributaries at present diverted by offtake structures and aqueducts.
- 100% flow in Reach 1.2 but with Guthega Power Station operating as a run-of-river power station, thereby changing the flow regime of the Snowy River.
- 13% ANF in Reach 1.3 comprising 6% spills and 20% releases at Island Bend Dam representing 26% of ANF through the dam, or alternatively from the Gungarlin River.

- No additional release to the Tooma River above Composite Option E. Flows of 25% ANF, 36% ANF and greater than 80% ANF would occur in the three reaches.

- Current flows in all other reaches and streams.

3.3 Proposed Maximum Flow

In the Snowy River below Jindabyne Dam, the proposed maximum level for releases following the first review of the Snowy Water licence is 307 GL if needed (Option 5). This represents an additional 51 GL above the 256 GL initial release, for additional channel maintenance flows in the Sandy Point and Orbost Reaches.

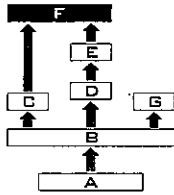
The proposed maximum level for releases for Reach 1.1 following the first review of the Snowy water licence is 38 GL, if needed. This represents an additional 6 GL above the 32 GL initial release, for additional to minimum habitat utilisation, flushing or channel maintenance flows.

The proposed maximum level for releases for Reach 1.3 following the first review of the Snowy water licence is 98 GL if needed. This represents an additional 16 GL above the 82 GL initial release, for additional minimum habitat utilisation, flushing and channel maintenance flows. If the flows are provided from the decommissioned Gungarlin Aqueduct no additional flow is required, as it would already be delivered as part of the 108 GL flow from the Gungarlin River.

Estimated additional economic cost \$10m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 21 and 23.



4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

The strategy of this option for the Snowy River below Jindabyne Dam is to use a combination of physical in-stream works and channel maintenance flows to help restore long deep pools in the Sandy Point Reach and alternating pool and bar bed forms in the Orbost Reach. However, habitat condition may not improve to the level expected. An additional contingency flow of up to 5% of ANF at Jindabyne would be required to complete the reforming of the pools and riffles (Section 3.3). The need for such a contingency flow would not be known until after the works are trialed over five to ten years.

The environmental condition in the Snowy River is expected to improve, varying from that of moderately modified to near-natural condition from Jindabyne to the sea. Refer to Options 4 and 5 for a detailed description of river habitat and biota conditions and their expected improvements. The improved environmental condition increases the potential to aid the recovery of vulnerable fish species in the lower Snowy River including the Australian Grayling and Cox's Gudgeon.

As the Mowamba aqueduct is not decommissioned in this option, the environmental benefits described for the Mowamba River and Cobbon Creek in Composite Options A, B, D and E do not apply to this option. An ECI value of about 0.30 is assessed for the 5.2 km impacted section of these two streams between the diversion weirs and the Snowy River.

In the upper Murrumbidgee River environmental condition is expected to improve above that for Composite Option D, particularly from Tantangara Dam to the Numeralla River. Habitat indices range from moderately modified to near-natural to natural condition. As the habitat for native fish species, including the threatened trout cod and Macquarie perch is further improved, total and native fish species abundance, and native fish species richness are expected to improve in various river reaches. Total fish abundance increases above that for Composite Option D in the first three river reaches, considerably so in Reach 5.1 (Option 15).

In the Geehi River below Geehi Dam, environmental condition is expected to improve to that of a moderately modified river. In the upper Swampy Plain River Reach, sub-index values range from moderately modified to natural

condition. Refer to Option 18 for a detailed description of river habitat and biota conditions and their expected improvements for the Geehi and upper Swampy Plain Rivers above Khancoban, and for tributary streams such as Lady Northcotes Creek, Three Rocks Creek, and other creeks diverted by the Geehi River and Middle Creek Aqueducts (Options 17, 18). The improved environmental condition provides the potential to aid the recovery of threatened species including trout cod, Macquarie perch and the spotted tree frog.

In the upper Snowy River, environmental condition is expected to improve to that of a moderately modified river in Reaches 1.1 and 1.3, and to a moderately modified to near-natural river in Reach 1.2. Refer to Option 10 for a detailed description of river habitat and biota conditions and their expected improvements for the upper Snowy River, and for tributary streams such as Munyang River, Perisher Creek, Piper Creek and Gungarlin River diverted by various aqueducts and offtake structures (Options 8, 9 and 10). The improved environmental condition provides the potential to aid the recovery of threatened species including the corroboree frog (if the Perisher Range aqueduct is decommissioned) and the leafy anchor plant.

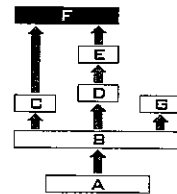
In the Tooma River below Tooma Dam, environmental condition is expected to improve to that of a moderately modified river, with individual sub-index values ranging from substantially modified to natural condition. Refer to Option 22 for a detailed description of river habitat and biota conditions and their expected improvements for the Tooma River, and for tributary streams such as Outstation, Ogilvies and Deep Creeks diverted by aqueducts and offtake structures.

Current environmental condition is sustained and improved in the other rivers and streams in the Inquiry area, as described in detail in Options 11, 19 and 23. The one possible exception is the 14 km long Island Bend Dam to Lake Jindabyne Reach on the upper Snowy River where the ECI value changes from 0.26 (current) to 0.25 (long term equilibrium), indicating that environmental condition marginally declines or is maintained.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.

Estimated consumer surplus \$61m



5. Effects west of the Inquiry Area

5.1 Water Management Effects

Additional flows could come from reductions in diversion on the Murray and Murrumbidgee rivers as follows:

- 14 GL from NSW Murray diversions. Allocations would be further reduced in approximately 15% of drier years. Allocations would be reduced compared to the standard case by up to 30% of allocated volume in a drought year.
- 15 GL from Victorian Murray diversions at river offtake. Sales allocations would be reduced by 5% of WR, on average, although a further 10% reduction could occur in 10% of years.
- 14 GL from implementing the NSW Government's policy that diversions on the Murrumbidgee could be reduced by up to 5% to return water to the Snowy. Security would be reduced in 85% of years. Allocations would be reduced by an additional 5-10% with the worst impact in low allocation years.

Water released through Tantangara would be delivered to Burrinjuck for use as environmental and irrigation releases.

This option involves redirecting water from Tooma Dam that currently passes to the Murrumbidgee system. Water sharing arrangements in Eucumbene Storage would need adjustment to partially offset the impact. There would also be a marginal reduction of about 10 GL in releases to the Murrumbidgee system resulting in an average reduction in diversions of about 3 GL at farm offtake.

Geehi and Guthega releases would have no impact on water security to the west. Releases below Island Bend would have no impact on water security if they are pumped from Jindabyne.

Estimated water efficiency costs \$42m

5.2 Salinity Effects

Estimated salinity costs \$3m

5.3 Agricultural Effects

Estimated reduction in produce surplus \$60m

5.4 Environmental Effects

Some minor impacts may occur associated with a reduced frequency of higher flow events in the Murray and Murrumbidgee Rivers. There may also be fewer opportunities for fish passage through locks in South Australia. Some minor benefit may occur as a result of less flow in the Tumut River or on improved flow regime in the upper Murray River.

6. Electricity Effects

6.1 Economic Impacts

Greenhouse abatement.

Estimated cost \$70m

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$98m

6.2 Outlet Works

Increased outlet capacity and power station at Jindabyne Dam.

High level gate outlet works at Guthega and Island Bend (Option 10), modifications to outlet gate at Geehi Dam (Option 18), and increased outlet gate capacity at Tantangara Dam.

Assumes taking flows from Tooma River aqueduct and releasing these at the dam to provide connectivity (13 GL), releasing flows from Outstation Creek (3 GL) and modifying Ogilvies Creek intake.

Estimated cost \$38m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

Impact of reduced reserves, higher operating costs and modifying structures.

Estimated cost \$188m

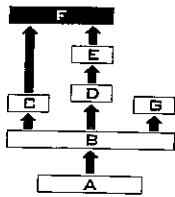
7.2 Sensitivity Issues

If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 7.

The choices of improving connectivity from the upper Snowy River to tributaries such as Munyang River, Perisher and Piper Creeks or Gungarlin River, instead of the upper length of the Snowy River above these tributaries, could be made through negotiation with the NSW National Parks and Wildlife Service. The impact on economic costs would be minor, but have potential savings of dam outlet works.

It may be possible to retain the Mowamba connectivity described in Composite Options A to D and defer the installation of the small power station. The direction of some water down the Mowamba River rather than through a generator would marginally increase the economic cost of generation.

Similarly, there are choices of improving connectivity from the Geehi River to tributaries such as Lady Northcotes Creek, instead of the

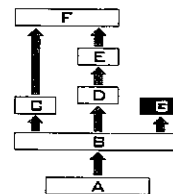


Geehi River above these tributaries, and of improving connectivity from the Tooma River to tributaries, such as Outstation, Ogilvies and Deep Creeks, instead of the Tooma River above these tributaries. These choices could be made through negotiation with the NSW National Parks and Wildlife Service. The economic input would remain similar to those already described in this option.

Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	61
Total estimated quantified benefit	61
Costs in the Inquiry Area	
Catchment and river measures	32
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	60
Electricity	
Greenhouse abatement	70
Fuel and capital	98
Outlet works	38
Total estimated quantified cost	343

Composite Option G: Maintain and Incrementally Improve the Environmental Condition of all Rivers in the Inquiry Area



1. Description

This option builds on the current sustainable condition for all rivers in Composite Option A. Additional flows, and where appropriate catchment and riverine works and measures are provided to the Snowy River below Jindabyne (Option 3), the Snowy River above Jindabyne (Option 9), the upper Murrumbidgee River (Option 14), the Geehi and upper Swampy Plain Rivers (Option 18), additional 10% ANF in the Eucumbene, Tooma and Tumut Rivers, and current flows in the lower Swampy Plain and Murray Rivers (Option 23).

2. Environmental Objectives

To improve the environmental condition of rivers and streams in the Inquiry area by providing minimum habitat utilisation and flushing flows.

To further improve the environmental condition of the Snowy River below Jindabyne Dam by the provision of additional flow for channel maintenance purposes in river reaches from the dam to the Delegate River.

To provide the potential to aid the recovery of threatened fish, frog and vegetation species.

3. Management Measures

3.1 Catchment and River Measures

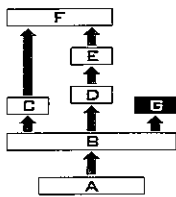
The range of catchment and river management measures are set out in Options 1, 8, 9, 11, 13, 14, 17, 19, 21 and 23.

In addition, stock some native fish species including the two-spined black fish and mountain galaxias in the Tumut River, to aid the recovery process, particularly if connectivity is to be re-established with tributary streams.

Estimated cost \$23m

3.2 Flow Management

- An additional release to the Snowy River of 102 GL above Composite Option A (for a total additional release of 140 GL) from Jindabyne Dam, with releases mimicking natural seasonal patterns. Flow at the dam would increase to 10% of ANF and flow in Jindabyne Gorge would increase to 15% of ANF with the Mowamba River and Cobbon Creek contributing 5% of ANF. Flow would increase to 60% of ANF in the Orbost Reach.
- For the upper Snowy River above Jindabyne Dam, add 32 GL to the current flow condition in Reach 1.1 and 82 GL to Reach 1.3, and change the flow regime in Reach 1.2. It includes:
 - 24% ANF in Reach 1.1 comprising the current 10% spills plus 14% additional flow from either Guthega Dam or aqueducts. There are a number of choices for improving connectivity, including to decommission or modify aqueducts to restore significant tributaries such as Munyang River or Perisher Creek. The Inquiry reviewed the connectivity to the Snowy headwaters. Given the small length (6 km) of this river reach, these alternatives could also be restored as headwaters.
 - 100% flow in Reach 1.2 but with Guthega Power Station operating as a run-of-river power station, thereby changing the flow regime of the Snowy River.
 - 10% ANF in Reach 1.3 comprising 6% spills and 14% releases at Island Bend Dam representing 20% of ANF through the dam. Alternatively, Gungarlin Aqueduct could be modified to provide flows from the Gungarlin River, delivering an additional 57 GL in Reach 1.3 and partially restoring the connectivity of the high montane sub-catchment.
- An additional release of 13 GL to the upper Murrumbidgee River above Composite Option A (for a total additional release of 30 GL) from Tantangara Dam. Total flow is 10% of ANF at the dam, increasing to 16% of ANF in the river reach below the dam, and to 78% of ANF in the river reach above Burrinjuck Reservoir.
- Addition of 20 GL (10% of ANF) from Geehi Dam or the aqueducts that divert tributary flows to the reservoir, to restore connection to the high montane catchments (such as Lady Northcotes Creek or Three Rocks Creek). Flow in the Geehi River (Reach 7.1) would be 19% of ANF, and in the upper Swampy Plain River (Reach 7.2) 50% of ANF.
- Addition of 29 GL or 10% of ANF from Eucumbene Dam, increasing the flow in Reach 10.1 to 15% of ANF.
- Additional flows of 22 GL which are a release of 10% of ANF from Tooma Dam, or from the aqueducts that divert tributary flows to the reservoir (to restore connectivity to catchments such as Outstation Creek, Ogilvies Creek or Deep Creek). Flows of 15% ANF, 28% ANF and greater than 80% ANF would occur in Reaches 6.1, 6.2 and 6.3 respectively. Releases are for the purpose of minimum habitat utilisation and flushing flows.



- For the Tumut River, this option adds 36 GL or 10% of ANF from Tumut Pond and Tumut 2 Dams to the current flow condition.

Alternatively, part of this flow could be delivered by decommissioning aqueducts and intake structures that divert tributary flows to the two storages:

- In Reach 9.2, 15.3 GL can be obtained from Burns Creek and tributary.
- In Reach 9.3, 2.1 GL can be obtained from Section Creek and Eight Mile Creek.

No change is proposed in Reach 9.1.

- Current flows in the lower Swampy Plain and Murray Rivers between Khancoban Dam and Lake Hume.

3.3 Proposed Maximum Flow

As described in Option 3, the proposed maximum level for releases in the Snowy River below Jindabyne Dam following the first review of the Snowy water licence is 168 GL if needed. This represents an additional 28 GL above the 140 GL initial release, for additional minimum habitat utilisation flows or a flushing flow.

The proposed maximum level for releases for Reach 1.1 following the first review of the Snowy water licence is 38 GL if needed. This represents an additional 6 GL above the 32 GL initial release, for additional to minimum habitat utilisation, flushing or channel maintenance flows.

The proposed maximum level for releases for Reach 1.3 following the first review of the Snowy water licence is 68 GL if needed. This represents an additional 11 GL above the 57 GL initial release, for additional to minimum habitat utilisation or flushing flows.

Estimated additional economic cost \$5m

3.4 Other Works Required

Other catchment and river management works required are listed in Options 1, 8, 11, 13, 17, 21 and 23.

4. Effects within the Inquiry Area

4.1 Expected Environmental Outcomes

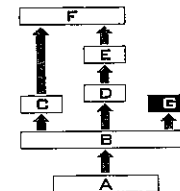
In the Snowy River below Jindabyne Dam, habitat condition is expected to improve to approximate a moderately modified condition in seven of the eight reaches. Refer to Option 3 for a detailed description of river habitat and biota conditions and their expected improvements for the Snowy River, and for the Mowamba River and Cobbon Creek (two tributaries currently diverted by the Mowamba aqueduct).

In the upper Snowy River, environmental condition is expected to improve to that of a moderately modified river in Reaches 1.1 and 1.3, and to a moderately modified to near-natural river in Reach 1.2. Refer to Option 9 for a detailed description of river habitat and biota conditions and their expected improvements for the upper Snowy River, and for tributary streams such as Munyang River, Perisher Creek, Piper Creek and Gungarlin River diverted by various aqueducts and offtake structures (Options 8 and 9). The improved environmental condition provides the potential to aid the recovery of threatened species including the corroboree frog (if the Perisher Range aqueduct is decommissioned) and the leafy anchor plant.

In the upper Murrumbidgee River environmental condition is expected to improve to that of a moderately modified river. The habitat for native fish species, including the threatened trout cod and Macquarie perch, is improved, and as a result total and native fish species abundance, and native fish species richness are expected to improve in various river reaches. Refer to Option 14 for a detailed description of river habitat and biota conditions and their expected improvements.

In the Geehi River below Geehi Dam, environmental condition is expected to improve to that of a moderately modified river. In the upper Swampy Plain River reach, sub-index values range from moderately modified to natural condition. Refer to Option 18 for a detailed description of river habitat and biota conditions and their expected improvements for the Geehi and upper Swampy Plain Rivers above Khancoban, and for tributary streams such as Lady Northcotes Creek, Three Rocks Creek, and other creeks diverted by the Geehi River and Middle Creek Aqueducts (Options 17, 18). The improved environmental condition provides the potential to aid the recovery of threatened species including trout cod, Macquarie perch and the spotted tree frog.

In the Eucumbene River below Eucumbene Dam, environmental condition is expected to improve above current condition, with habitat indices ranging from substantially modified (hydraulics, geomorphology and barriers) to moderately modified (water quality) to natural condition (riparian vegetation). Similarly, the biota indices are expected to vary from substantially modified (fish) to moderately modified (macro-invertebrates) to near-natural condition (aquatic vegetation). Refer to Section A3.3 p72 and Section A3.4 pp111-115 for details.



In the Tooma River below Tooma Dam, environmental condition is expected to improve to that between a substantially modified and a moderately modified river, with individual index values ranging from zero (fish index) in Reach 6.1 to substantially modified to near-natural condition.

Refer to Section A3.3 pp.49-50 and Section A3.4 pp 68-76 for a detailed description of river habitat and biota conditions and their expected improvements for the Tooma River.

If flows are delivered to the Tooma River by decommissioning Ogilvies, Outstation and possibly Deep Creek intake structures on these tributary streams instead of from Tooma Dam, the benefits to those streams would include those described in Option 22.

In the Tumut River environmental condition would not change from current in Reach 9.1 below Happy Jacks Dam. However in Reaches 9.2 and 9.3 below Tumut Pond Dam and Tumut 2 Dam respectively, environmental condition is expected to improve to between a substantially modified and moderately modified condition. Refer to Section A3.3 p.66 and Section A3.4 pp.103-110.

If flows are delivered to the Tumut River in part by decommissioning aqueducts and intake structures on streams such as Burns, Eight Mile and Section Creeks and their tributaries, the benefits to them would include those described in Option 20.

The environmental condition for the lower Swampy Plain and Murray Rivers is expected to improve to that of a moderately modified river, with individual indices varying from substantially modified to natural condition.

4.2 Socio/Economic Benefits

Recreational fishing, canoeing and rafting.
Estimated consumer surplus \$26m

5. Effects west of the Inquiry Area

5.1 Water Management Effects

Water security to the west need not be reduced by this option, although the commitment to savings totals 140 GL and may not be readily available. Refer to Option 3 for a detailed description.

Water released through Tantangara would be delivered to Burrinjuck for use as environmental and irrigation releases.

Estimated water efficiency costs \$42m

5.2 Salinity Effects

Estimated salinity costs \$3m

5.3 Agricultural Effects

Estimated reduction in producer surplus \$6m

5.4 Other Effects

No environmental impacts from this option.

6. Electricity Effects

6.1 Economic Impacts

Fuel and capital cost of substituting thermal for hydro generation.

Estimated cost \$64m

Greenhouse abatement.

Estimated cost \$49m

6.2 Outlet Works

Outlet works at Jindabyne Dam are estimated to cost \$21.0m (see Option 3).

No additional outlet works are required at Tantangara Dam.

High level gate outlet works at Guthega and Island Bend (Option 9), cone valve and stilling ponds at Eucumbene Dam (Option 12), outlet gate modifications to Geehi Dam (Option 18), and modifying aqueducts and intake structures at Tooma Dam (Option 22).

Estimated cost \$27m

7. Supplementary Comments

7.1 Financial Impacts on Snowy Hydro

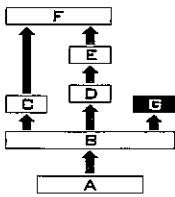
Impact of reduced reserves, higher operating costs and modifying structures

Estimated cost \$121m

7.2 Sensitivity Issues

If efficiency savings were not undertaken in the western river system, irrigation diversions would be reduced and there would be an agricultural impact similar to that projected in Option 5.

There are choices of improving connectivity from the upper Snowy River, Geehi River, Tooma River and Tumut River to various tributaries, as explained earlier in this Composite Option. These choices could be made through negotiation with the NSW National Parks and Wildlife Service. The impact on economic costs would be minor.



Benefit Cost Summary

Benefits in the Inquiry Area	Est \$m
Recreational fishing, canoeing, rafting	26
Total estimated quantified benefit	26
Costs in the Inquiry Area	
Catchment and river measures	23
Costs west of the Inquiry Area	
Water efficiency measures	42
Salinity	3
Agriculture	6
Electricity	
Fuel and capital	64
Greenhouse abatement	49
Outlet works	27
Total estimated quantified cost	214