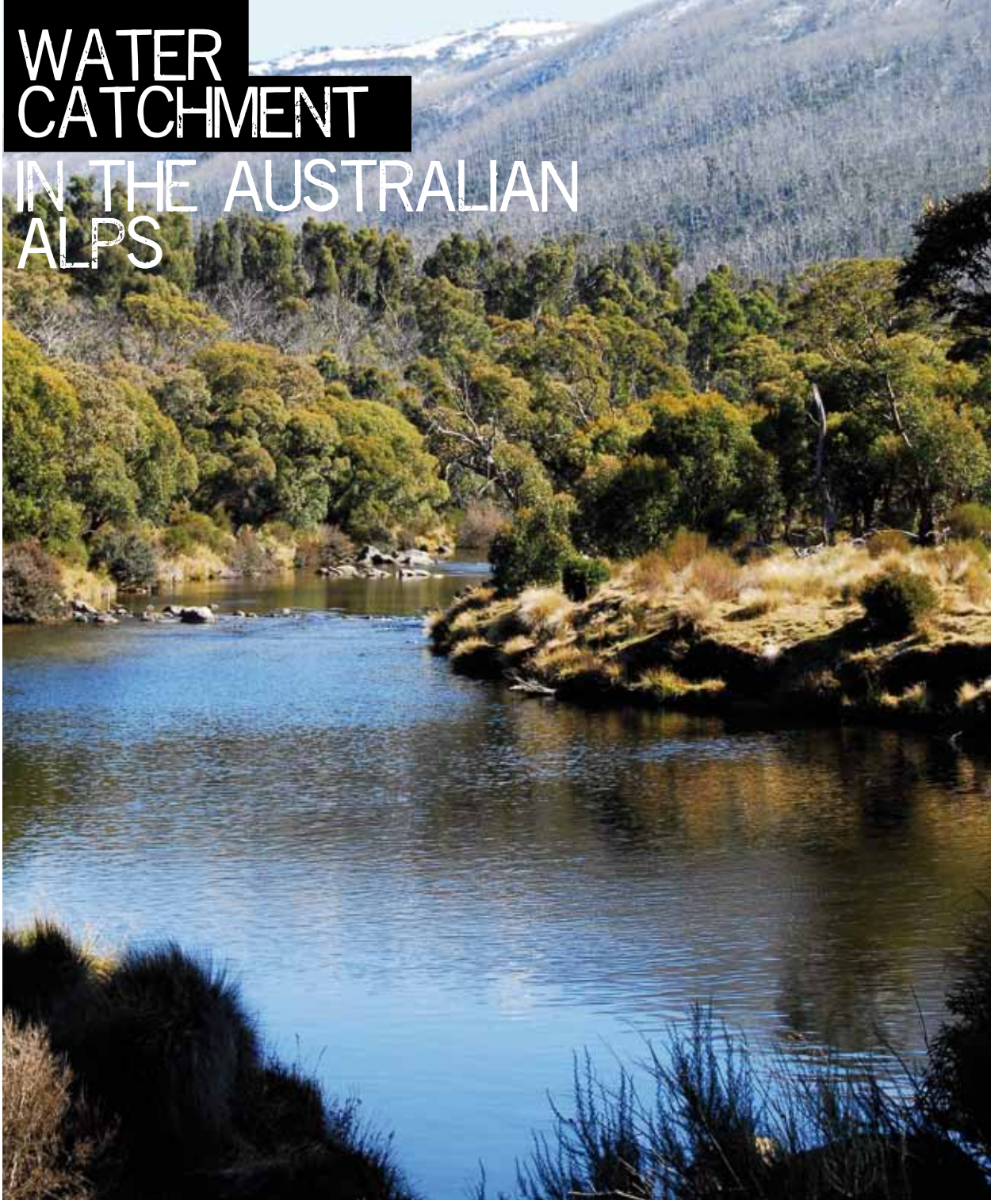
WATER CATCHMENT IN THE AUSTRALIAN ALPS



Long ago the Creator made the land, the people and the natural resources for the people to use. Spirit ancestors travelled the land and left behind reminders of where they had been, whom they had met and what they had been doing in the form of plants, animals and landforms. There are stories, songs, dances and ceremonies associated with these places, plants and animals. When we see the stars, mountains, rivers, hills, plants and animals we remember the stories of the journeys and we know how to live in this country. This is our culture.

text: Rod Mason
illustration: Jim Williams

The Australian Alps make their contribution to a number of vitally important streams in New South Wales, Victoria, South Australia and the Australian Capital Territory. The mountains capture precipitation - hail, rain and snow - and this water slowly filters from the catchment area to the surrounding lowlands through an extensive system of bogs, streams and rivers.

This water-gathering function produces an extremely important resource, one that is in demand - often with conflict, and which presents a challenge in managing the Alps.

Australia is the driest inhabited continent on earth which is why having a regular and reliable supply of quality water is essential for the survival of its inhabitants. The Alps are home to the headwaters of a number of major Victorian and NSW streams - the Murrumbidgee River, Snowy River and part of the headwaters of the Murray, south-eastern Australia's largest river system. As an example, the Alps deliver an average of 9600 gigalitres of high quality water to the Murray Darling Basin which is about 29% of the total Basin's average annual flows.

WATER CATCHMENT

THE AUSTRALIAN ALPS CATCHMENT

Two main factors contribute to the quality and quantity of water gathered by the Australian Alps:
- high levels of precipitation and low evapotranspiration; and
- high water-holding capacity of snow and alpine soils and vegetation, resulting in slow discharge of water throughout the year.

Precipitation and evapotranspiration

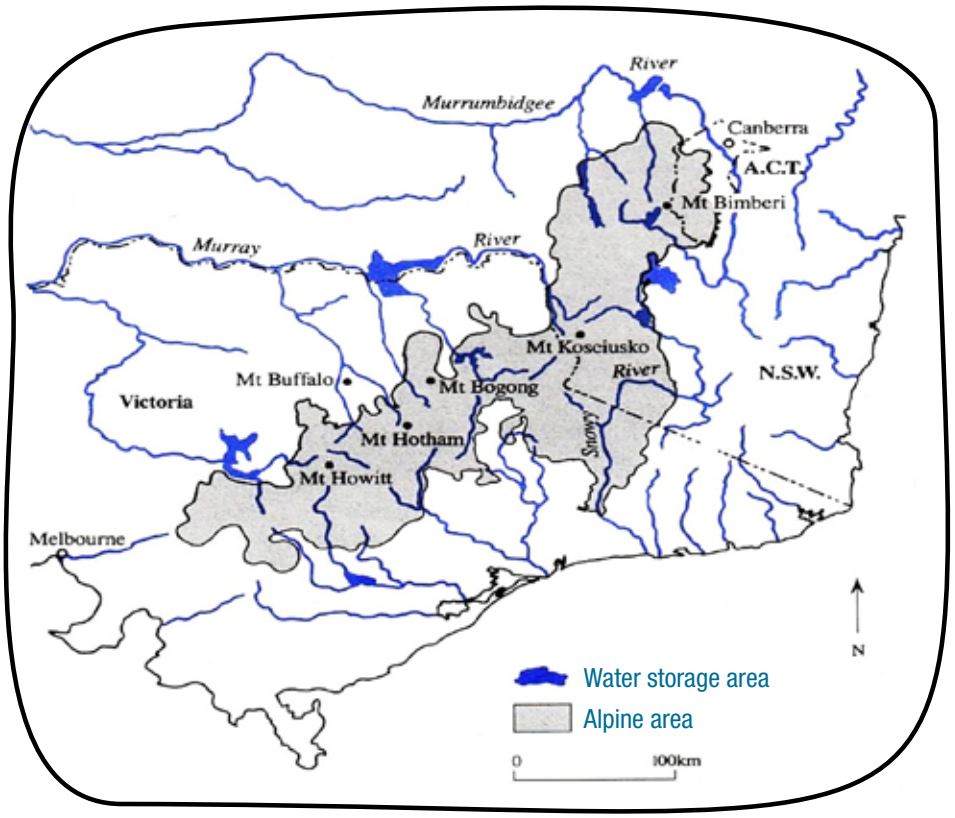
Precipitation in the Australian Alps can be in the form of fog, rain, sleet, ice or snow. It occurs all year round but is greatest during winter and spring. The Alps receive some of the highest levels of precipitation in Australia, primarily due to the greater altitude and lower temperatures relative to other Australian landscapes. It is these low temperatures that are responsible for the Alp's low rates of water loss through evaporation.

Precipitation, low evaporation rates and the capacity to hold water, are greatest in the subalpine and alpine zones. It's these zones which yield the most water per unit area. For example in the River Murray system, even though the alpine and subalpine zones make up only one percent of the total catchment area, they contribute an estimated 29% to its annual flow.

Average annual precipitation of the Upper Snowy catchment area (Source: Costin 1952)

Altitudal zone	Rainfall (mm)
Alpine	1800 – 2300
Subalpine	1300 – 2000
Montane	500 – 1300
Tableland (lower elevations)	500 – 800

Australian Alps Bio Region



WATER CATCHMENT

Sphagnum Moss can absorb up to twenty times its own weight in water.

Water holding capacity and slow discharge

The formation of snow and ice, and the unique alpine soils and vegetation give the Alps a large, natural capacity to hold water and regulate its release throughout the year. During winter, much precipitation is stored as snow and ice so is held back from streams. Under natural conditions peak stream flow is produced in spring as snow melts. Following this there is generally an exponential fall in stream flow, reaching its lowest levels during February to March.

Flooding associated with large rainfall events can occur throughout the year. However, the unique alpine vegetation and soils act as a buffer regulating the release of water and reducing the impact of these events.

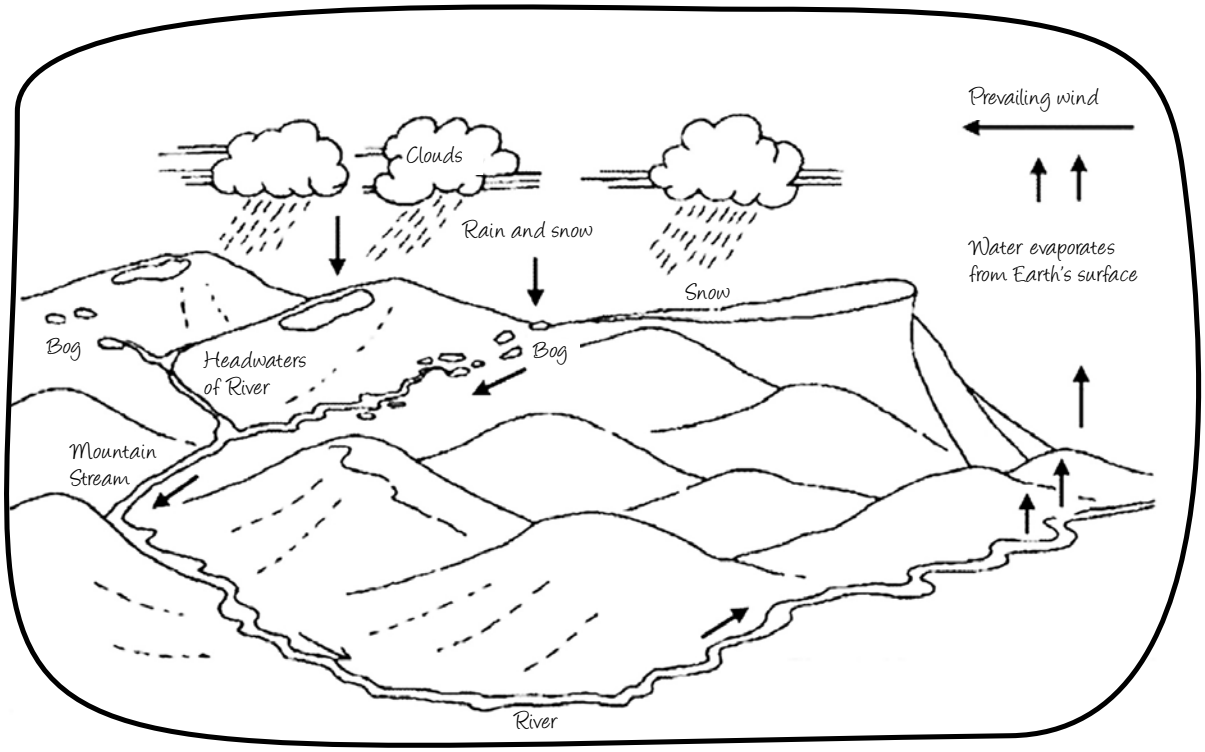
Continuous vegetation cover and porous soils are important in absorbing and retaining precipitation. Water collects in droplets on the leaves and stems of the Alps vegetation. The bog and fen communities are of particular significance in regulating the flow of water. Sphagnum Moss (Sphagnum cristatu), the major species in the bog communities, can absorb up to twenty times its own weight in water. In this way bogs act as natural reservoirs for the storage and slow release of water.

Water not absorbed by plants passes easily into the porous soils. Once water has entered the soil, the high component of undecomposed plant matter in peats and alpine humus soils enables them to hold water for long periods of time. Peats in particular can absorb large quantites of water and release it slowly. The alpine vegetation and steep terrain also serves to filter impurities from precipitation. This, combined with minimal human inhabitance in the area, means that Alps water, carefully managed to reduce human impact, is of the highest quality.

Dartmouth Reservoir captures flows from Alps sourced streams.

WATER CATCHMENT

The process of precipitation transport in an alpine environment. Snow and ice store large volumes of precipitation over the winter months. Rain and snowmelt is held in alpine soils and vegetation, particularly in bog communities, and released slowly into creeks and rivers.



WATER HARVESTING IN THE ALPS

Engineers soon recognised the water supply qualities of the Alps. If harvested, this water could alleviate some of the problems associated with Australia's frequent and unrelenting droughts by boosting domestic and stock supplies and providing irrigation water for the dry, lowland plains. In addition, this water could be used to power turbines in the production of hydro-electricity, reducing dependence on coal.

Harvesting for domestic, stock and irrigation use

The first significant steps towards harvesting Alps water for domestic, stock and irrigation use began in 1917 when the River Murray Commission (now the Murray-Darling Basin Commission) was formed. It included Commissioners from NSW, SA, Victoria and the ACT and its role was to cooperatively manage the development of the waters of the Murray Basin.

Their first major progress toward harvesting Alps water was to construct the Hume Reservoir (near Albury) in 1936. Its purpose was to store outflow from the headwaters of the Murray for domestic, stock and irrigation use in Victoria, SA and NSW. Building on this capacity, the Dartmouth Reservoir, which captures flows from Alps-sourced streams including the Mitta Mitta River, was built between 1978 and 1981. Precipitation entering Dartmouth eventually ends up in the Hume Reservoir and together their storage capacity is around 6.8 million megalitres.

Capturing water in reservoirs allows for flow to be regulated to coincide with the demands of downstream users. It doesn't, however, increase the overall supply of water.

Major developments towards increasing supply eventuated in 1946 when a joint Commonwealth, Victorian and NSW agreement was reached to examine the potential for diverting the east-flowing Snowy River and its main tributary, the Eucumbene, inland. The aim was to use this water to irrigate the plains west of the Great Divide and to produce hydro-electricity.

WATER CATCHMENT

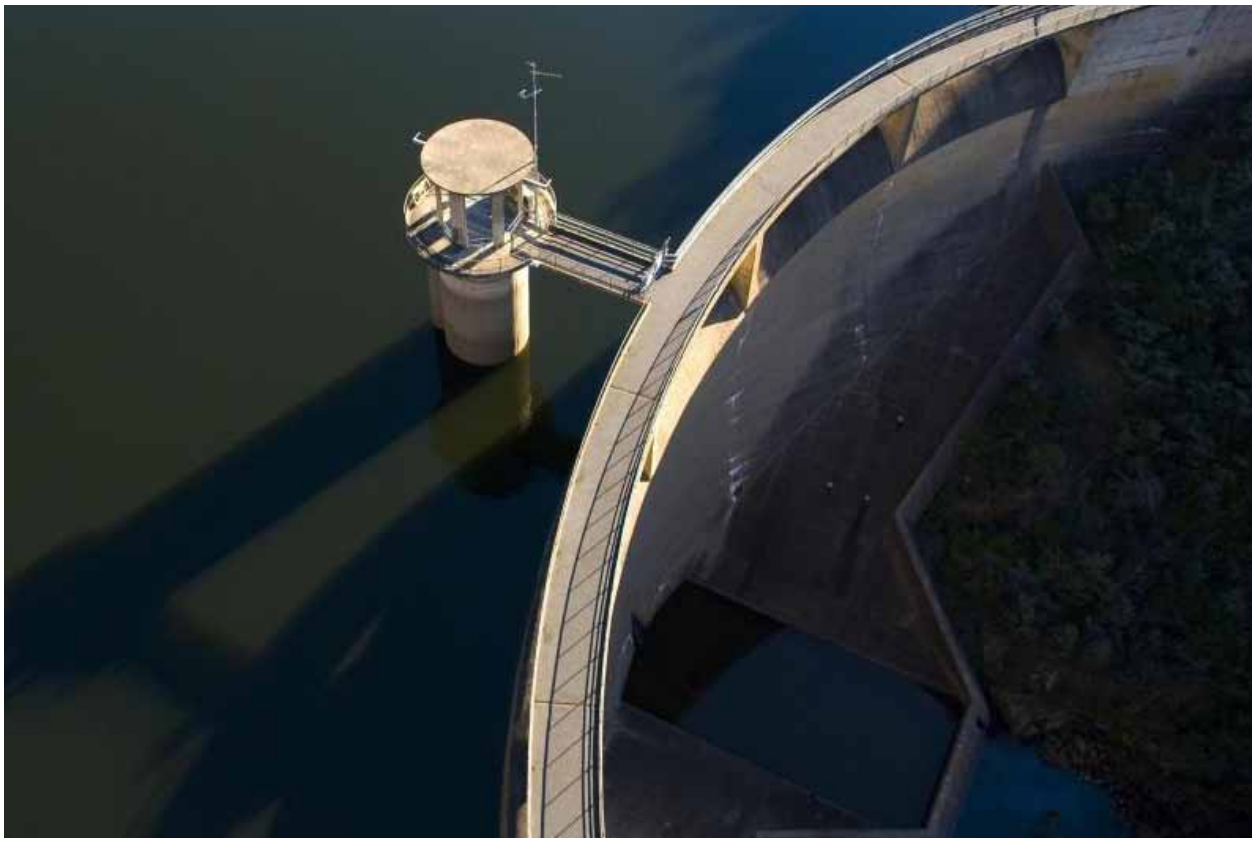
The Snowy Mountains Hydro-electric Authority Act was created in 1949. The Act decreed that the Authority would be empowered 'to construct, maintain, operate, protect, manage and control works for the collection, diversion and storage of water in the Snowy Mountains area, and for generating and transmitting electricity'.

In 1974, the Snowy Mountains Scheme was completed. Its infrastructure is responsible for collecting, storing and diverting the upper reaches of the Murray and Murrumbidgee Rivers and until recently 99 percent of the flow of the Snowy River. Water from the Snowy River is diverted into the Murrumbidgee via the Tumut River or into the Murray via the Geehi River. Through an environmental release, which is now up to 21 percent of the original flows, water is released down the Snowy River from Jindabyne Dam.

Water diverted from the Alps is a part of the survival of many downstream communities and underpins economic production. For example, the Murray- Darling Basin contains about 70 percent of Australia's irrigated crops and pastures and accounts for approximately 40 percent of the total value of Australia's agriculture.

Canberra's main water supply also comes from the Australian Alps through the Cotter catchment. The mountainous catchments in the south-western part of what is today Namadgi National Park were specifically included in the ACT for the purpose of providing the federal capital with domestic water. Management of the Cotter catchment for urban water supply has resulted in three major reservoirs and associated facilities that provide domestic water for Canberra and Queanbeyan.

Bendora Dam.



WATER CATCHMENT

HYDRO-ELECTRICITY

In the early 1900s, it was realised thatwater from the Alps could also be used forgenerating electricity. At the time, power requirements were modest and electricity was already being generated from coal deposits in NSW and Victoria. However planners foresaw a need for extra power from a hydro-electricity scheme that would provide security to electricity supply.

Victoria: the Kiewa Scheme

The first proposal to harvest Alps water for the generation of electricity was in 1911 when the Victorian Hydro-electric Company proposed to harness the energy from water draining off the Bogong High Plains. The development of the Yallourn brown coal power station took precedence, however, and it was not until 1938 that the State Electricity Commission of Victoria began work on the Kiewa Hydro-electric Scheme. The town of Mt Beauty was established to support the scheme, and the current Kiewa Highway was developed to link it with the railhead at Wodonga. Due to lack of funding, it was 1961 before a scaled-down version of the original project was completed.

Snowy River National Park.

NSW: the Snowy Mountains Scheme

Despite the Kiewa Hydro-electric Scheme being Australia's first, it is the Snowy Mountains Scheme that is the most recognised, for three main reasons:

- its contribution to inland water;
- its engineering magnitude and genius
- its contribution towards national pride and our cultural diversity.

Construction of the Snowy Mountains Hydro Scheme began in 1949 following the enactment of the Snowy Mountains Hydro-electric Authority Act, and the project was completed 25 years later. The Snowy Mountains Scheme is considered one of the most complex, multi-purpose, multi-reservoir hydro- electric power schemes in the world and even before completion was named as one of the civil engineering wonders of the modern world.

WATER CATCHMENT

The Snowy Mountains Scheme, now operated and maintained by Snowy Hydro Limited, consists of seven power stations (two underground), sixteen major dams, a pumping station, 80 kilometres of aqueducts and 145 kilometres of inter-connected trans-mountain tunnels in addition to the many hundreds of kilometres of roads that have been built to accommodate the building, maintenance and operation of the Snowy Mountains Scheme.

Sir William Hudson was the first commissioner of the Snowy Mountains Hydro-electric Authority

The Snowy Mountains Scheme collects and stores the waters of the normally east flowing Snowy River and its tributaries and diverts it through trans- mountain tunnels and power stations to the Murray and Murrumbidgee Rivers for irrigation. In doing so it harvests the potential energy of Alps water to produce electricity.

The Scheme's turbines have a total electricity generating capacity of 3,756 megawatts (MW), approximately 11 percent of south-east Australia's total electricity producing capacity. Annually it produces on average 4,500 gigawatt-hours of clean, renewable energy, 70 percent of all renewable energy available to the eastern mainland grid of Australia. In addition, the Scheme provides fast response, not possible in conventional thermal power stations, to changing loads in peak demand in Melbourne, Sydney, Brisbane, Canberra and Adelaide (Snowy Hydro Limited 2004; Gale 1999).

The achievement of such a major engineering feat provided a significant contribution to the national pride of a young nation. Like any major project, it was subject to controversy and debate, but it was so vast in conception and execution that it impressed itself on the national consciousness as no other engineering project has done since.

National pride.
Former Snowy Mountain Authority draftsman, Bruce Bashford, recalls...

I was coming back from Queensland, and I thought, 'We'll take some of these beaut watermelons and pineapples and stuff back.' So we went to this roadside stall, and we bought some. And we said, 'Gee this is cheap, isn't it?' And the guy said, 'Oh, you're from down south are you?' The whole bill came to about four quid, and he said, down south? Oh well - make it three quid.' Anyway he says, 'Whereabouts down south?' We says, 'Cooma.' 'Oh you'd never see fruit like this - make it two quid. What are you doing down there?' And we said, 'We're working on the Snowy Mountains Scheme.' And he goes, 'Here - just take the lot!' That was the feeling. I think that in a way typifies the way Australia looked at it.
Source: McHugh, S. (1989) The People behind the Power, p. 266- 267

POWER, DIVERSION & IRRIGATION
The Snowy Mountains Hydro Electric Scheme involved diverting the headwaters of the Snowy, Eucumbene and the Murrumbidgee Rivers westward through the Australian Alps. This provided water to the inland and created the Murray and Murrumbidgee Irrigation Areas. As part of the plan the water would drop steeply, approximately 800 metres, through power stations, creating power for mainland eastern Australia, from Queensland in the north, including Sydney and Canberra, to Melbourne and Adelaide in the south. There are also 100s of kilometres of power transmission lines connecting the Snowy Mountains Scheme power stations to the main areas of NSW, Victoria and the ACT.
Source: Australian Tourism Website

WATER CATCHMENT

SHAPING AUSTRALIA'S CULTURAL IDENTITY

The Snowy Mountains Scheme can also be seen as one of the origins of Australia's multicultural society. In the building of the Scheme, some two-thirds of the Authority's over 100,000 strong workforce came from over 30 countries.

This unique influx of people living and working in the area brought great cultural and social changes to the Alps. Many temporary settlements sprang up around the mountains, only lasting for the life of the project. Some remained, contributing to the growth of settlement within the Alps.

In the old days, if you wanted to go out somewhere for dinner in Cooma, you had a choice of three or four cafés and a hotel, and the menu might read Steak 'n Eggs, Chop 'n Eggs, or a Mixed Grill. Now you can get a Chinese, a Lebanese, a German - you name it and there's someone there to cook it for you, which is tremendous! There's a lot more culture, a lot more learning... the schools had to improve, and I guess so have the roads, which is a minor spin-off... but we've broadened our thinking, and our appreciation of different cultures.

Source: McHugh, S. (1989) The People behind the Power, p. 257

1. Tantangara Dam. Water from the upper Murrumbidgee River is collected here and diverted to Lake Eucumbene through a pressure tunnel. The water at the bottom of the dam overflows into the Murrumbidgee River.

2. English was taught to migrant workers in Cooma, 1951.

3. Constructing the Snowy Mountains Scheme: Blasting a tunnel 1955.

WATER CATCHMENT

ENVIRONMENTAL IMPACTS AND THREATS

The impacts of water harvesting

Despite the positive impacts of the Snowy Mountains Scheme, economically and socially, the modification of the natural flow of Alps water has had significant environmental impacts, including physical infrastructure, earthworks, aqueducts, roads and introduced weed species.

This is mainly due to the alteration of the natural timing and quantity of water flowing out of the Alps. For example, some rivers, such as the Snowy, no longer receive a substantial increase in flow during the spring. Others may receive an increase in the summer months when previously their flow was minimal. These effects are pronounced in the many small headwater creeks that are diverted by hydro aqueduct systems.

The environments of the upper Snowy, upper Murrumbidgee, Geehi, Swampy Plain, Tumut, Murray, Tooma and Eucumbene Rivers have all been significantly modified as a result of such changed flow regimes. Regulating the flow has a series of effects, among them:

- increasing the incidence of river bank destabilisation and erosion where flows are increased;
- reducing river bed size below dams where reduced flow increases the build up of silt and encroachment of vegetation;
- loss of and changes to the number and type of insect and fish species due to changes in habitat associated with large releases of cold water from reservoirs. Such releases differ from the warmer, shallower streamflows experienced prior to the Scheme;
- declining fish populations due to the interruption of migration patterns by dams and other infrastructure;
- an increase in salt levels in river systems where the salt flushing and dilution effect of flow has been decreased. This occurs due to farming practices and deforestation;
- dilution of salt levels where flows are increased; and
- reduced replenishment of groundwater supplies in environments where flows are reduced.

Managing former Scheme sites

In 2002 the Snowy Mountains authority was corporatised. As a part of the corporatisation process, $32 million dollars was provided by the Snowy Mountains Hydro-Electric Authority (which became Snowy Hydro Limited) to rehabilitate around 400 sites within Kosciuszko National Park which were disturbed during the construction of the Snowy Scheme. These sites include townships, camps, construction sites, quarries, landfills, roads, transmission lines and weather & river height gauging stations. Rehabilitation is a slow and difficult process given the weather extremes, infertile soils, but also the nature of many of the sites. There is no ‘one size fits all’ approach to stabilizing and rehabilitating each former site. The scale is similar to sites and issues faced in the open-cut mining industry. As a consequence, the program is being planned and implemented over a 15 to 20 year period. Typically rehabilitation involves landshaping and revegetation with native species.

Protective action

Today most of the alpine catchments are reserved in parks and are managed for the protection of the natural and cultural features including water catchment. Management plans for these parks recognise the importance of the inter-relationship between soils, vegetation and water in undertaking efforts to protect the quality and supply of Alps water.

WATER CATCHMENT

In 1994 the Council of Australian Governments began a process to address issues of environmental degradation associated with changed flow regimes while considering social and economic factors. One action that has arisen from this process has been the agreement between the NSW, Victoria and Commonwealth Governments in 2000 to return 21 percent of natural flows to the Snowy River over the decade. This process represents the growing awareness of environmental issues and a continual commitment to the protection of water quality and supply including that sourced in the Alps.

The Eucumbene River has been significantly modified by changed flow regimes due to the Snowy Mountains Scheme.

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GLOSSARY

Alpine: elevation above the treeline with mean midsummer temperatures below 10ºC and very high precipitation. Alpine zone landforms include rolling summits, exposed ridgelines and rocky outcrops. Vegetation includes herbfields, grasslands, bogs and fens.

Catchment: an area that drains all precipitation that falls on it (with the exception of evapotranspiration and groundwater losses) into one stream. Catchments are drainage basins bounded by divides, such as mountains ranges.

Evapotranspiration: water vapour returned to the atmosphere, either by direct evaporation or by transpiration from plants.

Precipitation: When cloud particles become too heavy to remain suspended in the air, they fall to the earth as precipitation. Precipitation occurs in a variety of forms including hail, rain, freezing rain, sleet or snow.

Transpiration: the evaporation of water through stomata of plant leaves and stems.

Salinity: the accumulation of salts in groundwater, soil and soil water associated with a loss of vegetation (dryland) or irrigation practices (wetland).

Subalpine: treeline and immediately below with a mean midsummer temperature above 10ºC, very high precipitation and snow persisting for one month or more. Landforms include undulated plateaus, shallow basins and rolling hills. Vegetation includes subalpine woodlands, mostly scattered Snow Gum with herbfield, grassland or heathland understorey.