Expert Panel Assessment

Snowy Precipitation Enhancement Trial (SPET)

Executive Summary

In Summary…

Snowy Hydro Ltd proposes to undertake a six year cloud seeding trial in the Snowy Mountains region of New South Wales. The proposal is referred to as the Snowy Precipitation Enhancement Trial (SPET).

The goal of the SPET is to increase snowfall in targeted areas. This increase will help to:

- address the significant adverse effects of climate change on the alpine region of New South Wales;
- offset the continuing decline in the Snowy Mountains' snow pack;
- ensure the protection of alpine and sub-alpine habitats;
- maintain security of water flows in the Murray and potentially Murrumbidgee catchments for both environmental and extractive use; and
- support the generation activities and hedge products demanded of Snowy Hydro Limited by the National Electricity Market.

The SPET will implement a state of the art winter cloud seeding program, providing a sound scientific basis for optimising the increase in snowfall in the alpine area.

An independent Expert Panel was assembled to assess and report on the potential environmental impacts of the SPET.

The Expert Panel agrees that the SPET is unlikely to have a significant adverse impact on the environment and would not be likely to significantly affect the environment.

1 Executive Summary

1.1 Introduction

1.1.1 Why is Snowy Hydro proposing the SPET?

In the Snowy Mountains region of New South Wales, small increases have occurred in both maximum and minimum winter temperatures since 1962. This has resulted in a decline in maximum snow depths and in mid-late season snow depths. There has also been a decrease in the number of snow days recorded in the region since 1970.

The scientific community believes that these are indicators of long term climate change. If left unchecked, this climate change will have significant adverse implications for the alpine region and water availability to the Murray River system.

In addition, south-eastern Australia is currently in an extended period of drought, and dry conditions could very well persist for some time to come. The demand for additional, clean, and sustainable water is with us right now.

Cloud seeding is a modern water management tool. Through the SPET, Snowy Hydro proposes to apply cloud seeding technology to ameliorate some of these climate change and ongoing drought related issues. In particular, snow dependent species such as the endangered Mountain Pygmy Possum and Corroboree Frog are likely to benefit from a more reliable snow cover. The SPET proposal should be viewed as an opportunity for local mitigation of global climate change.

1.1.2 Weather Modification – a sustainable way to increase the resource base

Winter cloud seeding experiments and operational projects designed to increase seasonal snow pack storage and subsequent runoff have been conducted throughout the world since the early 1950's.

Cloud seeding offers the potential to increase the resource base by increasing water supplies when needed. This avoids the need for large capital investments in additional water storage facilities. It is one of the most cost-effective, nonstructural tools available to water managers.

1.1.3 The Proposal

The six year cloud seeding trial proposed by Snowy Hydro in the Snowy Mountains region of New South Wales is described in detail in the following Expert Panel Report 2003.

The SPET will increase snowfall by seeding winter storms to enhance late spring and summer runoff from the Snowy Mountains. The SPET will deliver real benefits to a wide range of stakeholders.

This document provides an overview of the SPET. The specific objectives of the SPET are:

- To confirm the technical feasibility of enhancing snowfall in the Snowy Mountains region in the long term.
- To establish a state-of-the-art winter cloud seeding program using modern methods and tools to increase precipitation on the higher elevations of the Snowy Mountains;
- To enable an assessment of the SPET and identify the conditions best suited to effectively apply cloud seeding technology to the Snowy Mountains region in the long term; and
- To monitor the effects of the SPET on the environment within an adaptive management framework. This is to ensure that the activities of the SPET remain within prescribed limits.

1.2 SPET Overview

As the predominantly westerly continental winter cloud systems are forced to rise as they pass over the Snowy Mountains, changes occur within the clouds causing water vapour to condense into larger water droplets that can exist in the pure state below freezing (0°C). Precipitation from these clouds can result when impurities in the form of ice particles collide with these droplets, causing them to freeze and grow into numerous further ice particles. Snow occurs when there are sufficient ice particles to initiate the ice nucleation process, and the ice or snow crystals grow large enough to fall to the ground.

Winter cloud systems approaching the Snowy Mountains contain sufficient supercooled (below freezing) water droplets, that either form precipitation naturally because they are cold and there are sufficient ice nuclei available, or pass over the Snowy Mountains where they evaporate or pass out to sea, because the natural precipitation processes are inefficient.

Cloud seeding involves adding artificial ice nucleating particles into clouds containing sufficient below freezing water droplets to initiate the ice nucleation process. Dry ice pellets, some bacteria, liquid propane and silver iodide have been used in other cloud seeding programs to act as artificial ice nucleating particles.

The SPET will target the alpine area above 1400 m elevation of Kosciuszko National Park (KNP), south of the Jagungal Wilderness Area (approximately

1000 km^2). Originally, the proposal was to seed all of the alpine area above 1400 m (approximately 2000 km^2), resulting in an average annual increase in runoff from the increased snowfall of some 150 GL, with benefits to both the Murray and Murrumbidgee river systems. To meet objections from the New South Wales, National Parks and Wildlife Service, the target area for this SPET has been halved to exclude the Jagungal Wilderness area, resulting in a predicted annual average increase in water yield, for only the Murray River system of 70 GL.

The SPET will involve the use of modern cloud seeding tools and techniques to demonstrate the physical "chain of events" that occur when winter clouds are seeded and result in additional snow precipitation on the ground. These tools will include remote sensing platforms, weather balloons, computer models and dual ground based generators to distribute the seeding agent silver iodide and a tracer, indium sesquioxide, in trace concentrations into the predominantly westerly cloud systems that pass over the Snowy Mountains.

Enhanced precipitation resulting from the SPET will only fall as snow. The SPET design conditions are aimed at enhancing snowfall above 1400 m, and only winter storms that satisfy prescribed operational criteria will be seeded, so that the potential for erosive rainfall is eliminated.

The expected average annual increase in snowfall will be approximately 10%, and will always be within the range of existing natural variability.

1.2.1 Benefits to the Murray and Murrumbidgee Catchments

Given the current arrangements that prescribe the catchment based sharing of inflows between the two developments of the Snowy Mountains Hydro-electric Scheme (the Scheme), all of the additional inflows resulting from the SPET must be released by Snowy Hydro into the River Murray catchment. This Expert Panel report does not therefore address the potential benefits from additional releases into the Murrumbidgee River catchment. However, if Governments are willing to consider a temporary variation to these catchment based sharing arrangements for inflows, Snowy Hydro could also deliver some of the additional inflows to the Murrumbidgee River catchment.

1.3 Expert Panel

A panel of independent experts with appropriate and widely recognised local, scientific and technical expertise was assembled to undertake an assessment of the potential impact of the SPET on the environment.

Expert Panel members, based on their opinions, professional experience and review of available literature, and utilising a conceptual ecosystem model, conducted a systematic assessment of the proposed SPET. This report is the

outcome of the Expert Panel assessment. A summary of the findings of the Expert Panel follows.

1.4 Ecologically Sustainable Development

The proposed SPET has the primary purpose of achieving greater certainty in relation to the efficacy of, and potential impacts from, undertaking cloud seeding in the Snowy Mountains.

The Expert Panel agrees that there is unlikely to be a significant adverse impact on the environment from the SPET.

The panel also recognises that there is a need to undertake cloud seeding with a precautionary approach given the ecological significance of the KNP.

Accordingly, an adaptive management framework is recommended. Adaptive management incorporates monitoring and feedback mechanisms, and a framework for monitoring has been recommended to satisfy the complex needs of this project. The detail of the monitoring program will be developed in consultation with key stakeholders, prior to implementation of the SPET. The monitoring program will include a statistical design to evaluate the results of seeding in relation to precipitation changes both on and off target areas.

The nature of the SPET is, in effect, a direct positive response to address the precautionary principle.

The adaptively managed ecosystem approach proposed by the Expert Panel provides the appropriate risk based response that is required to address precautionary principle concerns, inter-generational equity, and biological diversity and ecological integrity issues.

1.5 Downwind Effects

A common misconception regarding cloud seeding is to consider the atmosphere a static pool of water passing over the earth. With this idea, it is easy to argue that because the supply is limited and we remove an amount falling in one area by cloud seeding, then there must be less available to fall in another downwind location because some of this fixed supply of water was removed from an upwind location. The atmosphere is a dynamic system and does not behave in this simplistic manner.

All of the available scientific evidence suggests that there will actually be positive increases in precipitation in the downwind areas. This is because the ice crystals formed by the seeding process survive longer and have a better chance of falling to the surface on the downwind side of the crestline than the natural cloud droplets, which evaporate sooner and never grow to precipitable sizes.

1.6 Alpine Ecology

There are unlikely to be any adverse long term ecological impacts that emerge from the SPET, because the design parameters for the SPET are framed within the current variability of the alpine ecosystem dynamics.

Cloud seeding is expected to deliver a more reliable and persistent snow cover, with potential long term beneficial impacts to the KNP alpine ecosystems.

The amount of snowfall enhancement is not expected to be more than 10% of the long term average, which is well within the inter-annual variability of 300%. Similarly, the amounts of silver iodide and indium sesquioxide introduced in the ice nucleating process are likely to be well within the range of natural occurrences of these elements, and below levels of ecotoxicological significance to biota.

1.7 Ecotoxicology

The expected environmental impact of silver iodide and indium sesquioxide can be summarised as being negligibly small, primarily because these compounds will be used in trace quantities, are not water soluble, and will not be readily bioavailable.

The bioavailability of silver ions arising from silver iodide in both soil and water is sufficiently ameliorated by the presence of dissolved organic carbon, chloride ions, carbonate ions and sulfidic materials, to be below toxic effects thresholds. In addition, silver ions are strongly adsorbed onto particulate matter in water. Findings from recent studies point to the fact that silver ion concentrations in natural waters are negligibly small. Studies have shown that most of these ameliorating factors exist in the KNP and, as a result, the bioavailability of silver is not expected to rise significantly above current background levels.

Indium sesquioxide is not water soluble, is therefore not likely to bioaccumulate, and does not represent an environmental hazard. In general terms the SPET not contribute significant amounts of indium to soil, water or snow, and indium levels are not expected to be detected at levels significantly above the current background.

1.8 Public Health

Cloud seeding will only be carried out during winter storms, and at locations where people are unlikely to be present. In any event, expert opinion is that risks to humans, whether occupationally or recreationally exposed, can be considered to be of negligible consequence.

1.9 Stream Hydrology and Fluvial Geomorphology

The hydrological and fluvial geomorphological impacts during the six year SPET will depend more on the natural variability in hydrological conditions that prevail during that period, than the impact of additional flows that would result from the SPET. Wet years and dry years produce very different hydrological patterns in the rivers, and there is a high degree of confidence that natural variation will override any variation due to extra runoff from cloud seeding.

1.10 Water Quality

Water quality in stream drainages of the KNP or the Murray River, is unlikely to be significantly altered by the SPET. Changes in overall flow regimes will be minor, and set within a context of high variability. Water quality is therefore unlikely to change as a result of increased flows or changes to the flow regime.

1.11 Conclusions

The conclusion from each of the assessments by the Expert Panel members is that the SPET will:

- not have a significant adverse impact on the environment, and would not be likely to significantly affect the environment;
- not have a negative impact on precipitation in areas downwind of the target area. The likely impact is in fact a small increase in precipitation in those areas;
- not impact on the conservation values of the KNP;
- be in accordance with ESD principles including the precautionary principle;
- have no adverse consequences on the outstanding scientific values of the KNP and the ability of the KNP to be listed on the World Heritage Register; and
- have the potential to act as a benchmark for future scientific investigations and environmental initiatives consistent with global climate change research initiatives.

The conclusion is dependent upon the SPET operating as planned, designed and constructed and an effective management and monitoring process in place to provide timely detection of any unintended ecological consequences or ecosystem effects.