Snowy Precipitation Enhancement Research Project

Questions and Answers:

What is Snowy Hydro proposing?

The proposal is to conduct a five year research project of winter cloud seeding to assess the feasibility of increasing snow precipitation in the Snowy Mountains. The method of cloud seeding to be used in the trial is silver iodide (as the seeding agent) and indium sesquioxide (as a tracer) dispensed from ground based aerosol generators. Trace chemistry and a statistical design will be used to evaluate the effectiveness of snow enhancement.

Previous detailed studies have shown that post frontal winter cloud systems passing over the Snowy Mountains have an abundance of supercooled liquid water (SLW) and water vapour suitable for the production of ice-phase precipitation (snow). When silver iodide particles seed these clouds they can nucleate new ice particle embryos, which grow naturally to form snowflakes. Hence, the objective of the cloud seeding is to create snow from post-frontal clouds that might otherwise dissipate.

The target area for the project is within the Kosciusko National Park (KNP) and includes alpine regions where snowfall precipitation is highest in winter. The target area, which excludes the Wilderness Areas, is part of the major catchment area of the Snowy Mountains Hydro-electric Scheme (the Scheme).

The expected average annual increase in snowpack as a result of the cloud seeding project is approximately 10%, resulting in an average annual increase in water yield of 70 GL.

The proposal is referred to as the Snowy Precipitation Enhancement Research Project (SPERP).

How does this proposal differ from earlier proposals?

The 1993 EIS and proposal for cloud seeding in the Snowy Mountains included a target area of over 2000km^2, extending over the Jagungal Wilderness area. The proposal expected to result in an increased water yield of 150 GL and provide benefits to both the Murray and Murrumbidgee River systems.

To address NPWS concerns about the possible impact of cloud seeding in a Wilderness Area, this area has been excised from the current project target area. This results in a reduction in the potential water yield from the original trial.

This current proposal also includes the use of the latest technology for monitoring clouds and measuring outcomes of the seeding program.

Why is Snowy Hydro proposing to trial cloud seeding?

The Intergovernmental Panel on Climate Change Third Assessment Report concluded that there is now strong evidence that human activity has brought about changes to

global climate. Furthermore, these trends will continue for the foreseeable future due to continued emissions of carbon dioxide and greenhouse gases from fossil fuels and other sources. A change in regional climate is likely to have an adverse impact on the operation of Snowy Hydro, and there is compelling evidence that climate change is already adversely affecting the alpine regions of mainland Australia.

In the NSW alpine area, 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 Snowy Mountain region since 1970.

It is clear that climate change and declining snow cover presents a very real threat to KNP. The SPERP proposal should be viewed as an opportunity for local mitigation of global climate change. 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.

Furthermore, cloud seeding will provide more water for electricity generation, thus offsetting increasing demand on carbon based electricity generation as well as providing additional water for release to the Murray River system.

What is the conclusion of the expert panel assessment?

The conclusion from each of the assessments by the Expert Panel members is that the Snowy Precipitation Enhancement Research Project would:

- not have a significant adverse impact on the environment, and would not be likely to significantly affect the environment;
- not impact on the conservation values of KNP;
- is in accordance with ESD principles including the precautionary principle;
- have no adverse consequences on the outstanding scientific values of 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 SPERP operating as planned, designed and constructed and having an effective management and monitoring process in place to provide timely detection of any unintended ecological consequences or ecosystem effects.

Why is a research project needed?

While there is a high level of confidence about the feasibility of cloud seeding and that there is no significant environmental impact, Snowy Hydro is taking a precautionary

approach to ensure that cloud seeding will provide beneficial outcomes and that the ecological values of the Kosciuszko National Park are maintained.

How does cloud seeding work?

Cloud seeding involves adding artificial ice nucleating particles into clouds containing sufficient below freezing water droplets to initiate the ice nucleation process. There is a range of different seeding agents that can be used depending on local conditions. These include dry ice pellets, some bacteria, liquid propane and silver iodide. For the SPERP, silver iodide is the best agent to be used for the local conditions.

What do we know about cloud seeding?

Cloud seeding technology is not new or untried, and has been used successfully in America for the last 50 years and in Tasmania for the last 40 years with water utilities continuing to use cloud seeding to augment water supply systems.

Scientists now have a significant body of experience to draw from and the SPERP experimental design has been developed by international cloud seeding experts drawing on the results of experiments undertaken in the US and in Australia.

Due to advanced techniques in radiometry, meteorology and new cloud seeding techniques, precipitation as snow rather than rain can be reliably predicted.

Proven techniques using tracing agents combined with advanced statistical techniques enable the evaluation and measurement of snow which is the direct result of cloud seeding.

Are there any known detrimental impacts from cloud seeding?

There are no known detrimental health or environmental effects from using cloud seeding technology any where in the world.

How will cloud seeding work in the Snowy Mountains?

As the predominantly westerly continental winter cloud systems are forced to rise as they pass over the Snowy Mountains, changes occur within the cloud causing water vapour to condense into larger water droplets that can exist in the pure state below freezing (0^oC). 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. Precipitation 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 below freezing water droplets, and either precipitate naturally because they are cold and have an abundance of ice particles, or pass over the mountains where they evaporate or pass out to sea, because the natural precipitation

processes are inefficient.

Cloud seeding during the SPERP will involve adding artificial ice nucleating particles into clouds containing sufficient below freezing water droplets to improve the efficiency of the ice nucleation process. Twelve automatically controlled ground-based generators will discharge the seeding agent into appropriate cloud systems.

What cloud seeding agents are being used?

Trace amounts of silver iodide will be used to seed the clouds. Trace amounts of indium sesquioxide will also be used as a monitoring tool to measure cloud seeding efficacy.

Will the cloud seeding agents harm the environment?

There is a high level of confidence that there will be no negative effects caused by the seeding agents. This is because the amount of silver iodide and indium sesquioxide being added to the environment would be in ultra-trace quantities over the very large target area. For this reason, we expect that the agents will be undetectable above background levels in the environment, and well below any thresholds for either acute or chronic toxic effects. In addition, the agents are not water soluble, and will not be readily bioavailable, which further reduces the likelihood of any adverse environmental impact, even in potential zones of accumulation.

Nonetheless, the SPERP includes a rigorous environmental monitoring program using some of the most precise analytical techniques to provide additional confidence that there will be no environmental harm.

What impacts will there be on the local ecology?

Expert panel members, based on their opinions, professional experience and review of available literature, and utilizing a conceptual ecosystem model, have conducted a systematic assessment of the proposed SPERP.

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

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

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

Will the extra snow pack created increase erosion when it melts?

There is a 300% seasonal variation in snow pack and the SPERP will operate within that seasonal variation. This means that there will never be more snow at any one time than there has been in past seasons. This also means that the hydrological and catchment impacts during the five year SPERP will depend more on the natural variability in hydrological conditions that prevail during that period.

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.

Will there be any impacts on water quality?

Water quality in stream drainages of the KNP or the Murray River is unlikely to be significantly altered by the SPERP. 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.

Will the trial impact on the Jagungal Wilderness Areas?

The trial will not include the Jugungal Wilderness areas, and will employee adaptive management techniques to ensure that there is no environmental impact. The impact of excluding this area from the trial has been to effectively halve the potential water yield that could have resulted from cloud seeding.

Will the trial present a risk to public health?

Due to the trace quantities of seeding agents expert opinion is that risks to humans, whether occupationally or recreationally exposed, can be considered to be of negligible consequence. Furthermore, cloud seeding will only be carried out during winter storms, targeting areas above 1400m – times and locations when people are not likely to be present.

Does cloud seeding in one area affect precipitation in another area?

In other words, does cloud seeding amount to “Robbing Peter to pay Paul?”

A common misconception regarding cloud seeding is to consider the atmosphere a static pool of cloud water passing over the earth, which is a limited steady state supply of water. With this conceptual model, it very easy to argue that because this supply is limited and we remove a percentage of the water in the form of precipitation from the atmosphere through cloud seeding in one area, there will be less available to fall at

other (downwind) locations because a larger fraction of this fixed supply of water was removed in another (upwind) location.

Fortunately, the atmosphere does not behave in this simplistic manner. Clouds are systems that continuously process moist air. They are created when tiny water droplets form when cooling rising air ascends.

Precipitation data from a number of cloud seeding projects in the USA have been examined in detail for evidence of extra area effects. There are no statistically significant indications of rainfall/snowfall decreases downwind from any long term cloud seeding projects.

In order to verify these past results in the Snowy Mountains, the SPERP will include studies to ensure that there are no out of target area affects from cloud seeding.

How will the SPERP provide better information about cloud seeding in the Snowy Mountains?

The design of the SPERP is based very strongly on the use of physical and chemical techniques for assessing the results of the snow enhancement project. The design includes a randomised treatment process in which two of every three storms would be seeded, leaving the other third unseeded.

New physical and chemical techniques have been developed which identify the seeded components of the snowfall, one of the challenges to be overcome in measuring cloud seeding efficacy. These techniques will be used in the SPERP as a primary assessment tool. In carrying out these physical and chemical evaluations, the objective is to establish and record the chain of events consistent with the predicted effects of seeding. These include changes in cloud super cooled liquid water content, of ice crystal distributions in the cloud systems passing across the target region, the structure and numbers of ice crystals per unit volume reaching the ground during seeded and non-seeded precipitation periods, and to detect and measure the concentrations of the seeding chemicals in the snowfall.

It is also necessary to measure the amounts of snowfall actually reaching the surface. The addition of the physical and chemical assessment tools then enables an assessment of the amounts of such snowfall that resulted from the seeding as distinct from that which is due to purely natural processes. Hence the design includes the traditional as well as the new physical and chemical techniques.

In the first year of the five year program , activities will involve the acquisition, installation and initial testing of the network of scientific instruments, radiotelemetry communications and the development of a Control Centre. First year efforts will also include testing of the instrumental network and determining targeting effectiveness of the seeding agent. Changes can be made if necessary.

The following four winter seasons are for conducting the cloud seeding using sub -micron particles of silver iodide and indium oxide. The seeding is randomised and managed by an independent organisation. Two thirds of the snow storms will be seeded, the other third not seeded. This allows for statistical analysis of the seeding results. The altitude of the freezing level will limit seeding operations. When it is above 1400 m or rainfall is

occurring at the 1400 m level, no seeding will occur. This will ensure that there is no adverse impact on the snow pack over ski resort areas.