



Cloud Seeding Program

2013 Operations Report

December 2014

snowyhydro
renewable energy

Introduction

Snowy Hydro Limited (Snowy Hydro) relies on precipitation falling over the catchments of the Snowy Mountains to supply water for the production of hydro-electricity. Cloud seeding over this area is used to enhance snowfall, ultimately leading to increased run-off and amount of water available to produce energy.

Cloud seeding operations undertaken by Snowy Hydro are authorised by the *Snowy Mountains Cloud Seeding Act 2004* (NSW) (SMCS Act).

The SMCS Act mandates that cloud seeding operations may only be carried out in accordance with an Environmental Management Plan (EMP) approved by the Minister administering the *Environmental Planning and Assessment Act 1979*, and the Minister administering Part 4 of the *National Parks and Wildlife Act 1974* (the 'relevant Ministers').

The Cloud Seeding Program EMP was formally approved by the relevant Ministers on 5 July 2013 following consultation with experts from the Office of Environment and Heritage (OEH), NSW Environment Protection Authority (EPA) and National Parks and Wildlife Service (NPWS).

The SMCS Act requires Snowy Hydro, by 31 March in each year, to report on cloud seeding operations during the previous year to the relevant Ministers and to the EPA. The report must include details of compliance with the EMP and details of research monitoring the impact of seeding agents on the environment.

The EPA is appointed to review each report on cloud seeding operations, and report the findings of the review and any resulting recommendations to the Board of the EPA and the relevant Ministers.

Snowy Hydro submitted the Cloud Seeding Program 2013 Annual Compliance Report (2013 Annual Compliance Report) to the relevant Ministers and the EPA in March 2014. The report demonstrated that Snowy Hydro has carried out cloud seeding operations in accordance with the SMCS Act and has complied with all obligations set out within the EMP. Importantly, it confirmed there continues to be no evidence of any significant adverse environmental impacts associated with cloud seeding activities.

The subsequent EPA review¹ published in November 2014 supported these findings.

The key points of the 2013 Annual Compliance Report are described fully in the following sections of this report:

- Operations, including the duration over which cloud seeding occurred and the total amount of cloud seeding agent released over the season;
- Meteorological monitoring, including controls to ensure precipitation falls as snow to at least 1400 metres during cloud seeding operations and assessment of downwind impacts; and

¹ Report on the Findings of the NSW Environment Protection Authority's Review of the Snowy Hydro Limited Cloud Seeding Program: 2013 Annual Compliance Report. Available from www.epa.nsw.gov.au/publications/140656SHLcloudseeding.htm.

- Environmental monitoring, including summary statistics of the monitoring program and details of research monitoring the impact of seeding agents on the environment.

Finally, the findings and recommendations of the EPA review are provided.

Operations

Target area

The SMCS Act states that the area primarily targeted for increased precipitation must be land within the Snowy water catchment.

An area of approximately 2110 km² was targeted during 2013 cloud seeding operations. Figure 1 shows both the target area and the Snowy water catchment boundaries.

Hours of operation

The SMCS Act stipulates that operations are only to be carried out when precipitation is likely to fall as snow to at least 1400 metres. Consequently, cloud seeding operations take place throughout the cool-season months, typically between May and September.

In 2013, the cloud seeding season commenced later than usual following approval of the EMP in July 2013. A total of 106 hours of cloud seeding occurred between 20 July and 22 August 2013.

Seeding agent and method of discharge

Silver iodide is the approved seeding agent. It is used as the ice nucleating material because it has similar physical properties to an ice crystal. It is also insoluble in water and non-bioavailable. In 2013, a total of 44.7 kg of silver iodide was dispersed over the 2110 km² target area.

Land-based aerosol generators are the approved method to disperse the seeding material. The seeding agent is released by up to 23 ground-based generators located along the western perimeter of the target area when suitable atmospheric conditions are present².

Operational incidents

There were no accidents or break downs resulting in spillage of cloud seeding agents, fuel, or failure of controls specified in the EMP.

² For explanation of how cloud seeding works and the atmospheric conditions required for cloud seeding operations, see www.snowyhydro.com.au/water/cloud-seeding.

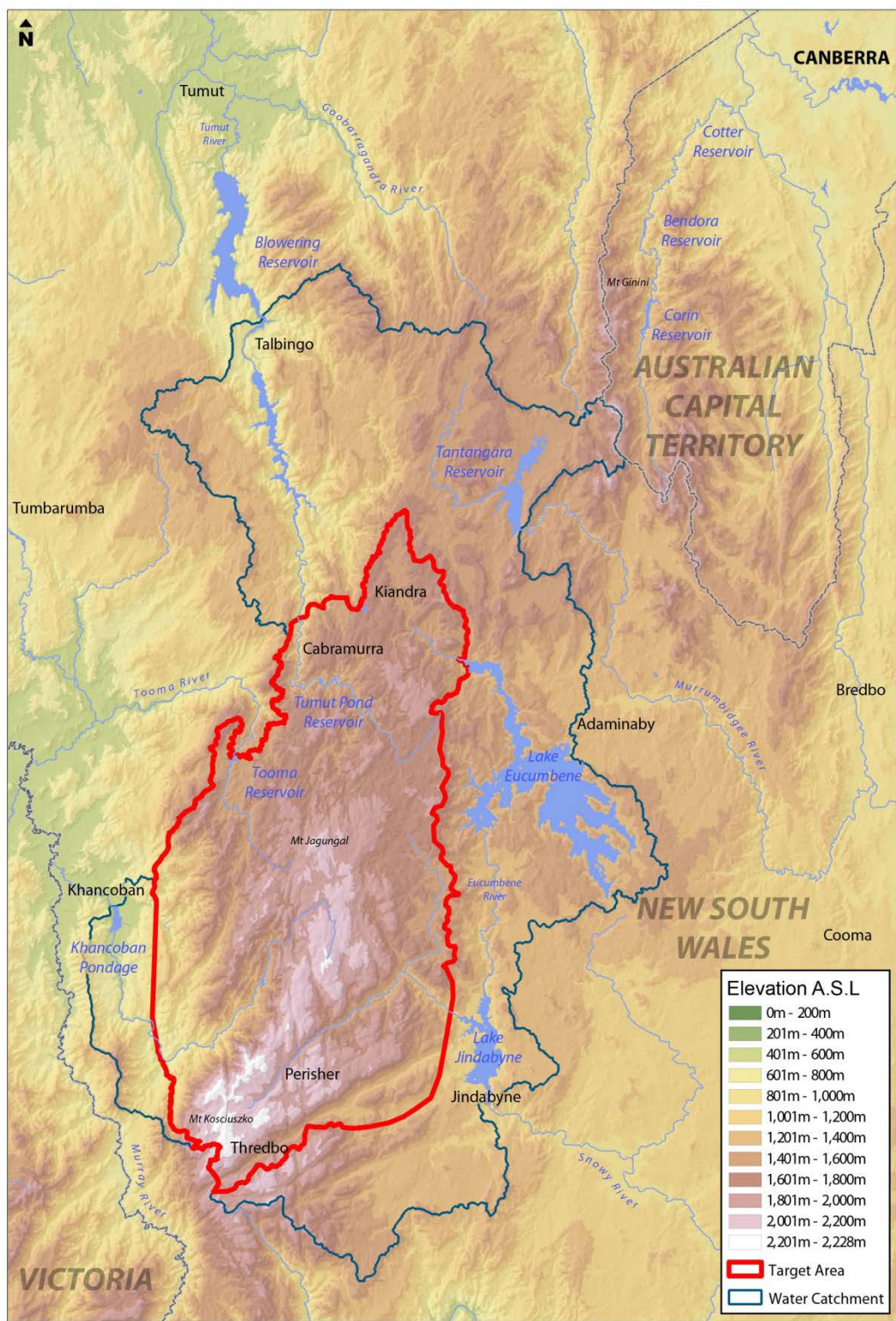


Figure 1: Map showing the Snowy water catchment (the area approved for cloud seeding) and the area which is primarily targeted for increased precipitation from cloud seeding operations (approximately 2110 km²)

Meteorological Monitoring

Snow level criterion

The SMCS Act mandates that the discharge of the seeding agent is to be carried out at a time when increased precipitation is likely to fall as snow to at least 1400 metres above sea level.

Weather balloons are released at three hourly intervals before and during cloud seeding operations to monitor atmospheric conditions. Cloud seeding does not commence, or is suspended, if the freezing level measured over the catchment is higher than 1600 metres. This is to ensure precipitation falls as snow to at least 1400 metres.

Additional controls are implemented if the freezing level is between 1550 and 1600 metres, including monitoring live camera feeds and verifying conditions with personnel within the target area.

During 2013:

- Cloud seeding operations did not commence when the freezing level over the catchment was greater than 1600 metres.
- There were no instances where the freezing level rose above 1600 metres during operations leading to the suspension or termination of operations.
- Freezing levels during operations were never observed to be between 1550-1600 metres necessitating additional controls.

Downwind impact

The cloud seeding program has been designed so that additional precipitation from cloud seeding falls over the target area. A component of the design is routine monitoring of precipitation to identify any possible effects of cloud seeding extending outside the target area.

Data from Bureau of Meteorology and Snowy Hydro weather stations provide the basis for comparison of the temporal and spatial variability of precipitation across the region during the winter months, both before and after cloud seeding operations commenced in 2004.

Analyses of precipitation amounts over 1990-2013 continue to show no evidence of an effect from cloud seeding on precipitation downwind of the target area. This supports results of previous, independent analyses by the Natural Resources Commission (NRC)³.

³ NRC Review of SPERP Annual Report 2011 (July 2012), available from www.nrc.nsw.gov.au/cloud-seeding.

Environmental Monitoring

Environmental chemistry

Snowy Hydro has monitored silver concentrations in a range of environmental matrices at potential accumulation zones within and around the target area since the commencement of cloud seeding over the Snowy Mountains in 2004.

The objectives of the monitoring program are to detect significant increases in the concentrations of silver compared with baseline concentrations, and to assess concentrations of silver compared with agreed guideline values of 0.1 mg/L for potable water and 1 mg/kg for all other matrices.

The EMP prescribes the number of sampling sites for each matrix and area, the replicates collected and analysed for each site and the sampling frequency. Once environmental samples are collected, they are sent to a laboratory for chemical analysis. The results are independently audited and analysed statistically.

Analyses of silver concentrations from samples collected prior to the commencement of cloud seeding in 2004 through 2013 continues to show no evidence that cloud seeding has contributed to increased levels of silver in any of the areas, or in any of the environmental matrices monitored.

The total number of samples analysed in 2013 along with summary statistics of silver concentrations is shown in Table 1 for potable water samples and Table 2 for 2013 soils, moss and sediment samples. All measurements are well below the relevant guideline values.

Table 1: Summary of silver concentrations in 2013 potable water samples (ng/L). The guideline value for silver in potable water is 100,000 ng/L

<i>Matrix</i>	<i>Number of samples</i>	<i>Minimum</i>	<i>Mean</i>	<i>Maximum</i>	<i>Guideline value</i>
Potable Water	36	0.1	0.7	5.2	100,000

Table 2: Summary of silver concentrations in 2013 soil, sediment and moss samples (mg/kg). The guideline value for silver in these matrices is 1 mg/kg

<i>Matrix</i>	<i>Number of samples</i>	<i>Minimum</i>	<i>Mean</i>	<i>Maximum</i>	<i>Guideline value</i>
Soil	210	0.01	0.07	0.45	1
Meadow Soil	40	0.02	0.04	0.08	1
Moss	48	0.002	0.01	0.04	1
Lake Sediment	23	0.01	0.04	0.08	1
River Sediment	50	0.01	0.03	0.12	1

Aquatic ecology

Macroinvertebrate fauna from 16 study sites within the target and a control area were sampled in accordance with the EMP by personnel from OEH with support from Snowy Hydro in November 2013.

Analyses showed that the aquatic macroinvertebrate fauna in the target area was not more impaired or different to that in the control area.

Environmental fate study

Researchers from The University of Queensland are investigating the environmental fate of silver in the Snowy water catchment deposited from the atmosphere.

Silver is naturally present in the atmosphere, soil and sediments of the Snowy Mountains. This originates from natural weathering of rocks and from dust sourced from metal-containing landscapes upwind of the Snowy Mountains. In addition, metals released hundreds of kilometres away from sources such as fossil fuel combustion and metal production are transported through the atmosphere and deposited in the Snowy Mountains. This process has occurred for at least the past 100 years.

The current study is investigating current emissions of silver from cloud seeding within this context. It will improve the understanding of whether silver released during cloud seeding operations is accumulating at accelerated rates in key features such as sediments deposited in glacial lakes and reservoirs.

A scientific paper, *"Attribution of sources to metal accumulation in an alpine tarn, the Snowy Mountains, Australia"*, presenting the initial findings of this study was published in October 2013 in the international peer-reviewed journal *Environmental Pollution* (Stromsoe et al., 2013⁴).

The researchers analysed 1800 years of metal accumulation in Club Lake from both natural sources such as rock weathering and from deposition of industrial pollutants from the atmosphere, to establish background rates for these processes. It was found that natural weathering and erosion processes in the catchment of the lake account for greater than 90% (92-97%) of accumulating metals. Despite more than 100 years of metal deposition from an atmosphere affected by background industrial activity, levels of these pollutants in the lake sediments were less elevated than might be expected.

It was concluded that metals deposited from the atmosphere to the lake are most likely diluted by soil washed in from the lake catchment. This process has diluted concentrations of background industrial metals in such key sediment accumulation zones and can also be expected to dilute the already low levels of silver derived from cloud seeding, deposited to the lake.

Results from the completed study will be reported to the relevant Ministers and the EPA in 2015. Research findings will be used by Snowy Hydro to inform the current environmental monitoring program.

⁴ Stromsoe, N., Callow, J.N., McGowan, H.A., Marx, S.K., 2013. Attribution of sources to metal accumulation in an alpine tarn, the Snowy Mountains, Australia. *Environmental Pollution* 181, 133-143.

EPA Review

Following submission of the 2013 Annual Compliance Report, the EPA published its review in November 2014. The EPA concluded:

- *“SHL has complied with all of its obligations as detailed in the Act*
- *SHL has complied with all of its obligations as detailed in the EMP for cloud seeding operations approved by the relevant Ministers on 5 July 2013*
- *management of the cloud seeding sites was found to be of a high standard and consistent with the site controls specified in the approved EMP*
- *environmental monitoring carried out during the 2013 cloud seeding season did not identify evidence of any significant adverse impacts on the environment from cloud seeding activities*
- *macro-invertebrate monitoring carried out during the 2013 cloud seeding season did not identify any evidence of any significant adverse impacts on the health of macroinvertebrates*
- *as a result of cloud seeding activities the 5-year interval between environmental monitoring programs prescribed in the approved EMP is appropriate and supported by the analysis of monitoring carried out during the 2013 cloud seeding season.”*

The recommendations were:

- *“the EPA conducts an on-ground audit of SHL’s cloud seeding operations during the 2014 season*
- *future reviews are also undertaken in consultation with input from partner agencies of the NPWS and OEH*
- *SHL continues to pursue research opportunities on the cloud seeding operations in the Snowy Mountains*
- *the outcomes of this review are communicated to the relevant Ministers.”*

Conclusion

The 2013 Annual Compliance Report detailing cloud seeding operations and activities through 2013 was submitted to the relevant Ministers and EPA in March 2014. The EPA reviewed the report and confirmed Snowy Hydro has complied with all obligations set out in the SMCS Act and detailed within the EMP through the reporting period. There continues to be no evidence of any significant adverse environmental impacts associated with cloud seeding activities.

For more information on Snowy Hydro’s Cloud Seeding Program please refer to our website, www.snowyhydro.com.au/water/cloud-seeding.