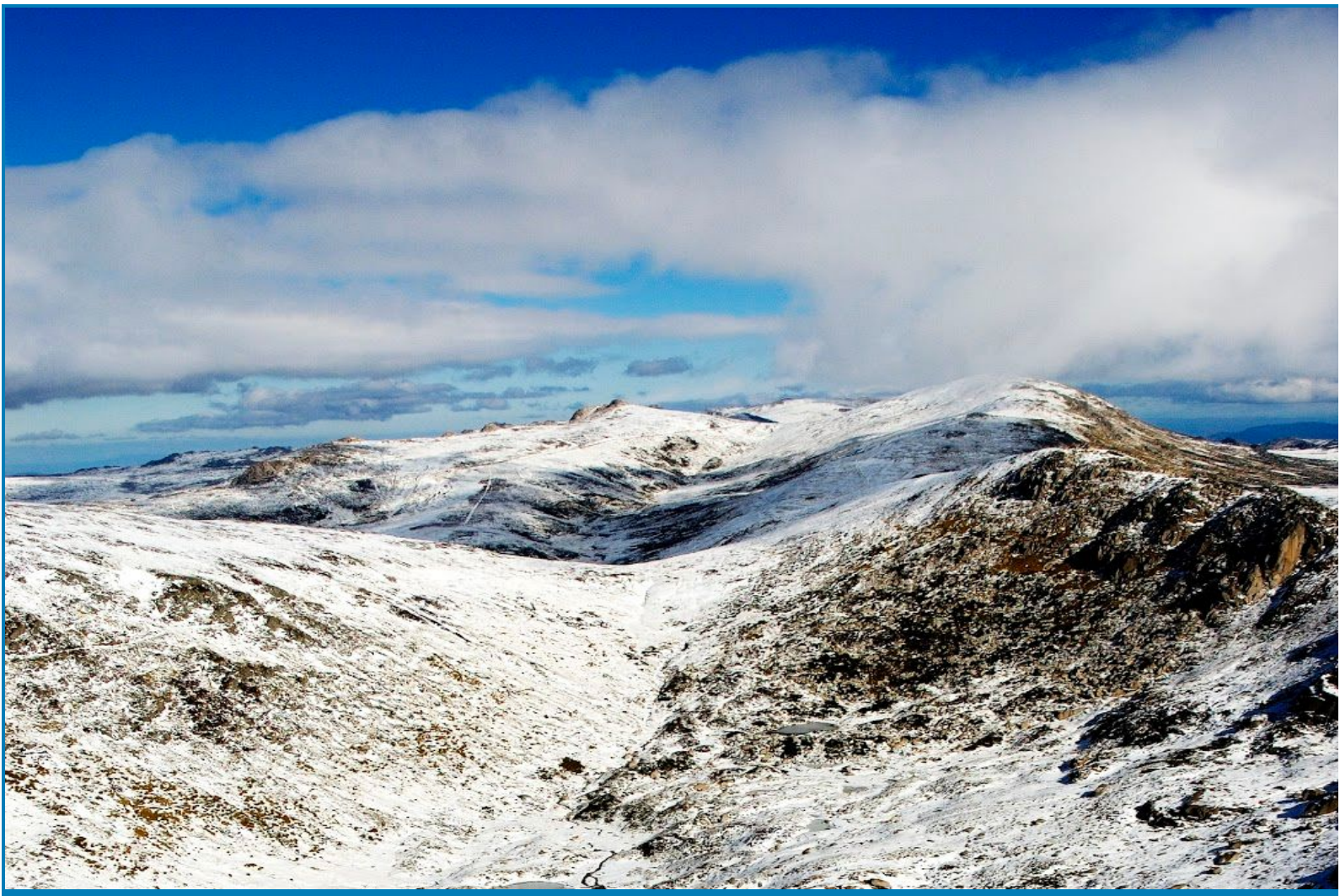
snowyhydro



Cloud Seeding Program

2018 Operations Report

October 2019

Introduction

Snowy Hydro Limited (Snowy Hydro) relies on precipitation falling over the catchments of the Snowy Mountains to supply water for the production of hydroelectricity. Cloud seeding over this area is used to enhance snowfall, ultimately leading to increased runoff and 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').

In accordance with the SMCS Act, the EMP must be reviewed at least once every five years. The previous EMP was approved in 2013; consequently, the Environment Protection Authority (EPA) coordinated a five-yearly review in 2018 in consultation with Snowy Hydro, the Office of Environment and Heritage (OEH), and a range of stakeholders. The current Cloud Seeding Program EMP was formally approved by the relevant Ministers on 28 June 2018.

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 2018 Annual Compliance Report to the relevant Ministers and the EPA in March 2019. The report demonstrated that Snowy Hydro has complied with all obligations set out within the EMP and responsibly carried out cloud seeding operations in accordance with the SMCS Act. Importantly, the 2018 Annual Compliance Report confirmed there continues to be no evidence of any significant adverse environmental impacts associated with cloud seeding activities.

The subsequent EPA review[1] published in August 2019 supported these findings.

The key points of the 2018 Annual Compliance Report that 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: 2018 Annual Compliance Report. Available from https://www.epa.nsw.gov.au/legislation/snowy-hydro-cloud-seed.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 land within the Snowy water catchment.

An area of approximately 2110 km^2 was targeted during 2018 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 2018, a total of 118 hours and 1 minute of cloud seeding occurred between 11 May 2018 and 21 August 2018.

Seeding agent and method of discharge

Silver iodide is the approved seeding agent. Silver is naturally present in the atmosphere, soil and sediments of the Snowy Mountains. Silver iodide is used as the ice nucleating material because it has similar physical properties to an ice crystal. It is also insoluble in water and does not become biologically available in the environment. In 2018, approximately 46.2kg of silver iodide was dispersed over the 2110 km^2 target area (~0.00000002 kg/m^2) .

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 present[2].

Operational incidents

There were no accidents or breakdowns 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 http://www.snowyhydro.com.au/our-energy/cloud-seeding

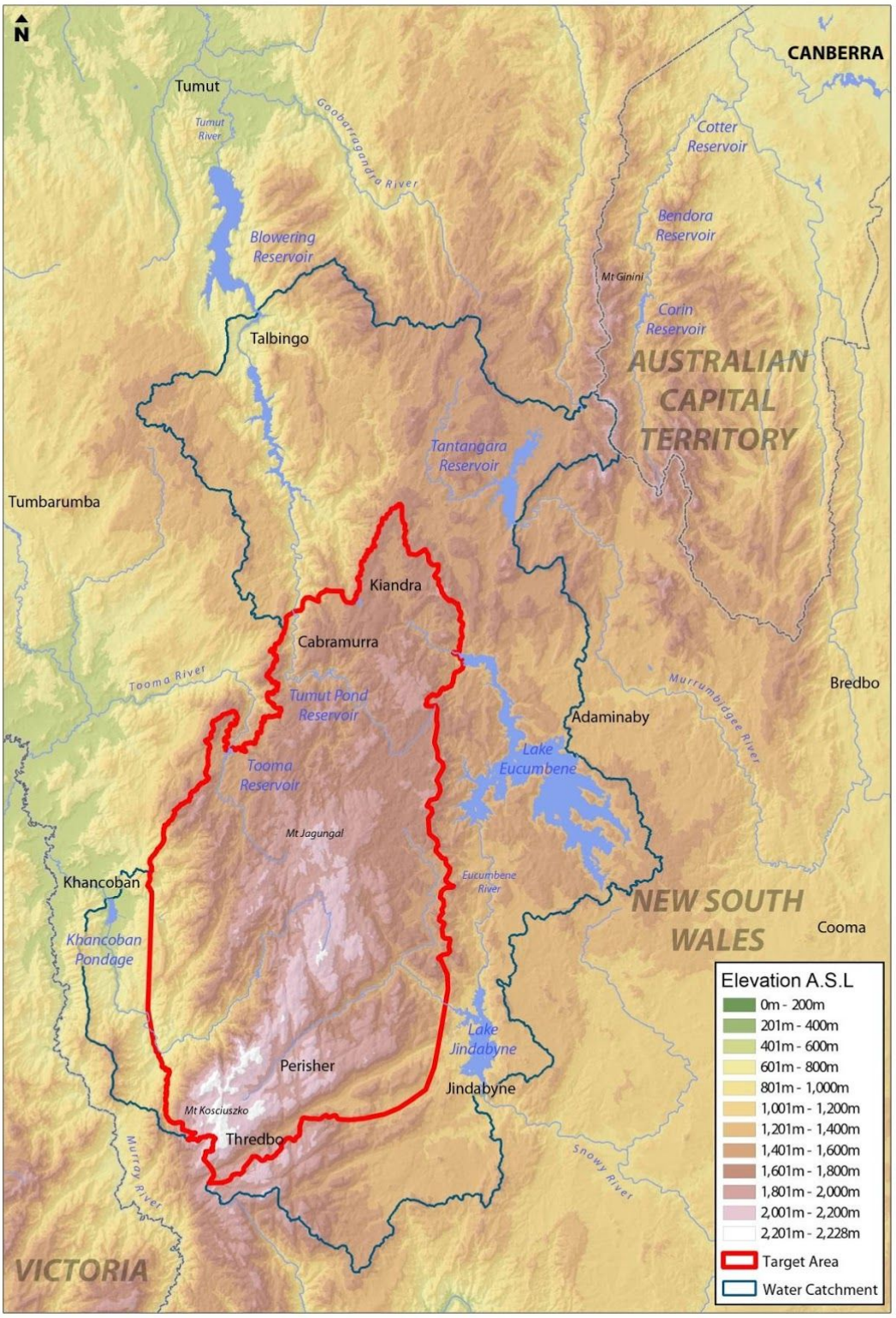


Figure 1: Map showing the Snowy water catchment (the area approved for cloud seeding) and the area which is primarily targeted for increased precipitation from cloud seeding operations (approximately 2110 km^2)

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.

Prior to and during cloud seeding operations, weather balloons are released at intervals of three hours or less 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 2018:

- 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.
- There were no instances where the observed freezing level was between 1550 - 1600 metres; therefore additional controls were not triggered.

Potential 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 the 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 1990-2018 continue to show no evidence of an effect from cloud seeding on precipitation downwind of the target area. This supports the results of previous, independent analyses by the Natural Resources Commission (NRC)[3].

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

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

cloud seeding over the Snowy Mountains in 2004. Analyses of silver concentrations from samples collected prior to the commencement of cloud seeding in 2004 through to 2018 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 objectives of the monitoring program are to detect 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 an independent laboratory for chemical analysis. The results are independently audited and analysed statistically.

In accordance with the EMP, all matrices with annual or five-yearly sampling frequency were sampled following the cessation of the 2018 season. In consultation with the EPA, a number of extra samples were collected and analysed. A total of 507samples were analysed in 2018. Summary statistics of silver concentrations are shown in Table 1 for potable water samples, and Table 2 for other matrices. All measurements are well below the relevant guideline values.

Table 1: Summary of silver concentrations in 2018 potable water samples (ng/L). The guideline value for silver in potable water is 100,000 ng/L

Matrix	Number of samples	Minimum	Mean	Maximum	Guideline value
Potable Water	33	0.16	6.22	95.02	100,000

Table 2: Summary of silver concentrations in 2018 soil, sediment, peat and moss samples (mg/kg). The guideline value for these matrices is 1 mg/kg

Matrix	Number of samples	Minimum	Mean	Maximum	Guideline value
Soil	269	0.014	0.068	0.645	1
Meadow Soil	28	0.016	0.039	0.094	1
Peat	47	0.015	0.175	0.847	1
Sphagnum Moss	51	0.001	0.011	0.065	1
Lake Sediment	17	0.006	0.024	0.066	1
Reservoir Sediment	6	0.032	0.057	0.083	1
River Sediment	56	0.008	0.027	0.090	1

Aquatic ecology

Analyses of data collected following the 2018 season showed no evidence of any difference over time in the impairment of the macroinvertebrate assemblages or multivariate structure of edge or riffle assemblages which could be related to cloud seeding. Aquatic macroinvertebrates sampling will therefore take place after the 2023 cloud seeding season, in accordance with the EMP.

Environmental fate study

Researchers from the University of Queensland were engaged by SHL in 2012 to investigate the environmental fate of silver and indium[4] deposited in the Snowy water catchment from the atmosphere, either from long-range sources unrelated to cloud seeding, or released during cloud seeding operations. This investigation was concluded in 2014 and no evidence was found that cloud seeding had increased silver concentrations in the environment. The results of this study by the University of Queensland have been published in international peer reviewed literature.

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 industrial 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 findings of the University of Queensland research were presented to Snowy Hydro, the EPA and OEH, and the report detailed a series of recommendations for potential improvements to the monitoring program. Snowy Hydro considered these recommendations and amended the EMP in consultation with the EPA and OEH as part of the required 5-yearly review of the EMP.

[4] Indium was considered as part of this study although the approved, inert, tracing agent indium sesquioxide has not been released since 2011

EPA Review

Following submission of the 2018 Annual Compliance Report, the EPA published its review in August 2019. The EPA concluded:

- *"Snowy Hydro Limited has complied with all of its obligations as detailed in the Act*
- *Snowy Hydro Limited has complied with all of its obligations as detailed in the Environmental Management Plan for cloud seeding operations approved by the relevant Ministers on 28 June 2018*
- *Snowy Hydro Limited has complied with all of its obligations as detailed in the Protection of the Environment Operations Act 1997*
- *analysis of potable water, soil, sediment, peat mire and moss sampling carried out during the 2018 cloud seeding season showed silver concentrations at all these matrices remain below the associated values in the Environmental Management Plan".*

The recommendations were:

- *"future reviews are also undertaken in consultation with input from partner agencies of the National Parks and Wildlife Service and the Department of Planning, Industry and Environment.*
- *Snowy Hydro Limited 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 2018 Annual Compliance Report detailing cloud seeding operations and activities through 2018 was submitted to the relevant Ministers and EPA in March 2019. 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, http://www.snowyhydro.com.au/our-energy/cloud-seeding/.