



Environment Protection Authority

# Report on the NSW EPA's review of Snowy Hydro Limited's Cloud Seeding Program 2020 Annual Compliance Report



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# Executive summary

Snowy Hydro Limited has been conducting a winter cloud seeding trial in the NSW Snowy Mountains area since 2004. On 31 May 2013 amendments to the *Snowy Mountains Cloud Seeding Act 2004* (the Act) came into effect, enabling Snowy Hydro Limited to conduct permanent cloud seeding operations within an expanded area of the Snowy Mountains, in accordance with an Environmental Management Plan (EMP) approved by relevant Ministers. The Act defines the relevant Ministers as the Minister for the Environment and the Minister for Planning and Environment, who approved the EMP on 28 June 2018.

The Act also authorises aerial application of existing and alternative cloud seeding chemicals, and prescribed a review and oversight role for the NSW Environment Protection Authority (EPA). Snowy Hydro Limited is required to provide a report to the EPA detailing its compliance with the EMP and the results of any research and monitoring into the impact of cloud seeding operations on the environment by 31 March each year. The EPA is required to review this report and convey its findings, along with any recommendations, to the Board of the Environment Protection Authority and the relevant Ministers.

The EPA has reviewed Snowy Hydro Limited's annual compliance report for the 2020 cloud seeding season and has found that:

- the compliance report was submitted to the relevant Ministers and the EPA by the due date
- Snowy Hydro Limited has complied with all of its obligations as detailed in the Act
- Snowy Hydro Limited generally complied with all its obligations in the Environment Management Plan.

# Introduction

## Background

Cloud seeding is a process used to improve the capacity of orographic clouds (clouds formed as moist air rises over mountains) to yield precipitation as snow. To achieve this, chemical particles are introduced, or seeded, into these clouds. Snowy Hydro Limited (SHL) uses silver iodide as the seeding particle in the Snowy Mountains. Silver iodide has physical properties very similar to natural ice crystals. In addition, silver iodide is practically insoluble in water, tends not to dissociate to its component ions of silver and iodine, and does not become biologically available in the environment. Instead, it remains as a solid in soils and sediments.

During cloud seeding operations, the seeded silver iodide particles combine with naturally occurring supercooled water droplets in the clouds to form ice crystals. These crystals then grow until they become too heavy to stay within the cloud and fall as snow.

To seed the clouds, ground based generators are arranged along the western side of the Snowy Mountain range. The generators are able to disperse minute quantities of the seeding agent into winter storm clouds as they pass across the range. Cloud seeding operations only target cloud systems travelling from west to east and when temperatures guarantee that precipitation will fall as snow above 1400 metres.

Snowy Hydro Limited has been conducting a winter cloud seeding trial in the NSW Snowy Mountains since 2004. Independent evaluation of the trial indicates that snowfall can be increased by an annual average of 14% through cloud seeding. Environmental monitoring has to date not detected any significant adverse environmental impacts. The 2020 cloud seeding operations comprised 98 hours and 17 minutes of cloud seeding between 1 June 2020 and 27 September 2020. Approximately 38.8 kilograms of silver iodide was dispersed during these operations, covering a target area about 2110 square kilometres.

Under the Snowy Mountains Cloud Seeding Act 2004 (the Act), cloud seeding operations may only occur in accordance with an EMP that has been jointly approved by the relevant Ministers. The current EMP was approved by the relevant Ministers on 28 June 2018 following the five yearly review as required under the Act.

The Act requires that Snowy Hydro Limited provide an annual report to the NSW Environment Protection Authority (EPA) and the relevant Ministers by 31 March, detailing its compliance with the EMP and the results of any research and monitoring into the impact of cloud seeding operations on the environment. The EPA is required to review this report and convey its findings, along with any recommendations, to the Board of the EPA and the relevant Ministers.

## Purpose

The purpose of this report is to provide the Board of the EPA and the relevant Ministers with an overview of the findings of the EPA's review of Snowy Hydro Limited's Cloud Seeding Program 2020 Annual Compliance Report, in accordance with the Act and the approved EMP.

# EPA review of Snowy Hydro Limited's *Cloud Seeding Program 2020 Annual Compliance Report*

## Review

The EPA has undertaken its review of Snowy Hydro Limited's *Cloud Seeding Program 2020 Annual Compliance Report* (the report), in accordance with the Act and the approved EMP. In carrying out its review of the report, the EPA consulted with the Department of Planning, Industry and Environment (DPIE) Environmental Protection Science section. The EPA also consulted with the National Parks and Wildlife Service (NPWS) with respect to cloud seeding operations that took place within Kosciuszko National Park.

## Findings

The review of the 2020 annual compliance report found that:

- Snowy Hydro Limited has complied with all of its obligations as outlined in the Act. Snowy Hydro Limited generally complied with all its obligations within the EMP.
- There were no accidents or breakdowns to report that resulted in spillage of cloud seeding agents or fuel, or failure of controls specified in the EMP.
- Monitoring was carried out in accordance with the EMP.
- Analysis of the monitoring data did not detect any evidence of significant adverse environmental impacts associated with cloud seeding activities.
- Cloud seeding is not having a measurable effect on the concentrations of silver in various parts of the environment.
- There were no new operations involving land-based methods of discharge of seeding or tracing agent within any area of land managed under the *National Parks and Wildlife Act 1974*.
- No modifications or new facilities for cloud seeding operations were installed.

## Discussion

During 2020 cloud seeding operations, Snowy Hydro Limited dispersed approximately 38.8 kilograms of the approved seeding agent, silver iodide, into suitable storm systems. Weather conditions suitable for seeding in the Snowy Mountains during the 2020 period resulted in 98 hours of cloud seeding events, which was 51 hours fewer than in the previous year. As a result, less silver iodide was used – 20.3 kilograms less than in the previous year.

During the 2020 cloud seeding season, there were no new operations involving land-based methods of discharge of seeding or tracing agent within any area of land. In January 2020, the Snowy Mountains region was impacted by several bushfires. Two cloud seeding sites within the Snowy Mountains region ('Deep Creek' and 'Happy Jacks') received major fire damage. Equipment at Happy Jacks is expected to be repaired by winter 2021 and planning is underway for repairs to Deep Creek at a later date. No cloud seeding generators or LPG storages were on site at the time of the fires. SHL advised that the small quantities of antifreeze and effluent that had escaped the EMP controls during the bushfires have either burnt off or evaporated. With the exception of the fire damage, no accidents or breakdowns resulting in spillage of cloud seeding agents occurred.

The EMP includes an adaptive environmental monitoring program where the future program is informed by the results of the previous environmental monitoring. Based on the analysis of

samples collected from 2004 to 2019, the EMP's prescribed five-year interval between environmental monitoring programs was found to be appropriate.

Given this, in 2020 potable water was the only source sampled. The annual compliance report indicated that 2020 potable water samples were similar to those from previous years. Silver concentrations have increased since 2013 but remain several orders of magnitude below relevant guideline values. Analysis of silver concentrations from samples collected by the environmental monitoring program, from before cloud seeding started in 2004 through to 2020, showed no evidence that cloud seeding has contributed to increased levels of silver in any area or in any environmental matrix monitored.

Macroinvertebrate sampling has been used as a surrogate to assess the condition of river health. Analyses of data collected on macroinvertebrate assemblages following the 2018 season has shown no evidence of cloud seeding activities impacting on the health of the regional watercourse. Recommencement of macroinvertebrate sampling will take place after the 2023 cloud seeding season, in accordance with the EMP.

The annual compliance report advised that, based on continued elevated levels of silver readings at the intermediate potable water monitoring site (due to accumulated sediment contamination in the rainwater tank), consideration should be given to reviewing the site representativeness as part of the potable water sampling program. This issue will be pursued in 2023 with Snowy Hydro during the five-yearly review of the EMP.

On 17 February 2021, Snowy Hydro personnel inspected a number of cloud seeding sites, accompanied by NPWS in many instances. No significant issues or changes were reported, but storage of metal plates and vegetation maintenance were identified by NPWS as minor concerns to be investigated by SHL. NPWS requested that SHL continue its site inspection and auditing process and requested reports of any significant issues or change.

Snowy Hydro Limited reported that:

- no infrastructure was decommissioned during the reporting period
- no major visual modifications were made to existing infrastructure
- there were no accidents or breakdowns to report that had resulted in spillage of cloud seeding agents or fuel
- there was no failure of any of the controls specified in the EMP.

NPWS was consulted on the installation of a jib crane at the Blue Cow monitoring site and a new Parsivel disdrometer at Thredbo, Guthega and Upper Tumut remote weather stations. NPWS had no concerns over the new infrastructure apart from the jib crane being of similar colouring to the existing SHL equipment, which is not visually sympathetic to the site.

While stakeholders formally raised no current or emerging issues for the 2020 cloud seeding season, mechanisms within the EMP allow relevant agencies of the Minister for the Environment to request consideration by Snowy Hydro Limited of emerging environmental issues between each five-yearly review.

## Conclusions and recommendations

After reviewing the Snowy Hydro Limited 2020 annual compliance report and Snowy Hydro Limited on-ground operations, the EPA concludes that:

- Snowy Hydro Limited has complied with all of its obligations as detailed in the Act.
- Snowy Hydro Limited has generally complied with all of its obligations as detailed in the EMP 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 sampling carried out during the 2020 cloud seeding season showed silver concentrations remain several orders of magnitude below relevant guideline values.

It is recommended that:

- monitoring be continued as per the schedule of the EMP, and data compared over time to identify trends
- future reviews be undertaken in consultation with partner agencies of the NPWS and DPIE
- Snowy Hydro Limited continue to pursue research opportunities on the cloud seeding operations in the Snowy Mountains
- the outcomes of this review be communicated to the relevant Ministers.



# Appendix A: Snowy Hydro Limited compliance with the Snowy Mountains Cloud Seeding Act 2004

Obligations under the Snowy Mountains Cloud Seeding Act 2004	Compliance status (report reference)
The area to be primarily targeted for the increased precipitation is land within the Snowy water catchment.	(1.4) Addressed
Operations may be carried out only if there is an approved Environmental Management Plan.	(1.1) Addressed
Operations must be carried out in accordance with the approved Environmental Management Plan (whether being carried out within or outside the Snowy water catchment).	(1) Addressed All operations carried out within the catchment.
The seeding agent used must be an approved seeding agent and used in accordance with the conditions (if any) of its approval as a seeding agent.	(2.2) Addressed
The tracing agent used must be an approved tracing agent and used in accordance with the conditions (if any) of its approval as a tracing agent.	(2.2) Addressed Tracing agent not used.
The seeding agent and tracing agent must be discharged by the use of an approved method.	(2.2) Approved Land-based aerosol generators.
The discharge must be carried out in accordance with the conditions (if any) of its approval as a method of discharge.	(2) Addressed
The discharge of the seeding agent is to be carried out at a time when increased precipitation in the Snowy water catchment is likely to fall as snow at an elevation above 1400 metres from the mean sea level.	(3.1) Addressed
Snowy Hydro Limited must consult with the NPWS before carrying out any new operations involving a land-based method of discharge of seeding or tracing agent within any area of land reserved under the National Parks and Wildlife Act 1974 (that is, operations in an area that has not been the subject of previous consultation with the NPWS).	(2.3) Addressed No new operations carried out.
Snowy Hydro Limited must consult with the NPWS before installing, or carrying out major modifications to, any facilities required to carry out cloud seeding operations within any area of land reserved under the National Parks and Wildlife Act 1974.	(2.3) Addressed No modifications or new installations carried out.
Installation of new facilities for cloud seeding operations must not be carried out within any wilderness area (within the meaning of the National Parks and Wildlife Act 1974).	(2.3) Addressed No new facilities installed.
A seeding agent is not to be discharged from land-based aerosol generators in any wilderness area (within the meaning of the National Parks and Wildlife Act 1974).	(1.4) Addressed All land-based generators located in approved areas by NPWS.
An application for approval of the use of a thing as a seeding agent in cloud seeding operations must be accompanied by details of the health risk assessment carried out in relation to the proposed use of the seeding agent (including the process used to carry out the assessment and the results of the assessment).	N/A

Obligations under the Snowy Mountains Cloud Seeding Act 2004	Compliance status (report reference)
<p>An application for approval of the use of a thing as a tracing agent in cloud seeding operations must be accompanied by details of the health risk assessment carried out in relation to the proposed use of the tracing agent (including the process used to carry out the assessment and the results of the assessment).</p>	N/A
<p>An application for approval of an Environmental Management Plan must be accompanied by an independent scientific assessment of any proposed cloud seeding operations that differ from the operations currently authorised. Any such scientific assessment must comply with any requirements imposed by the relevant Ministers and notified to Snowy Hydro Limited.</p>	N/A
<p>Snowy Hydro Limited must, by 31 March in each year or such later date as agreed by the relevant Ministers, provide a report on its cloud seeding operations during the period of 12 months ending on 31 December in the previous year to the relevant Ministers and to the EPA. Without limiting the generality of subsection (1), the report must contain the following information:</p> <ol style="list-style-type: none"> <li>a. details of compliance with the approved Environmental Management Plan</li> <li>b. details of research concerning, and monitoring of, the impact of tracing agents and seeding agents on the environment (including the findings of any such research or monitoring).</li> </ol>	(4) Addressed Report on cloud seeding operations received by EPA 31 March 2020.

# Appendix B: Snowy Hydro Limited compliance with the Environmental Management Plan

Obligations under the Environmental Management Plan	Compliance status (report reference)
Cloud seeding will not commence if the freezing level over the catchment is greater than 1600 metres, and will be suspended or terminated if the freezing level rises above 1600 metres during cloud seeding campaigns.	(3.1) Addressed There was one instance where the freezing level rose above 1600 m (Event 6). In Event 6, operations were suspended.
Additional controls will be implemented when the freezing level is between 1550 metres and 1600 metres above sea level, including: <ul style="list-style-type: none"> <li>a. video monitoring at locations over the target area at approximately 1400 metre elevation to assist in determining that precipitation is not falling as rain</li> <li>b. when required, undertaking telephone polling to external parties and/or Snowy Hydro Limited personnel within the target area to confirm that precipitation is not falling as rain at approximately 1400 metre elevation.</li> </ul>	(3.1) Addressed There were no instances where the freezing level was between 1150 m and 1600 m.
Snowy Hydro Limited will consult with the NPWS prior to undertaking major vegetation management and site access beyond maintenance of the existing tracks and site footprints.	(2.3) N/A
The Annual Compliance Report will include: <ul style="list-style-type: none"> <li>a. sample locations, data results, evaluation and adaptive management recommendations for the environmental monitoring program</li> <li>b. details (including results and evaluation) of any emerging environmental issues</li> <li>c. results from meteorological monitoring that can demonstrate Snowy Hydro Limited's compliance with the requirement to ensure that increased precipitation falls as snow in areas at an elevation above 1400 metres above sea level</li> <li>d. results from analyses of downwind precipitation</li> <li>e. the event time and duration over which cloud seeding occurred</li> <li>f. any accidents or break downs resulting in spillage of cloud seeding agents, fuel, or failure of controls specified in this Environmental Management Plan</li> <li>g. the quantity of cloud seeding agents that were released per seeding event per generator</li> </ul>	(a – 4.1-4.3) Addressed  (b – 4.4) Addressed: No emerging environmental issues  (c – 3.1) Addressed: Table 3.1.  (d – 3.2) Addressed: Figure 3.1 (e – 2.1) Addressed: Table 2.1  (f – 2.3) Addressed: No accidents or breakdowns  (g – 2.2) Addressed: Table 2.2

Obligations under the Environmental Management Plan	Compliance status (report reference)
<p>In addition to the Annual Compliance Report, Snowy Hydro Limited will also prepare a Cloud Seeding Operations Annual Report which is to be made publicly available on the Snowy Hydro Limited website within a reasonable timeframe after any recommendations from the Board of the EPA and the relevant Ministers. The Cloud Seeding Operations Annual Report will include, but not be limited to:</p> <ul style="list-style-type: none"> <li>• summary statistics of the Environmental Monitoring Program</li> <li>• details of compliance with approved Environmental Management Plan</li> <li>• summary statistics on the overall duration over which cloud seeding occurred and the total amount of cloud seeding agents that were released over the season.</li> </ul>	(1.2) N/A
<p>Disputes between NSW government agencies and Snowy Hydro Limited with regards to cloud seeding operations will be resolved in accordance with the following escalation process:</p> <p>use of established paths of communication between Snowy Hydro Limited and the agency (officer to officer)</p> <p>communication between Snowy Hydro Limited Executive Officer and agency Department Director</p> <p>communication between the Chief Executives of Snowy Hydro Limited and the agency.</p>	(2.4) Addressed No disputes between NSW Government agencies and Snowy Hydro Limited.
<p>Snowy Hydro Limited will continue to consult with other relevant land managers with respect to vegetation management and site access. Snowy Hydro Limited will also consult with relevant land managers in situations where major visual modifications are made to infrastructure or if new sites are installed and/or existing sites are removed. No new infrastructure will be established without the prior endorsement by the relevant land manager.</p>	(2.3) Addressed No major visual modifications made to existing infrastructure, and no infrastructure decommissioned. Installation of new infrastructure at four monitoring sites.
<p>DPIE, the EPA and other identified stakeholders will be advised as soon as practicable following the commencement of, and on the conclusion of cloud seeding campaigns.</p>	(2.1) Addressed DPIE and EPA and other identified stakeholders were advised by email.
<p>Existing sites authorised under the Act will be defined by Snowy Hydro Limited (coordinates and identified on a map), and provided to OEH and the EPA prior to commencement of first annual winter operations. Thereafter, prior to the installation of any new authorised sites, updated coordinates and maps are to be provided to OEH and the EPA.</p>	(1.4) Addressed A map of existing sites and details of their coordinates was provided to the EPA and DPIE in June 2013. There were no changes to infrastructure in 2020.

Obligations under the Environmental Management Plan	Compliance status (report reference)
<p>Implement all management controls (Table 1), being those included for each of the following activities:</p> <ul style="list-style-type: none"> <li>• installation and modification of generators</li> <li>• operation and maintenance of generators (including release of cloud seeding agents and increased precipitation)</li> <li>• storage and preparation of cloud seeding agents and other chemicals</li> <li>• installation and modification of weather stations</li> <li>• installation and modification of communications equipment</li> <li>• operation and maintenance of weather stations and communications infrastructure</li> <li>• operation and maintenance of snow sampling sites</li> <li>• Environmental Monitoring Program</li> <li>• removal of infrastructure and rehabilitation of sites.</li> </ul>	<p>(2.3) Addressed Infrastructure, including cloud seeding agents and fuel, is managed in accordance with these requirements.</p>
<b>Meteorological monitoring</b>	
<p>Undertake monitoring of downwind precipitation – mean wintertime daily precipitation anomalies will be updated each year and included in the Annual Compliance Report following cloud seeding operations to continue to monitor downwind precipitation.</p>	<p>(3.2) Addressed Figure 3.1.</p>
<p>Snow sampling profile sites and preferred access routes will be defined by Snowy Hydro Limited (coordinates and identified on a map) and provided to OEHL and EPA prior to commencement of first annual winter snow sampling operations. Updated coordinates and maps are to be provided to OEHL and EPA if sites change.</p>	<p>(1.4) Addressed No snow profile sampling took place in 2020.</p>
<b>Environmental chemistry monitoring</b>	
<p>Environmental sampling to be undertaken as per Table 3 in the Environmental Management Plan.</p>	<p>(4.1.2) Addressed Table 4.1.</p>
<p>Specific quality controls applied to the collection and handling of all samples collected for the cloud seeding program include:</p> <ul style="list-style-type: none"> <li>• the use of a new clean plastic vial/bag for each sample</li> <li>• the use of a new pair of clean disposable gloves at each site and procedures to minimise contact with the inside of vials/bags to minimise the potential for sample contamination</li> <li>• all sampling equipment is washed with ultra-pure water or water from the sampling location prior to use</li> <li>• the use of a data management system including the barcoding of each sample to ensure every sample is individually trackable from collection, return to base, dispatch to the laboratory and the return of results.</li> </ul>	<p>(4.1.3) Addressed Samples are collected and processed in accordance with internal work instructions and quality assurance and quality control procedures.</p>
<p>Samples sent for laboratory analyses will be analysed for total silver concentration with an appropriate level of quality assurance and quality control (QA/QC).</p>	<p>(4.1.3) Addressed</p>
<p>For those samples that are analysed chemically, the data is to be analysed statistically and interpreted on the basis of three statistical tools.</p>	<p>(4.1.5) Addressed Due to extremely low values observed in 2020 and previous surveys, no statistical analysis was undertaken for this matrix.</p>

Obligations under the Environmental Management Plan	Compliance status (report reference)
Implementation of steps in decision tools and environmental suspension criteria.	(4.1.1, 4.1.5) Addressed
<b>Macroinvertebrates monitoring</b>	
Sampling will be undertaken on a five-year sampling interval, with the first round of sampling to be undertaken following the first year of cloud seeding operations. In the event that additional river sediment sampling is required as a result of the triggers outlined in the Environmental Management Plan, macroinvertebrates sampling will also be undertaken at the affected locations.	(4.2) N/A Macroinvertebrate sampling was not required in 2020.
If macroinvertebrate sampling sites are changed and/or added outside of the Environmental Management Plan Review process, updates to the Environmental Management Plan will be provided to EPA/OEH prior to sampling being undertaken.	(4.2) N/A Macroinvertebrate sampling was not required in 2020
The macroinvertebrate sampling program implemented by Snowy Hydro Limited (and endorsed by OEH) uses the NSW Australian River Assessment System (AUSRIVAS) protocol.	(4.2) N/A Macroinvertebrate sampling was not required in 2020.
<b>Additional monitoring</b>	
<p>Relevant agencies of the Minister for the Environment may request consideration by Snowy Hydro Limited of emerging environmental issues between reviews of this Environmental Management Plan.</p> <p>In order for issues to be considered by Snowy Hydro Limited, the agency will provide a clear outline of the issue to Snowy Hydro Limited based on direct evidence or established scientific theory. The agency and Snowy Hydro Limited will then agree on an appropriate research/monitoring/consultation/reporting regime.</p>	(4.4) N/A No emerging environmental issues were raised with, or identified by, Snowy Hydro Limited during this reporting period.