

# Socio-economic Impacts of Cloud Seeding on the West Coast Community

---

Hydro Tasmania and West Coast Council

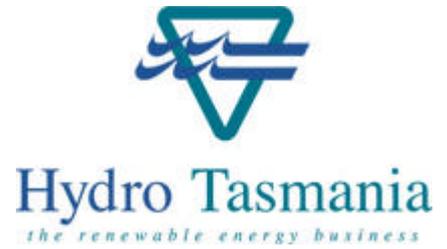
April 2008



**Myriad Consultancy**

*'the Market Research people'*

This Report has been prepared on behalf of:  
**Hydro Tasmania**



**&  
West Coast Council**



This report has been prepared by:  
**SGS Economics and Planning Pty. Ltd.**

ACN 007 437 729

119 Macquarie Street

Hobart 7000

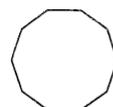
phone: 03 6223 6006

fax: 03 6224 9009

email: [sgstas@sgsep.com.au](mailto:sgstas@sgsep.com.au)

web: [www.sgsep.com.au](http://www.sgsep.com.au)

in conjunction with



**Myriad Consultancy**

*'the Market Research people'*

# Table of Contents

---

<b>1</b>	<b>Introduction</b> .....	<b>1</b>
1.1	Background.....	1
1.2	Aim of this study.....	2
1.3	Project Committee and Consultants' team.....	2
1.4	Remainder of this document.....	3
<b>2</b>	<b>Effects of Cloud Seeding</b> .....	<b>5</b>
2.1	Regional rainfall regime.....	5
2.2	Measures of cloud seeding effectiveness.....	5
2.3	Cloud seeding operations.....	6
2.4	Impacts of cloud seeding in Western Tasmania.....	7
<b>3</b>	<b>Socio-economic Profile of the West Coast</b> .....	<b>10</b>
3.1.1	Population and households.....	10
3.1.2	Income.....	11
3.1.3	Housing and home ownership.....	11
3.1.4	Unemployment.....	11
3.1.5	Labour force participation rate.....	12
3.1.6	Employment by industry.....	12
3.1.7	Mining.....	12
3.1.8	Tourism.....	13
3.1.9	Non-resident workers.....	13
3.1.10	Other economic characteristics.....	13
3.1.11	Public health and wellbeing.....	14
<b>4</b>	<b>Social impacts assessment</b> .....	<b>16</b>
4.1	Findings of the consultation.....	16
4.2	Summary.....	22
<b>5</b>	<b>Economic impact assessment</b> .....	<b>24</b>
5.1	Basis of assessment.....	24
<b>6</b>	<b>Preliminary overview of possible responses</b> .....	<b>27</b>
<b>Tables</b>		
<b>Table 1.</b>	Targeting of seeding events, 1998-2007.....	6
<b>Table 2.</b>	Perception of effect of cloud seeding in different areas.....	18
<b>Table 3.</b>	Costs and benefits of cloud seeding.....	26
<b>Figures</b>		
<b>Figure 1.</b>	Targeted cloud seeding catchment areas.....	1



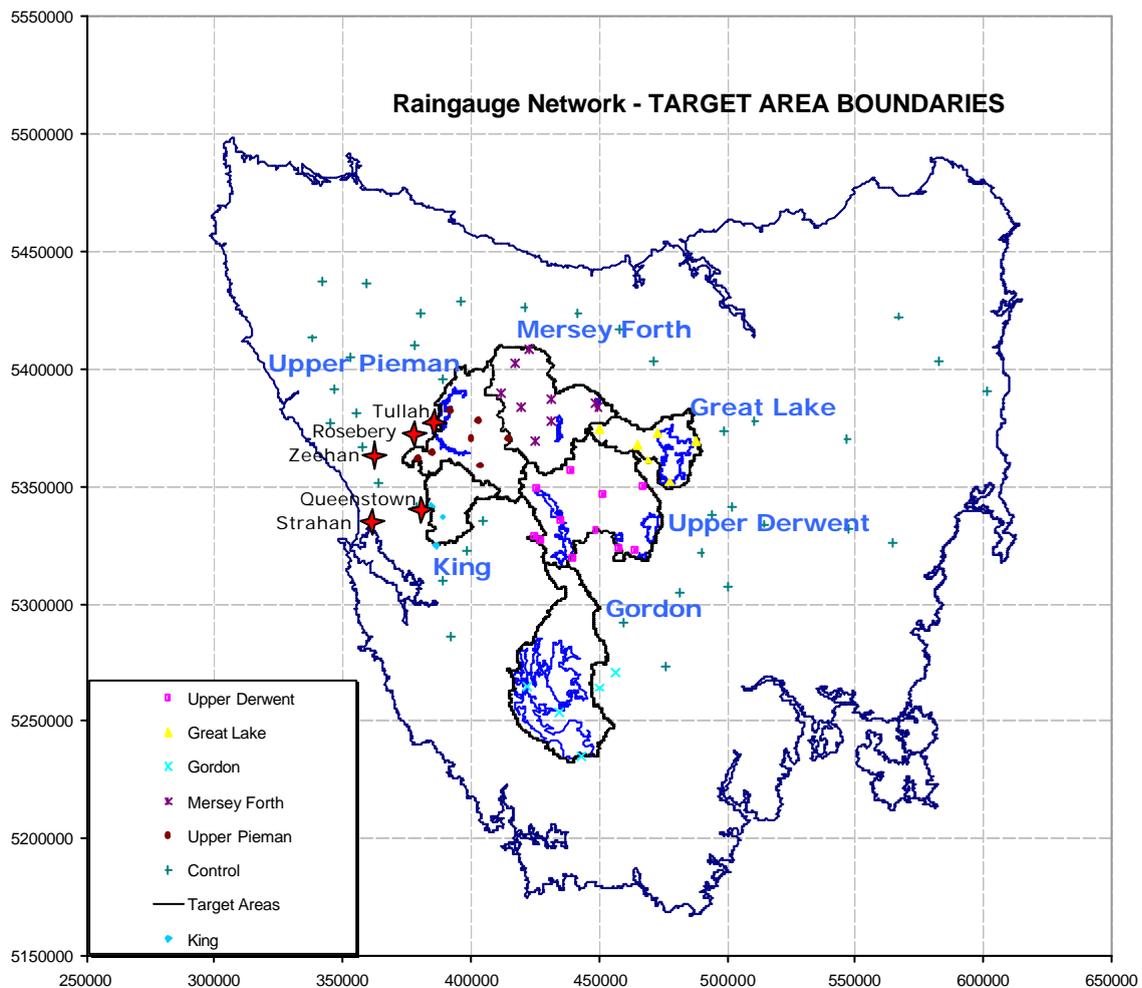
# 1 Introduction

## 1.1 Background

There is an on-going vigorous debate between Hydro Tasmania and the West Coast Council over Hydro Tasmania's annual cloud seeding program. While Hydro Tasmania considers the activity desirable to augment electricity production, the West Coast Council reports negative impacts on its community and economy.

Hydro Tasmania has maintained an operational cloud seeding program since 1998, following earlier programs including three independent cloud seeding experiments in Tasmania. Added up, these activities result in 23 out of 42 winter seasons being seeded between 1964 and 2005.

**Figure 1.** Targeted cloud seeding catchment areas



Source: Hydro Tasmania

Hydro Tasmania's current annual cloud seeding program starts in April and finishes in November, running for up to eight months of the year. Cloud seeding may take place when the conditions are favourable, any day of a week. Hydro has seeded on average 20 days each year when conditions are suitable, adding an estimated equivalent 12 megawatts continuous output to its production capacity.

The catchment areas targeted by these cloud seeding activities are partly located in the West Coast Council LGA, but the target areas are predominantly located downwind from the West Coast communities. The river systems carry the water to the main storage lakes, including Lake Burbury, Macintosh, Pedder, Gordon, Rowallan, St. Clair, King William, Echo and Great Lake and to Macquarie Harbour and other river mouths.

Of the West Coast Council's major towns, at least Tullah and Rosebery are located within or in immediate vicinity to the target area. Together, they host around 40 percent of the West Coast Council area's population. In addition, Queenstown is close to the King catchment and may be affected.

While the West Coast Council considers Hydro Tasmania's cloud seeding activity has negative effect on its community and economy, Hydro Tasmania states that its cloud seeding activity is sufficiently targeted not to cause significant amounts of additional rain outside its target areas. The West Coast Council doubts this referring to research showing that cloud seeding can cause rain outside of the target areas.

## 1.2 Aim of this study

As per the project brief, the objective of the project is:

*"To identify, assess and document the socio-economic impacts, both perceived and actual, of Hydro Tasmania's cloud-seeding program on the residents of the West Coast of Tasmania".*

This study into the impacts of Hydro Tasmania's cloud seeding on the West Coast Council aims to investigate if and to what degree cloud seeding results in impacts on the community and economy of the West Coast Council area. Among the outcomes of the study is a collation of community views, including possible mitigation measures.

This report aims to assess likely minimum and maximum effects of cloud seeding on rainfall in the West Coast, and from this, the likely minimum and maximum social and economic impacts.

## 1.3 Project Committee and Consultants' team

The Project Committee steering this consultancy project consists of representatives of both Hydro Tasmania and West Coast Council. They have both been involved and consulted throughout the process.

The consultants' team brings together a professional mix of scientific expertise on cloud seeding, statistical skills, sound socio-economic knowledge and experience and proven competence in community consultation:

- SGS Economics and Planning, as principal consultant
- Myriad Research, as community research specialists and;
- Professor Michael Manton, as adviser to the consultants performing/executing the scientific review and statistical analysis.

Consultation with leading scientists, key economic stakeholders of the West Coast economy and representatives of the West Coast community, ensure an objective analysis and the accurate reflection of the community's perceptions and the actual dynamics and effects of cloud seeding.

The West Coast Council has requested the following statement be included:

*Council's engagement with this process and the resulting reports has been designed to be constructive but should not in anyway be seen to limit any organization, business or individuals rights on the issue.*

*Council contests some of the statements contained within the report due to the variability of weather patterns and the amount of scientific debate still occurring on the merits of cloud seeding and the persistence effect.*

## 1.4 Remainder of this document

This document is presented in five main sections:

1. **Effects of Cloud Seeding on Rainfall** This section summarises a more detailed analysis (Background Report 1) that reviews the scientific literature on cloud seeding, presents an analysis of natural variability of rainfall, and estimates the minimum and maximum possible effects of cloud seeding on rainfall in the West Coast. It also provides information on the frequency and location of recent seeding practices
2. **Socio-Economic Profile of the West Coast** This section summarises the nature of the West Coast community and its economy. The detailed analysis is in Background Report 2.
3. **Social Impacts of Cloud Seeding** This section provides a summary of the research into attitudes and perceptions of rainfall on the West Coast and the community's perception of and response to cloud seeding. Three detailed attachments (Background Reports 3a, 3b & 3c) provide the supporting survey and other evidence for this section<sup>1</sup>.

The findings of Section One are then brought in to distinguish actual impacts from perceived impacts, and the likely actual effect of the cloud seeding. The implications of perceived effects are then considered.

---

<sup>1</sup> Note that the three surveys are not released publicly as they contain confidential comments that may be attributed to specific sources.

4. **Economic Impacts of Cloud Seeding** This section assesses the economic impacts of cloud seeding by considering the effect of rainfall on costs in the West Coast and the effects of additional rainfall that may arise from cloud seeding. The impact of perceived effects is also considered. The full analysis is in Background Report 4.
  
5. **Measures and strategies** Mitigation measures proposed by the community during the community interviews, telephone surveys and focus groups and arising from discussions between the consultants and clients are presented.

## 2 Effects of Cloud Seeding

### 2.1 Regional rainfall regime

Rainfall on the West Coast is high and has been since the beginning of weather records. Rainfall in Queenstown averages around 2500 mm per annum. However, the natural variability of rainfall is very high. Seasonal rainfall typically varies plus or minus 23% from the average from one year to another. Monthly rainfall varies even more with August rainfall usually varying 46% below or above the average. Extreme rainfall seasons or months vary even more. Of all recorded extreme high rainfall months, none have occurred within the current operational phase of cloud seeding and half occurred prior to 1948.

Long term rainfall data do not reveal any obvious trend in annual precipitation for Queenstown, but there seems to be a shift in seasonal patterns. Autumn and winter appear to have become drier over the past 100 years while spring has been experiencing increasing rainfall. At the annual level these two movements largely compensate each other. Such apparent trends occur against a background of large inter-decadal variability. Rainfall statistics for Queenstown, Strahan and Rosebery also vary strongly between each other.

### 2.2 Measures of cloud seeding effectiveness

The review of experiments and findings shows that clear evidence of the effectiveness of cloud seeding is often elusive. However, of all of the areas in the world, evidence for effectiveness is strongest in Western Tasmania.

The high natural variability of rainfall makes it extremely difficult to discern cloud seeding effects. Long term experiments are required to produce conclusive evidence. "Even in the best experiments, it has taken more than a hundred seeded days to detect with any confidence, a 10% increase due to seeding", (Bigg, E.K. & Turton, E., 1988). These experiments need to meet stringent design criteria in order to deliver useful data.

Cloud seeding experiments show seeding is most effective when clouds have a high super cooled liquid water content (LWC). The premise is that cloud seeding can improve the efficiency of precipitation by the appropriate introduction of artificial ice nuclei into clouds deficient in naturally occurring ice nuclei as evidenced by high supercooled LWC. The relationship between supercooled LWC and precipitation is not straightforward but results from Stage II suggest that Tasmanian cloud seeding operations are effective in increasing rain on an already rainy day.

Cloud seeding is potentially effective in regions where clouds frequently undergo orographic uplift; i.e. airflow over mountainous areas. The most suitable clouds are stratus clouds in a maritime airstream with cloud tops between -10°C and -12°C. These circumstances often occur on the Tasmanian West Coast.

## 2.3 Cloud seeding operations

The current operational phase of cloud seeding commenced in September 1998 and continues to present. Cloud seeding operations are undertaken from April to November. There are fewer flights during April and November (approximately 2 seeding events per month), while July through to October are the most intensely seeded months (approximately 5.5 events per month). Note that these averages are influenced by very high seeding frequencies in 2000 and 2001. More recently seeding frequency is much lower than these peak years.

Hydro Tasmania conducts an average of four seeding operations per month. The decision to fly is based on an assessment of conditions on the day and cannot be reliably predicted in advance making advance notification impossible. The number of flights is roughly twice as high as the number of seeding days because during flights it often becomes clear conditions are not/no longer suitable to seed. Most flights occur in the daytime, between 6:00 am and 6:00 pm. About 8% of flights occur at night, with a further 12% in early morning or evening.

The most common target area is the Gordon catchment, which is not near any of the townships of the West Coast Council area. Other areas that are targeted frequently during seeding flights are Upper Derwent and Upper Pieman. Rosebery is located west of Upper Pieman and Tullah within it. This catchment was seeded on about 33% of seeding days, an average of about 9 times per year. King catchment is next to Queenstown. King is targeted the least of all areas, only 15% of seeding days an average of 4 times per year. Strahan and Zeehan are both further away from the catchment areas and are not areas where clouds may undergo orographic uplift inducing seeded rainfall. The proportion of seeding events in each catchment is summarised in Table 1.

**Table 1.** Targeting of seeding events, 1998-2007

<b>Targeted catchment area</b>	<b>Frequency</b>	<b>Seeded</b>	<b>Relation to West Coast communities</b>
Gordon (Go)	49%	132	Distant from the West Coast
Great Lake (GL) (or Target East)	41%	111	Distant from the West Coast
King (K)	15%	41	Close to Queenstown
Mersey Forth (MF)	32%	85	Distant from the West Coast
Upper Derwent (UD) (Target West)	41%	111	Distant from the West Coast
Upper Pieman (UP)	33%	89	Close to Rosebery, includes Tullah
<b>Total seeding days</b>		<b>269</b>	

Source: Hydro Tasmania cloud seeding flight logbook, 1998-2007; many seeding events target more than one catchment

## 2.4 Impacts of cloud seeding in Western Tasmania

For flood impacts and design of stormwater infrastructure the rainfall amount, particularly extreme events, is most significant. For tourism, events and effects on construction and maintenance activity, it is important to know what effect cloud seeding has on the **number of rainy days**.

There seems to be some evidence of persistence effects due to cloud seeding. However, the evidence is not conclusive: a) studies conducted in the area have returned mixed results, b) establishing statistical evidence is difficult because of the high natural variability of rainfall and c) there is insufficient understanding of the physical process that would explain the phenomenon.

In regard to this study it is important to note it is very unlikely the rainfall effects of cloud seeding in Tasmania are underestimated (assuming there are persistence effects). The time units used in most analyses are wide enough to account for these effects. Also, analysis of the second experiment with 'suitable day' as time unit returned results of a similar magnitude. In short, estimates or rainfall effects of cloud seeding are unlikely to be changed significantly by this effect.

### Extreme events

Most extreme rainfall events occur during storms, when seeding does not generally take place. However, seeding operations are undertaken if there is a good chance of rainfall anyway increasing the likelihood of a coincidence between seeding and relatively heavy rainfall.

Twenty of the forty most extreme rainfall events from 1997 to 2007 in Queenstown occurred before the seeding program began or during the non-seeding months. Twenty of the most extreme events occurred during the seeding seasons from September 1997 to October 2007 when seeding takes place. However, there was only one extreme rainfall event of the 20 most extreme rainfall events from 1997 to 2007 during the seeding season that coincided with seeding operations targeting the King catchment. This was the 20<sup>th</sup> wettest day between 1997 and 2007.

Based on this we estimate that Queenstown may experience an extreme rainfall event coinciding with seeding once in approximately 10 years time, although it is not established that the seeding caused the event. Consequently, Strahan could potentially be affected by flooding through the King River at most once a decade too.

Of the 31 most extreme rainfall events in Rosebery from September 1997 to October 2007, 10 occurred during non-seeding periods and 21 occurred during the seeding seasons from 1998 to 2007. Seeding in the Upper Pieman catchment occurred on four days of the 21 most extreme rainfall events. These were not the most extreme events for Rosebery. The five wettest days in the period did not coincide with seeding. Seeding is expected to coincide with at most one extreme rainfall event every two years (on average) in Tullah and Rosebery but is not necessarily the cause.

Increases in rainfall intensity immediately following seeding may be noticeable, even if the maximum overall increase for the day of say, 35% is not readily apparent due to high levels of variability. However this effect has not been studied in detail.

## Frequency of rainfall

Based on the fact that Tasmanian cloud seeding operations are effective in increasing rain on an already rainy day there should be no effect on the number of rainy days. However, it will increase the intensity of rain in the target areas on days when seeding occurs, without necessarily producing an extreme rainfall event.

## Overall effect on rainfall

The magnitude of the effects of cloud seeding is still regarded as uncertain by most scientists. However, there are some clear indications of the range within which these effects lie. Collating various studies on cloud seeding in Tasmania, the conclusion is that cloud seeding is effective and that precipitation is enhanced by up to 8% per 'seeded' month in the target areas.

There is some evidence that suggests some unintended seeding occurs outside the targeted areas. Queenstown, Rosebery and Tullah are most prone to these effects. The maximum effect of cloud seeding in these townships would be the 8% increase in monthly rainfall for seeded months. However, the most likely effect is much less.

At the minimum, the effects of cloud seeding are estimated to be negligible in townships outside target areas. Scientific evidence so far does not produce any substantial evidence of unintended seeding outside the targeted areas. The evidence provided is no more than suggestive. If there are no effects outside target area then there should be no direct effects of cloud seeding in Queenstown, Rosebery, Zeehan and Strahan. Tullah is located within the Upper Pieman target area and in terms of minimum effects, is expected to be affected by cloud seeding. Rainfall effects in Tullah at a minimum are estimated to be a 4% increase in monthly rainfall for seeded months.

Rainfall in Zeehan is not likely to be affected by cloud seeding at all, being well upwind from any target area and away from the mountain. The township is not known to be prone to flooding as a consequence of excessive rainfall. Therefore, our 'best estimate' is that cloud seeding does not affect Zeehan at all.

Further randomised trials could better evaluate the impacts of cloud seeding, but the benefits would have to be demonstrable given the opportunity cost of not seeding. Targeting could be refined by using more sophisticated modelling, potentially reducing any unintended effects that do occur.

## Other effects

There is no evidence of adverse environmental and health effects of the seeding agent silver iodide. Silver iodide binds easily with particles in the soil, chloride ions and clay minerals. Iodine as iodide is non-toxic and is even used as a food supplement to improve nutrition. Concentrations of silver iodide in rain water from cloud seeding are more than 1000 times below recommended limits. Very small amounts are used each year, spread at levels of a few grams per square kilometre.

There is no statistical evidence cloud seeding on the West Coast deprives the Midlands and the East Coast from rainfall. Clouds are not static objects moving from one place to the other but form and dissipate in response to a wide variety of atmospheric factors. International research so far has not been able to establish significant evidence of rain deprivation in downwind areas. Some evidence is available that says cloud seeding may actually increase rainfall in downwind areas depending on the specific topographic and climatic characteristics of the area (but these are generally not applicable to Tasmania). Rainfall on the West Coast results from weather conditions that are not comparable to the conditions producing rain in the Midlands and the East Coast, being produced by separate weather systems. However, while some researchers acknowledge that cloud seeding may lead to either an increase or decrease in downwind areas, the topographical and meteorological conditions under which these findings were made do not apply to Tasmania.

## 3 Socio-economic Profile of the West Coast

Background Report 2 on the socio-economic profile of the West Coast and its townships provides a detailed picture of the current population and changes affecting life in the West Coast. This profile is based primarily on the 2006 Census with some trends from earlier censuses, and other statistical sources, and provides the context against which the impacts of cloud seeding will be assessed: what people are affected and in what way?

Historically, population growth on the West Coast was driven primarily by mining activities. Later the Hydro-Electric Commission (nowadays Hydro Tasmania) attracted workers to the area to build and operate its dams and power generators. Employment in mining experienced major ups and downs, following a path of mining activities depending on volatile global market prices. Employment opportunities with Hydro Tasmania have decreased significantly over time as dam building activities have ceased and operation activities have been largely automated.

The fishing industry is another significant contributor to the local economy, and includes aquaculture activity as well as wild fisheries (rock lobster, abalone). In more recent years the West Coast has been able to develop its tourism sector, which provides income and employment to a steady and increasing number of people. These main economic drivers have and continue to play a determining role in the growth and opportunities of the population of the West Coast community.

An important factor in people's daily lives on the West Coast is its climate and rainfall specifically. With annual rainfall between 2 and 3 meters a year rainfall is an undeniable presence much as extreme heat and aridity is in some other parts of Australia. Other factors specifically affecting the demographics of the West Coast are its remoteness, natural beauty and the affordability of real estate.

### 3.1.1 Population and households

In spite of recent strength in the mining sector and a growing tourism industry, the population of the West Coast has been in decline for at least two decades and continues to fall. Much of the new mining employment is taken up by families residing elsewhere with workers commuting on rotating shifts. Families often choose to locate along the Northwest coast of Tasmania, while the income earner of the family stays in the West Coast during work shifts. This trend does not contribute to the community life of the area.

The population of the West Coast is ageing. The proportion of 65 to 74 years olds increased from 4% to 8% from 1996 to 2006, in line with the rest of Tasmania. However the West Coast has a smaller proportion of persons aged over 74 than the rest of the state. Furthermore, there has been a marked decrease of persons in the 25 to 34 years age group from 19% in 1996 to 13% in 2006. The severe dip in the age profile shows that a large proportion of young adults leave the West Coast.

Population in the West Coast has been sustained by natural increase offsetting the migration of young adults and to a much lesser extent, the elderly. The crude birth rate is relatively high and

the death rate relatively low compared to Tasmania as a whole. This accounts for the relatively high proportion of children. However, the rate of natural increase is falling sharply as birth and death rates approach those of the rest of the state. Unless new residents can be attracted to the area, population will begin to fall at a faster rate.

Approximately 70% of all households in Tasmania consist of family households whereas on the West Coast this percentage is lower at 64%. Queenstown and Tullah have particularly high portions of lone person households. This is largely due to mining workers who moved to the area for their jobs.

### 3.1.2 Income

The West Coast has relatively more households earning low incomes of up to \$500 per week than Tasmania as a whole but it has fewer households earning medium incomes (\$500 to \$1000). At the higher end of the income spectrum (\$1,000 and more) West Coast is broadly in line with Tasmania as a whole except for very high incomes, where West Coast lags behind the rest of the state.

The distribution of income is not even across the LGA. Strahan has a lower proportion of the lowest income group while Tullah followed by Zeehan have a higher proportion of households with income of less than \$500. Queenstown and Rosebery have the highest proportion of income earners in the \$1000-\$2000 per week category of the West Coast towns. Incomes overall grew more slowly than for the state as a whole. However, there were stronger gains in Strahan and Tullah than in other parts of the West Coast. The income distribution in Zeehan shifted toward lower incomes. The changes had the effect of reducing previously large disparities between communities.

### 3.1.3 Housing and home ownership

Prior to the 1980s, most housing in Tullah, Rosebery and Zeehan were owned by the mines or Hydro Tasmania and workers had to leave when they were no longer employed by these organisations. This in part accounts for the lower level of older residents than in Tasmania as a whole. More recently there is a high proportion of households that fully owns their dwelling, approximately 48% compared to 38% in Tasmania as a whole. This is offset by a much smaller proportion, 20% of households purchasing their homes compared to 33% in Tasmania. This probably reflects an important characteristic of the West Coast, the generally low real estate and rental prices by Tasmanian and national standards.

### 3.1.4 Unemployment

Overall unemployment was higher in the West Coast compared to Tasmania at the time of the last census. This was true for every age group as well as the workforce overall.

Differences in the rate of unemployment were highest for the 15-19 age groups, at 21% in the West Coast compared to 16% for Tasmania. The other age group with a larger than average difference was the 55+, with 9% unemployed in the West Coast compared to 5% for the state as a

whole. Other age groups typically had about a 1-2% difference from the statewide levels of unemployment.

While higher than state averages, unemployment levels have been trending downward in all age groups since 2001. This is in sharp contrast to the trend pre 2001 where unemployment was rising for all age groups under age 45 from 1996 to 2001. The rising unemployment rate in the late 1990s was undoubtedly a contributor to population loss during that period. More recent improvements would have made some contribution to slowing the rate, but being still significantly above state average levels, would not be helping to retain population in the West Coast.

### 3.1.5 Labour force participation rate

In contrast to unemployment, labour force participation rates are higher than in Tasmania as a whole. This reflects how participation rates are calculated, and the fact that the West Coast has a smaller proportion of persons aged 75+ than the rest of the state. Strahan has a notably higher participation rate than the West Coast average and Tullah a notably lower one.

### 3.1.6 Employment by industry

The dominance of mining is striking, with nearly 30% of all employment. The only other sectors with a proportion of employment greater than Tasmania are Accommodation, and Food services, Transport, Postal and Warehousing, and Administrative and Support Services. The first of these three is more than double the Tasmanian average, showing the importance of tourism to the region. Traditional industries of Agriculture Forestry and Fishing are minor contributors to overall employment.

### 3.1.7 Mining

The West Coast has a long and rich mining history including a range of minerals in both open cut and underground mining operations. The West Coast is a particularly rich source of many ores found in characteristically hard rock provinces including copper, tin, gold, zinc, lead, nickel, silver and iron.

The West Coast is somewhat unusual in sustaining mining activity for well over 100 years. Many mining communities are quite transient, with the mines being exhausted and either other economic activity largely taking over (eg Ballarat) or the town dying out. In the West Coast, many long standing mines continue to sustain activity and new mines and mineral processing activities continue to be developed in the area.

Tasmania and the West Coast continue to benefit from strong international demand for minerals. The character of mining has changed with a change from a dependence on the mining company for most of the housing and other services provided to employee and contractor residents to a more restricted role of employer with few services provided. The other change is in work practices and the increasing pattern of mining families living out of the area with workers coming in for four days

of long shifts. This reduces the degree of identification between the community and the mining companies, and undercuts much of the social and economic role that mine workers and their families once played in the community.

As well as bringing employment and wealth, the mines have left other legacies in the region: acid mine drainage, and despoiled landscapes. The gradual restoration of vegetation cover is similarly witness to the vastly improved practices of modern mining and cessation of the old forms of mineral processing that proved so destructive. Nonetheless, there remains substantial remaining environmental effects of past mining activity on the environment.

### 3.1.8 Tourism

Tourism supports approximately 500 jobs, including the effects of multipliers, or nearly 25% of the employment in the West Coast. Its economic role is substantially less significant than mining in financial terms as the level of wages and value adding in the tourism industry is much less per capita than in mining. However, it probably spends a greater share of its turnover locally and fewer workers commute to work in this industry than in mining.

Tourism is strongly seasonal in character with quite low activity from May to September. October, November and December form a clear 'shoulder' season. Takings drop more strongly in the off season than occupancy, reflecting the generally lower off season rates and use of promotional packages to fill rooms.

### 3.1.9 Non-resident workers

Nearly 9% of workers in the area live outside of the West Coast. Indications that just under 18% or 110 workers in the mining industry may do so. Other industries where some workers are living outside the West Coast include construction and health care. This reduces local spending, the proportion of families resident in the area and tends to 'hollow out' communities. It also contributes to a declining local population, even while employment levels in the area remain strong.

### 3.1.10 Other economic characteristics

Residential property sales show a rising trend in both volume and price. The increase in mean sales value was 59% from 2000 to 2004. However, average prices are far below Tasmanian averages. In 2004, the West Coast average is only 27% of the Tasmanian mean sales price. Further, the rate of increase in sales prices is slower, 59% compared to 84% for Tasmania as a whole over the same period, further widening the gap in property values.

Housing approvals were reasonably steady from 2000 to 2004. Apart from the burst of units in 2000, they averaged about 6 houses per year. Non residential construction was more volatile from year to year. Total average building approvals per year have averaged \$2.7 million. This building activity corresponds to an average of about \$500 per capita per year. This compares to just over \$1000 per capita per year for Tasmania as a whole.

The West Coast has nearly 40% more length of roads per capita than Tasmania as a whole. However, a higher proportion of these roads are state government owned. The West Coast Council owns about 17% more roads per capita than local governments across the state, relatively a modest increase for a rural council. About the same proportion are paved as the statewide ratio.

### 3.1.11 Public health and wellbeing

Some concerning statistics from 1999 showed the West Coast has quite poor health status compared to Tasmania for a number of measures. These include

- 30% higher standardised death rate<sup>2</sup> (SDR) all causes (males 15-64)
- 54% higher standardised death rate (SDR) cancer (males 15-64)
- 66% higher standardised death rate (SDR) circulatory diseases
- 35% higher standardised admission rate, respiratory treatment
- 15% lower immunisation rate (12 months of age)

*Other health issues identified include high incidence of:*

- *Insulin dependent diabetes mellitus*
- *Vehicle accidents*
- *Accidents caused by poisoning*
- *Suicide and attempted suicide*

*Lifestyle related causes identified included:*

- *Cigarette smoking*
- *Overweight*
- *Physical inactivity*
- *Elevated blood pressure and cholesterol levels*
- *Heavy alcohol intake*
- *Inappropriate dietary behaviours*

*Source: Rosebery, Zeehan and Tullah Health Needs Assessment, 2000*

More recent data shows significant improvement in some measures. The immunisation rate for one year of children was up from 69% in 1999 to 97% in 2002; cancer SDR is now on 13% above state rates (down from 54%<sup>3</sup>) and the SDR from a range of 'other major causes' is 28% *below* state average.

However, by other measures, the West Coast still lags (statistics for age group 0-74):

- SDR, all causes, 25% above the state average
- SDR from circulatory diseases, 50% above state average
- SDR from ischaemic heart disease, 47% above state average
- SDR from injuries and poisonings, over double state average rates

<sup>2</sup> Most causes of death vary significantly with people's age and sex. Standard death rates improve comparability over time and between different populations, as they measure death rates independently of the varying age structures of different populations.

<sup>3</sup> Note that the age group profiled is different but there is a significant improvement nonetheless.

While a range of health services are provided to residents of the West Coast, there is often limited depth – a single practitioner or an infrequent visiting service may be all that is available and no back up if that person or service is unavailable at times. Some services are simply not available locally and a trip to Burnie or Hobart is required, relying at times on volunteer supported transport services. It has proven difficult to attract some health workers to the West Coast.

A number of factors were identified that contribute to poorer health outcomes on the West Coast:

- Lack of health education and poor chronic disease management;
- Lack of recognition of lifestyle contributions to poor health as noted above and the need for preventative approaches to health care. Isolation and restricted recreation opportunities contribute to this.
- Service delivery fragmentation and poor access for some services
- Stress arising from 12 hour mining shifts and the impacts on workers families and opportunities for recreation and community engagement

The West Coast is relatively isolated from the rest of the state. It is 2 to 2½ hours drive to the north west coast and about 3½ to 4 hours to Hobart in good conditions. However the roads are windy and hilly and often subject to adverse weather including snow and ice at times. This adds to the sense of isolation.

Frequent rain and cloud cover adds to the need for heating and gives a gloomy atmosphere that can contribute to depression and inactivity. These factors were noted in the *Health Needs Assessment* report.

Perhaps symptomatic of the malaise implied by this is the high concentration of gaming machines. In 2004 there were 75 gaming machines at 7 licensed premises in the West Coast or 14.7 machines per 1000 population. This compares to 4.7 machines per 1000 population in the state as a whole in the same year.

## 4 Social impacts assessment

The social impact assessment was based primarily on three forms of consultation with west coast residents.

- One on one depth interviews with representatives of 21 community organisations
- A telephone survey of 200 west coast residents
- A focus group in each of four towns with 7 or 8 residents in each

Detailed findings from each are included in Attachments 3 a, 3b & 3c<sup>4</sup>.

The community consultation encouraged respondents to speak freely about their views of the matters raised. It did not attempt to provide information or correct any errors of facts in the views expressed.

These views are then assessed in light of the technical review of cloud seeding operations and impacts, the socio demographic situation on the west coast and some of the economic context. This shows which community views are likely to be the result of changes in rainfall arising from cloud seeding, and which views may have arisen for other reasons.

A negative perception can have an effect whether the person with the perception has a correct understanding of the cause or not. Both the perception and the underlying cause need to be taken into account when considering impacts and ways of addressing them.

The following discussion draws together the main threads of the consultation findings. It uses the responses to all three consultation approaches, identifying the source of the finding where relevant.

### 4.1 Findings of the consultation

#### **The community's view of itself**

The following views were mostly taken from participants at the focus groups.

*'We know the names of all the kids and all the dogs'*

'Community' is the operative word – West Coasters look out for each other. This is perceived to be a very safe place for children growing up, where doors can be left unlocked and keys left in the door. Help is available when needed, and everyone knows each other. There is no rush, parking meters or traffic lights. This is not a sophisticated society, no pretentious airs and graces, and the old fashioned values still prevail.

---

<sup>4</sup> Note that the three surveys are not released publicly as they contain confidential comments that may be attributed to specific sources.

West Coasters have a real pride in relation to their unique community and situation. People here see themselves differently, something that can't be put into words. They are generally happy to be separate from the rest of the world.

*'The windy road is like the Great Wall – it keeps civilisation at bay'.*

The locals are aware of the unique environmental aspects of the built and natural landscape, and want this protected from the threats posed by outsiders and their development plans.

*'Strahan is like Lorne was 30 years ago, but Lorne has now been destroyed by wealthy baby boomers'.*

This is generally an affordable area to live in. Low mortgages means a low cost of living. Some even love the weather:

*'We can wash our cars or have a bath without feeling guilty'.*

There are some downsides with living on the West Coast ...

- health services perceived to be inadequate
- lack of affordable public transport on and from the Coast, more expensive fuel, and dangerous roads to negotiate
- more expensive and a limited range of groceries and other consumables locally available
- unsatisfactory mobile phone communications and TV reception
- a lack of support services for senior citizens (health, transport, etc)
- lack of opportunities and activities for young people, with an exodus to larger urban centres for secondary and tertiary education
- concerns about the effects of the 'seagull' workforce (eg. miners) on locals (particularly young people)
- developers and absentee business owners *'charging city prices for accommodation but country rates for wages'*, and the effect on staffing and service levels
- ... and the weather *'it can get you down'*.

### **General environmental concerns**

In the survey of community residents, cloud seeding was specifically mentioned, unprompted, by 22% of respondents as one of their principal environmental concerns, the most frequently mentioned issue. The concern was lowest for Rosebery/Tullah residents (13%) and highest for Strahan residents (34%). This is in striking contrast to the findings in Section 2 Tullah and Rosebery are most likely to be affected by cloud seeding and Strahan unlikely to be affected. The next two largest issues, rain in general and water pollution were also important issues – both mentioned by around 14% of respondents.

### **Awareness of cloud seeding**

All but one resident surveyed and all participants in other interviews and focus groups were aware of cloud seeding being conducted on the West Coast, an extraordinarily high awareness level.

Eighty three percent of survey respondents were aware that Hydro Tasmania was responsible, which is also very high.

### Knowledge about cloud seeding

Around 36% of respondents to the survey had at least some idea of what cloud seeding was, and how it happened. However, less than 10% had an accurate understanding of the process, and were able to name the cloud seeding agent used. The majority of West Coast residents interviewed have either a general, hazy or in many cases quite incorrect understanding of when and how cloud seeding happens.

Only 15% of respondents could state with any accuracy when cloud seeding was conducted, ie. the time of the year, with Strahan residents being most informed (27%) and Zeehan residents least informed (8%). Respondent comments indicate a high degree of misunderstanding as to the 'when' of the cloud seeding program. Many believe cloud seeding is conducted all year round, in the summer, just at night ... or have no idea.

### General effects of cloud seeding

When asked a general question about the effect of cloud seeding on rainfall, **(Do you think cloud seeding has affected the rainfall in general?)** the majority of those surveyed (81%) believe that cloud seeding has affected rainfall in general. When asked about the effect in different areas, they think the seeding is having a bigger impact over their towns (85.2%) and the West Coast generally (76.4%) than over the target area (56.1%), even more than the 81% who thought there was an impact in general. *This suggests that further probing of the issue caused people to increase their perception of the effect.* Table 2 summarises resident perceptions regarding where they believe there has been increased rainfall.

**Table 2.** Perception of effect of cloud seeding in different areas

Area	'A lot'	'A little'	Total*
	%	%	%
Hydro catchment areas	39.4	16.7	56.1
West Coast generally	62.6	13.8	76.4
Local area/town	67.0	18.2	85.2

\* The others said no effect or don't know.

It is notable that the towns with the highest proportion of respondents that considered there was a large effect on the towns were Strahan (88%) and Zeehan (78%), the two towns furthest from the target areas and least likely to have any effects from cloud seeding.

The 'don't know' response varied markedly for the three different areas – from 29% for the Hydro catchment areas, to just 5% for local area/town. Residents are much clearer in their minds about the effect of cloud seeding on their local rainfall as compared with the Hydro catchment areas.

The perception of the impacts of cloud seeding was also shared by community organisations interviewed, but by a much lower proportion. Six of the 21 organisations interviewed felt that cloud seeding had a significant impact on rainfall in their area (29% of this group compared to 67% of the survey group). A clear majority of community organisations (62%) believe that cloud seeding had at least some effect on rainfall in their area, but significantly less than respondent to the community survey (85%).

While many recognise that the cloud seeding is targeted at the dam catchments, there is significant scepticism as to whether the targeting is very accurate. This response was evident from the survey and was reiterated in the interviews with community groups and the focus groups.

*'The targeting of cloud seeding is not precise and much of the rainfall happens in the townships. When one looks at the topography of the area, one can see that wind streams bend through the mountain ranges; north-westerly winds are 'bent' northerly so that rain ends up in communities.'*

*'They don't hit their catchments, they hit Strahan and Queenstown'*

In contrast a minority of respondents held the view that targeting by Hydro Tasmania is quite accurate.

### **Specific effects of cloudseeding**

*'You can tell it's Hydro rain when they've seeded – it falls differently'.*

There was a diversity of views about how cloud seeding affected rainfall. These views affect the way in which people assess the impacts of cloud seeding. Many thought that cloud seeding rain was different from 'normal rain'. We noted that views were quite strongly held, given that in general residents would not know when cloud seeding is occurring. Views of the effect of cloud seeding include:

- Transforming a drizzle into a "downfall"
- Making rainfall heavier
- Colder, more persistent rain

### **Effects on activities and lifestyle**

For residents that say that cloud seeding has affected rainfall in their town, 75% believe that cloud seeding had affected their lifestyle in some way, and highest for Zeehan residents (86%).

Interviews with representatives of organisations described in more detail the ways in which activities and lifestyles are affected by rain and potentially cloud seeding. Activities reported to be affected included sports, recreation, health and well being, family activities/lifestyle and business/work, road works and other maintenance, with outdoor activities more affected than others. Specific impacts cited include:

- Attendance at sports events and community activities, some with loss of income

- Parent football supporters, feelings of depression or demoralization and cancellation or postponement of sporting events.
- Harder to attract volunteers
- Psychological effects 'log cabin fever' and 'demoralization'.
- Need to keep students inside, inside sport and non-classroom activities
- Impacts on infrastructure with some unable to cope with heavy rainfall (gutters, drains)

Some activities are carried out regardless of rain. They just plan and work around it where necessary. These include health and community services. Of the organisations interviewed, those rating the effects of cloud seeding as most significant were education followed by sports and recreation and community groups. Health reported to lowest impact on activities.

There was widespread recognition that rain affects life on the West Coast and that one has to plan for it and work around it. A number of organisations noted that rain does not affect their activities because they plan for it. One third of the organisations believed that cloud seeding (as distinct from rainfall) did not have an adverse effect on their organisation's activities either because they needed to plan for rain anyway and they can work around it, or because it did not have effect in their area beyond normal rainfall.

Nonetheless many residents are concerned about the effects on their quality of life, particularly their kids being 'cooped up' and less able to enjoy healthy outdoor activities and the general community health effects of higher rainfall (e.g. depression).

As noted by some participants in both the organisation interviews and the focus groups, many people don't clearly distinguish between the effects of rain and the effects of cloud seeding.

### **Other concerns**

Other than the additional rainfall on the West Coast, there were significant concerns about health and equity issues of cloud seeding.

People are concerned about the chemicals used in the cloud seeding process. While some are aware of the seeding agent used, few have specific knowledge of its health effects. The lack of information and knowledge leads to uncertainty and anxiety about possible adverse health effects.

Many residents are concerned that other parts of the state need the water more than the West Coast; *'We get enough rain anyway'* and *'Hydro cloud seeding dumps the rain on our communities (which don't need it) and not on the dry Midlands and East Coast'*. There is a fairly widely held perception that seeding in the West Coast reduces rainfall elsewhere and limited knowledge that rainfall in drier parts of the state typically originates from different weather systems than those seeded in the West Coast.

The question of insurance cover was raised a number of times in relation to flooding/storm/surge events, eg. Gordon River, August 2007. People wonder whether normal insurance covers 'artificially induced' flood events and whether those responsible may be sued for damage.

## Information

*'Seeding should be 'advertised' before it's done so we can re-arrange our activities'*

There was a widely expressed wish for more timely and accurate information about cloud seeding, ideally advance notice. A notice in The Advocate and on the Hydro Tasmania website some weeks after the event is seen to be less than adequate. People want to know when the flights are happening, and what the result is as soon as possible after the event (so they can see for themselves the cause/effect). They feel they are kept in the dark with little information to go on. In that environment, doubts grow and negativity flourishes.

There is also clearly an underlying concern by the community about the quality and detail of the information they have been provided. Close to 60% of those surveyed want to know more about this issue. Interestingly, 40% of the survey group did not wish to know any more about cloud seeding operations on the West Coast – despite clear misconceptions being evident re the facts of cloud seeding (and perhaps indicating either information overload or more likely distrust of what they might be told).

To the extent that there is an information vacuum, it has increased community concerns, eg. in relation to the chemicals used and possible adverse effects on community health and the environment generally. With ready access to the internet, people do their own research and can invariably find websites that support their chosen view.

There is a pressing need for more information about the facts of cloud seeding, preferably from an agency that is perceived to be independent. Survey respondents said they were more likely to trust information from the CSIRO (80%) or the Bureau of Meteorology (76%), followed the local council (68%), Environmental Departments of State and Federal Governments (both 35%) and least of all Hydro Tasmania (22%). This information would be backed up by independent studies into the benefits and safety of cloud seeding.

## General perception of cloud seeding

There were diverse views provided by those interviewed. In general, many more people were unhappy with cloud seeding than supported it. About half of those who were against cloud seeding felt that the activity was unwarranted, given the already heavy natural rainfall experienced by West Coast residents.

Those that supported cloud seeding (a small minority) cited the economic benefits of producing more electricity, took the view that it had little effect on the West Coast communities, or that, given the generally dry nature of Australia, they were thankful to have abundant water on the West Coast.

## Response to cloud seeding

Most organisations appear to have taken either no specific action to respond to perceived additional rainfall due to cloud seeding or have altered their programs or operations to reduce or avoid the impacts. Actions that have been taken included:

- cancelling or not taking on some activities that are harder to manage in the rain
- providing covered outdoor spaces for some activities
- planning indoor alternatives to outdoor activities

Community response to the situation varied from resignation, *'what can I do?'*, to pragmatic *'put another log on the fire and stay home'*, to proactive *'bought a treadmill to put in the shed so my son and I can do some exercise'*. But the response from a local accommodation business shows that even when action is taken, there is a residual cost: *'We bought another dryer. We had to do more advertising to get more visitors. We dropped our prices so lost money compared to previous times when business was good'*.

## Perception of Hydro Tasmania as the cloud seeding entity

A number of those spoken to in all three forms of consultation expressed either distrust of Hydro Tasmania or the view that Hydro Tasmania had disadvantaged the West Coast without sharing the benefits. In some cases this appears linked to the much lower presence in the community these days compared to earlier periods.

*'When Hydro workers lived in the community there was good feeling, good sense of community. When they pulled out, they left derelict buildings'*

Some have suggested that there is a degree of sneakiness or dishonesty on the part of Hydro in either not revealing information or not providing accurate information. This was raised in discussion about the lack of notification of when cloud seeding occurred. A number of respondents expressed the idea that cloud seeding took place at night (discreetly) to avoid attracting attention.

## 4.2 Summary

There is widespread agreement in the community about the adverse impacts of frequent rain. There was a substantial but not universal perception that cloud seeding makes this worse, albeit the perception was strongest in the areas least likely to be affected.

The community generally has poor information about cloud seeding: timing, likely effects, safety, etc. although some individuals are clearly well informed. The lack of information makes it harder for residents to distinguish the effects of cloud seeding from general rainfall. This contributes to their perception or at least concern about effects being worse than they are in many cases.

While more information is clearly required, there is a barrier of mistrust for a substantial part of the community to receiving information from Hydro Tasmania. Nonetheless it will be essential to provide some additional information if the community is to gain a perspective on cloud seeding effects.

It has been recognised in Section 2 that the effect of cloud seeding on areas near target catchments is not well known. To the extent that there is some impact, the community has suggested a number of possible mitigation measures and these are described in Section 6.

## 5 Economic impact assessment

### 5.1 Basis of assessment

A separate report, **Background Report 4 – Economic impacts of cloud seeding** uses the assessment of the likely minimum and maximum effects of cloud seeding on rainfall in the West Coast, and based on information from the community and other sources, estimates the likely minimum and maximum economic impacts of this.

The assessment of the economic impact of cloud seeding was based on field interviews with economic stakeholders to try to establish the kinds of effects on economic activity, and where possible gain evidence about the scale of effects. Secondary data was then used to estimate the scale of these effects when applied across the entire West Coast LGA. The first step in the process was estimating the cost of rainfall on the business. Once this had been completed an assessment of the incremental cost of the additional rainfall due to cloud seeding could be calculated.

The report looks at eleven potential sources of costs to the community and produces an assessment of the possible impact of cloud seeding on each. Costs increased by rainfall cited by economic stakeholders include:

- Increased building costs due to delays, deferred activity, the need for greater protection from rainfall etc.
- Increased maintenance costs due to constraints on timing of activities and direct impacts of water
- Additional building structures required by frequent rain (canopies, shelters etc.)
- Increased infrastructure costs (capital and maintenance) to deal with the effects of higher rainfall
- Deferred or cancelled activities, whether of a community nature or commercial
- Lost tourism business as visitors leave the area or are deterred from visiting
- Mine pumping costs due to greater water volumes

Other costs raised by the general community or identified by SGS include:

- Health and welfare costs, cited in the social impact interviews
- Loss of residents to the region (eg mining families choosing to live on the north west coast while workers commute)
- Additional cleaning costs and costs of floods
- Additional heating, lighting and drying costs

The analysis considers both the costs incurred by normal frequent rainfall and the additional effects, where they exist, of cloud seeding on these. It also considers the economic impacts of perceptions of cloud seeding where relevant.

A recurring finding of the analysis is that, while naturally occurring, heavy, frequent rainfall creates substantial costs for West Coast residents, the impacts of cloud seeding are very limited as:

- seeding takes place only in part of the year (20 days per year over 8 months),
- affects a small part of the total West Coast community, and
- has a modest effect on total rainfall in areas affected.

In particular, cloud seeding does not increase the number of days of rainfall and so is expected to have reduced effects on tourism and events.

Benefits to the state as a whole arise from additional power generation. As Hydro Tasmania is a State government owned business, the benefits accrue to all Tasmanians, not just to West Coast residents. Based on a state population of just under half a million, the low estimate of the benefit of additional power generated is about \$7.50 per person per year. In terms of the total West Coast population of about 5150, this amounts to about \$38,000 per year. This is used in calculating the benefit of additional power to the residents of the West Coast.

The maximum impacts calculated are based on assuming the maximum impact of cloud seeding as an 8% increase in rainfall in affected areas during seeded months. This is much higher than Hydro Tasmania uses when estimating benefits from cloud seeding. The high estimates for costs based on rainfall increases of 8% are almost certainly too high.

The minimum effect is based on much lower – and more realistic – effects of cloud seeding within the catchments and less effect in areas outside of the targeted catchments. Actual effects may be more than the minimum but are likely to be substantially less than the maximum effects estimated. A summary of the findings are shown in the table below.

The costs associated with **high rainfall** on the West Coast are substantial, of the order of \$20 million for those costs for which estimates were made. These costs are substantially dominated by the costs to the mines. However, even assuming the highest possible impacts from cloud seeding, the additional costs are assessed as being a small portion of total costs arising from rainfall at \$185,000. Again, these are dominated by costs to the mines. The estimated minimum additional costs attributed to cloud seeding are low at about \$20,000 per year.

For Tasmania as a whole, cloud seeding offers a substantial cost benefit of at least \$3.7 million. For West Coast residents, the benefits exceed the cost for the minimum impact estimate, but costs exceed the direct benefits to the West Coast community for the maximum impact estimate. Costs in this case are heavily dominated by the costs to the west coast mines (two thirds) rather than the broader community.

For lost tourism business and loss of residents to the region, the perceived impact of cloud seeding and high rainfall are likely to be far greater than the direct costs arising from cloud seeding.

Table 3. Costs and benefits of cloud seeding

Cost item	Cloud seeding impact	Estimated max additional cost, normal rainfall	Cloud seeding incremental cost	
			Max	Min
Construction	Minimal	\$600,000	\$15,000	\$0
Maintenance	Minimal	\$750,000	\$10,000	\$0
Building structures	None	ne		
Infrastructure	Some	\$650,000	\$21,000	\$5,000
Deferred or cancelled activities	Minimal	\$120,000	\$6,000	\$1,000
Lost tourism business	Minimal	\$1,800,000	\$12,500	\$0
Mine operating costs	Significant	\$16,000,000	\$120,000	\$10,000
Health and welfare	Negligible	ne		
Loss of residents to the region	None	ne		
Cleaning, Floods	Unlikely	ne		
Heating and lighting costs	None	ne		
<b>All costs (rounded up)</b>			<b>\$185,000</b>	<b>\$20,000</b>
<b>Benefits of cloud seeding</b>				
Additional power generated net of seeding costs	Direct			
- Statewide benefit			\$8.0 million	\$3.7 million
- Benefit to West Coast residents			\$80,000	\$38,000
Regular reliable water supply	Negligible	ne		
<b>All calculated benefits</b>				
- Statewide benefit			<b>\$8.0 million</b>	<b>\$3.7 million</b>
- Benefit to West Coast residents			<b>\$80,000</b>	<b>\$38,000</b>
<b>Net benefit (rounded)</b>				
- Statewide benefit			<b>\$7 million</b>	<b>\$3.7 million</b>
- Benefit to West Coast residents			<b>-\$105,000</b>	<b>\$18,000</b>

ne: not estimated as no additional effects from cloud seeding expected.

## 6 Preliminary overview of possible responses

The assessment of the social and economic impacts of cloud seeding show that there are some real costs on the West Coast community, albeit the range of estimates is very large. In the minimum case, it is arguable that these costs are negligible. The level of detailed information on additional rainfall in local areas makes a more precise assessment impossible at this time.

During the telephone survey and focus group phases of the project, stakeholders were asked directly what measures they thought could be adopted to mitigate or minimise the impacts of cloud seeding on themselves and the broader community. This section provides a record of their responses. It is unlikely that a single solution will suit everybody.

SGS understands that Hydro Tasmania will use these responses as a starting point for discussions with stakeholders.

At this stage none of these are put forward as recommendations, merely potential options that one could choose from with some comments on the implications and pros and cons of each.

### **Stop cloud seeding entirely**

Given the high benefit to cost ratio for the state as a whole, this seems to be a sub-optimal choice.

### **Stop all cloud seeding in tourism season – April, October, November**

This could reduce the impact on tourism by up to 50%, with a much smaller relative effect on cloud seeding benefits. There are a limited number of seeding days in April – on average less than three – and in November – average less than 2 – reducing the total number of seeded days based on an average year by about 20%. Further, there are indications that seeding effectiveness may be less in spring (September to November), therefore less is given up in yield.

However, against this, the estimated impact of cloud seeding on tourism even in the maximum impact estimate is very small, under \$5,000 per year, compared to an average benefit of \$185,000 per successful seeding event.

### **Move target boundaries for King and Upper Pieman to the east**

Targeting currently aims to cause more rain to fall from near the edge of the catchment and down wind from there, placing the bulk of the seeded rain within the catchment. However, if the dynamics of the wind and other factors are not as expected, some rain may fall outside of the catchment. Rainfall outside the catchment is of no value to Hydro Tasmania.

Moving the target boundary to the east would reduce the probability of rain falling outside the catchment and affecting the West Coast community. To the extent that it reduces unintended seeded rainfall on the West Coast community, all impacts from cloud seeding would be reduced.

Moving the boundaries eastward may result in some rain overshooting the target catchment and being lost downwind instead of upwind. This is only a risk for the King catchment where parts of the downwind area are not in other Hydro Tasmania catchment areas

A more significant effect may be that the seeding misses the orographic lift in some cases, particularly when winds are light. Assessing this would require more detailed physical analysis and is beyond the scope of this report.

Other effects are that rainfall distribution between catchments may be less balanced. That is, King and Upper Pieman catchments may receive less additional rainfall even though they may have unused storage capacity, while Mersey Forth and Upper Derwent catchments may receive more than they can store. Assessing these operational effects are beyond the scope of this report, but Hydro Tasmania may be able to comment on this.

The combination of missing orographic uplift and overshooting the catchment to non-dam catchment areas may substantially reduce the potential additional yield in the King catchment. If the reduction were too severe, it may not be worth targeting the catchment any more if the boundary were shifted. Offsetting this, the King catchment is relatively infrequently targeted already.

### **Stop cloud seeding King and/or Upper Pieman catchments in tourism season – April, October, November**

While the case for stopping cloud seeding entirely in the tourist season may be extreme, the case for stopping seeding in the catchments closest to the West Coast community is somewhat stronger.

A detailed analysis of the seeding flight log books shows that the King catchment is targeted on average less than once (0.7 times) in April each year, 0.6 times in October and 0.2 times in November. Further, on only two occasions was the King catchment targeted alone, both in October, with every other case the King being one of two or more catchments targeted.

The Upper Pieman catchment is targeted more often in general, and in these months as well: April 0.7, October, 1.8, and November 0.5 times per year. The Upper Pieman is targeted on its own more often – seven out of 89 seeding events or 8% of the time – but still relatively infrequently. Only two of these occurred in the three months proposed, both in October.

While seeding in these catchments would be reduced by about 4 events per year, in most case seeding would still be able to proceed in other catchments (all but 0.4 events per year on average), so only a small part of the benefit would be lost.

For many years, as seeding doesn't occur in these areas often at that time of year, there would be no loss of seeding opportunities. Arguably there would also be no benefit for the same reason, but a commitment not to seed in these areas at this time could help improve the perception of cloud seeding and of the approach taken by Hydro Tasmania in the community.

### **Move target boundaries to the east for King and Upper Pieman during the tourist season**

This is another variant on reducing impacts explored above. It combines some of the features of previous options, but arguably has the lowest impact on foregone seeding opportunities while providing most of the benefits. It would have the lowest effect on perceptions however.

### **Establish a cloud seeding liaison group**

This was suggested by some community members. One organisation recommended a similar arrangement to the Liaison Group established for the Lake Margaret Pipeline be created as a means of improving communication and understanding.

The liaison group would include two to three representatives from each of Hydro Tasmania and the community nominated by the West Coast Council. While it would meet relatively frequently at first, meetings would be reduced to an as needs basis when the mode of operation becomes established.

The group would provide an informed forum to resolve operational issues that affect the community and ensure that information was provided on any changes or developments arising from cloud seeding activities. It is proposed that such a group should be established with a sunset clause.

### **Use dispersion modelling to improve targeting**

Most effects on the West Coast community arise from seeded rain falling outside of the target areas. This 'lost' rain contributes to any adverse effects and represents 'lost' rain for Hydro Tasmania. As such, it is in everyone's interest to minimise this effect.

Dispersion modelling has been proposed as a way of increasing the accuracy of targeting. However, at this time the degree of potential benefit in improved targeting is not known.

Clearly the use of dispersion modelling will add to the complexity and cost of operations.

The potential benefits and additional costs should be assessed before implementing this approach. However, it may provide a cost effective way to achieve a result that benefits all parties.

### **Conduct additional limited experiments**

One of the disadvantages of conducting more experiments on cloud seeding is the need to have control days – days suitable for seeding that are not seeded. These foregone opportunities have a substantial cost, as noted, of the order of \$185,000 per event. However, a limited set of experiments could be conducted to determine the effects of cloud seeding on the two catchments closest to the West Coast communities. This would potentially have several benefits:

- The opportunity cost would be substantially reduced, arguably by more than two thirds as on average about three catchments are targeted on each seeding flight and these two catchments are targeted less than average (King in particular).

- The information provided would give insight into the value of targeting these specific catchments and potentially the effects of targeting accuracy and impacts on the communities on the edge or just outside of the target areas. If it leads to improved targeting, less wasted seeding effort, and reduced impacts on the community, both Hydro Tasmania and the West Coast community would benefit from the findings. To the extent that it enabled impacts on non-target areas to be better quantified, it would reduce the uncertainties of the community about seeding effects.
- The concentration on a smaller area may allow a greater density of rain measuring devices to be deployed.
- It may be feasible to combine the experiment with dispersion modelling and supplement it with physical observations, arguably more easily achieved in two smaller areas near population than across all of the Hydro Tasmania catchments.

Potential disadvantages include:

- The areas may be too small to isolate from seeding in other catchments. Just as some seeded rain may 'spill' from these catchments upwind into the West Coast communities, so seeding activity in Mersey Forth or Upper Derwent may affect the King and Upper Pieman.
- The frequency of seeding in these two catchments is already low. By having control days as well, seeding frequency may be so low that meaningful results take many years to accumulate.
- Continued seeding of these catchments may prevent some of the other actions proposed from being implemented, maintaining animosity from the community toward Hydro Tasmania.

### **Install additional rain gauges**

Some community members believe that additional rain gauges may better assist relating cloud seeding activities to actual rain experienced in their area. Additional rain gauges could provide them with more opportunity to see these connections.

### **Provide real time 'information' to the community on cloud seeding**

A frequently voiced concern of the community was that they were poorly informed about cloud seeding activity, particularly when and where it takes place. Reports are published generally some weeks after seeding has occurred, too long after the event for residents to relate seeding to any rain events that occurred.

It may be possible to provide an engaging information service: 'sky watch', with regular 'live' reports from the CSO to the local radio station. It would have to be designed to ensure safe operation and not reduce the effectiveness of seeding. For safety and operational reasons, the pilot would have control of initiating all calls in. The radio station could record these for broadcast at the first opportunity (eg the next hourly news bulletin). The CSO might call in:

- When they take off
- When they make a go/no go decision to seed
- When seeding starts and stops and over each target

- Where seeding physically occurs (ie the area over which they are flying rather than the target)
- Possibly some description of cloud and other weather conditions during seeding
- When the plane is back on the ground

It may also be engaging to invite listener feedback: Did they see any effects on the ground and if so what?

Over time it is expected that the listeners will be most impressed with the low frequency of seeding compared to the frequency of rain. It may also be useful to see how perceptions of rain events on the ground relate to the particular targets of different seeding events. This becomes possible by linking nearly real time information about seeding with residents' experiences. There may or may not be any observed effects on the ground associated with seeding events in any catchment.

### **Upgraded flood forecasting**

While there has been no demonstrated cases of seeding causing flooding, and current practice is to avoid seeding that could affect areas with flood warnings, the current flood forecasting is recognised as fairly basic, and conditions might arise when seeding could potentially aggravate a flood event. By developing more sophisticated flood warning methods, this risk could be further reduced to the point of near zero probability. In addition, the wider community could benefit from improved flood warnings, even if not related to cloud seeding.

One potential negative is that if Hydro Tasmania supports such an initiative, some in the community would see it as an admission that they have some responsibility of past flood events. It needs to be made clear that this is not the case.

### **Truly independent referee**

West Coast Council has observed that the current referee is a Hydro Tasmania employee working within the Hydro Tasmania organisation. They believe that an operations referee needs to be more independent to have the confidence of the community concerning operating decisions that may affect the community.

### **Sponsorship**

Many in the community expressed the view that if cloud seeding continues, Hydro Tasmania should mitigate the effects with community infrastructure support funded to some extent by the Hydro Tasmania, with Government support, e.g. building shelters, indoor sports facilities, and better health facilities. Industry assistance to affected industries would also be justified, e.g. reduced power rate and 'free pump time' to compensate industry for Hydro caused water infill to mines. One suggestion was for a 'resilience' program. Funds could be made available for sporting groups e.g. \$100k for grant proposals, hut request for Scouts, grandstand for football or bus for the community.

Even if small, it may be appropriate for Hydro Tasmania to recognise that seeding does impose some real costs on the community from additional rain. While it will be virtually impossible to tie particular impacts to seeding, sponsoring a series of events or local organisations could be welcomed by the community.

- **The sponsorship may be for events that celebrate rain!** To lift community spirits; or to attract tourists in off season
- **Provide education and training:** Wet weather construction and maintenance approaches; designing for a wet climate
- **Payment of rates to the West Coast Council instead of rate equivalent payments to State treasury.** This may require legislative change.

It is likely that other creative suggestions may be forthcoming so it is not recommended that the scope of projects funded be too limited.

### **Provide community education about the facts of cloud seeding**

Community members observed that major misconceptions abound, including a commonly held view that if there's a plane heard above and it rains, it's due to cloud seeding (whether in summer, winter, autumn or spring). And for some a rain event means 'they must be cloud seeding'!

Achieving a wide circulation and readership of the reports supporting this project would be difficult. However, there were a number of requests for more information on aspects of cloud seeding. These could be provided in the form of 'fact sheets' each one addressing one topic, so residents could readily get answers to specific issues without having to read a large report.

These could be reproduced in the media, made available at schools (for study projects) or distributed through other public venues (libraries, internet access centres).

Some community members suggested that communication and public relations staff should be utilized.

### **Avoid poorly informed, negative comment about cloud seeding and rainfall**

The economic assessment noted instances where the cost of *perceptions* about cloud seeding and rainfall are likely to far exceed the actual costs. To the extent that this is so, it is important to ensure that discussion or information about these issues are as balanced and accurate as possible. It would be inappropriate to attempt to discourage or prevent discussion of the issue. However, responsible stakeholders have an interest in ensuring that these issues do not become the main image identified with the area, potentially harming the best interest of the wider community. This was commented on by a number of community residents that felt this is already occurring.

### **Establish a joint position between Hydro Tasmania and the West Coast Council on cloud seeding issues and communications**

It would aid in providing credibility to communications to the public about cloud seeding if the information put out by all parties was consistent. To achieve this would require that areas of agreement are identified, and areas of uncertainty acknowledged by both sides. Agreement about the importance of resolving uncertainties would also be desirable.

### ***Other community suggestions***

#### **Alternative energy sources to hydro (eg wind)**

Some members of the focus groups would like to see Hydro Tasmania investigate other (more environmentally friendly) forms of energy generation, including more efficient re-use of water in its dams for power generation, and the recommissioning of the Lake Margaret Power Station.

#### **Recommission Lake Margaret Power station and open as tourist attraction**

Hydro could create some positive PR by re-opening the Lake Margaret Power Station and the adjacent village as a tourist attraction. It was regarded as a wonderful resource sitting there doing nothing. A working power station would be a unique tourist attraction (oldest in southern hemisphere) as well as providing power.

#### **More Hydro Tasmania staff and presence in the community**

Some people would like to see Hydro Tasmania having a stronger presence in the community – via a local office or agency. They would like to see Hydro Tasmania staff living on the Coast to ‘see what it’s really like’.

There was a general view that Hydro Tasmania needs to have more dialogue with the community. They need to discuss the times and areas that they cloud seed, and take into consideration West Coast activities such as school and sporting events. They need local, on-ground knowledge, better monitoring, and to change flight paths to seed closer to the target areas. In general, Hydro should gain an appreciation of what happens on the West Coast.

#### **Avoid seeding on the days of specific events, holidays**

Some community members requested that seeding avoid days of major public events which involve organised outdoor activities, and if possible also school holidays and weekends.

#### **Make cloud seeding subject to a development application**

Some thought cloud seeding operations should be put in as a development application to Council just like all other operators and developers have to.

#### **Wood heater buyback scheme**

That Hydro fund a wood heater buy back scheme for residents in the three affected towns, Tullah, Rosebery and Queenstown. An amount similar to the Launceston scheme of \$500 was suggested for residents to replace wood heaters with electric ones with council administering the funds on Hydro’s behalf.

Attachments

**Background Report 1, Effects of Cloud Seeding on Rainfall in the West Coast, SGS  
Economics & Planning**

**Background Report 2 Socio-economic profile of the West Coast community, SGS  
Economics & Planning**

**Background Report 3a Community group interviews, Myriad Consultancy**

**Background Report 3b Community Survey, Myriad Consultancy**

**Background Report 3c Focus Groups, Myriad Consultancy**

**Background Report 4, Economic Impacts of Cloud Seeding, SGS Economics & Planning**

Background reports 3a, 3b and 3c have been provided to the West Coast Council and Hydro Tasmania on a confidential basis. As some sensitive views may be attributed to individuals the detailed comments are not being published for wider circulation.