Otago Regional Council

MEMORANDUM

To:	**Air Quality Project team**
From:	**Sarah Harrison, Scientist – Air Quality**
Date:	**14 February 2025**
Re:	**Summary of air quality management options**

Purpose

ORC has commissioned a number of reports to inform air quality management options for the upcoming reviews of the Air Strategy and Regional Plan: Air. The purpose of this memo is to summarise the outputs of three reports addressing:

- Estimations of particulate matter reductions required to meet air quality standards and guidelines in Otago's polluted airsheds[1]
- Regulatory and non-regulatory mechanisms most likely and most efficiently to achieve reductions based on other successful air quality programmes[1,2]
- Estimating the human health costs and benefits associated reductions[2,3]

Background

Regional councils are required to monitor air quality anywhere national standards are unlikely to be met. In recent years ambient air quality standards and guidelines have been updated. The table below lists the current (2004) and proposed (2020) New Zealand standards (National Environmental Standards for Air Quality, NESAQ) and guidelines (Ambient Air Quality Standards, AAQG) for Otago's pollutants of concern: PM_{10} (particles less than 10 micrograms in diameter) and $PM_{2.5}$ (particles less than 2.5 micrograms in diameter).

The current NESAQ limits were based on the World Health Organization (WHO) guidelines 2005. In 2021 WHO undertook an update based on the previous 15 years of new research. This increased understanding of the health impacts of air pollution and led to a focus on $PM_{2.5}$. The health impacts of $PM_{2.5}$ are greater due to smaller particle size. The guidelines contain 24-hour and annual limits; these correspond to of chronic and acute health impacts, respectively.

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[1] Wilton, 2023

[2] Wilton, 2025

[3] Wilton and Zawar-Reza, 2024

Table 1 Air quality standards and guidelines for PM_{10} and $PM_{2.5}$

Pollutant	Averaging Time	NESAQ 2004		Proposed NESAQ 2020		WHO 2021	
		Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances
PM_{10}	24-hour	50	1 per annum	50	1 per annum	45	3-4[b]
	Annual	20[a]	NA	NA	NA	15	NA
$PM_{2.5}$	24-hour			25	3 per annum	15	3-4[b]
	Annual			10	NA	5	NA

[a] AAQG
[b] 99th percentile, 3-4 exceedances per year

To determine which standards and guidelines are most appropriate to use as targets, a review (Wilton, 2023) of the criteria and their technical support in terms of health research was undertaken. This review concluded the annual $PM_{2.5}$ WHO guideline provides the best level of health protection for the following reasons:

- $PM_{2.5}$ is a better indicator of combustion sources than PM_{10} (which also has natural sources). It is also more harmful to human health than PM_{10}.
- Chronic exposure is more detrimental to human health outcomes, even though there are groups within populations that would be vulnerable to acute exposure as well. Annual limits are therefore more protective than 24-hour limits.
- The 2021 WHO guideline values represent the concentration limit at which there are no negative health outcomes.

Air quality management scenarios

To estimate the improvement required for annual $PM_{2.5}$ concentrations for each airshed relative to the potential targets WHO annual guideline for $PM_{2.5}$ and NESAQ for PM_{10}, ORC commissioned a required reduction model (Wilton, 2023) for the following airsheds: Alexandra, Arrowtown, Clyde, Cromwell, Milton and Mosgiel[4]. To assess how the required reductions compare to relatable change scenarios for communities, the required reductions were then compared to reductions achieved through different burner scenarios listed below based on understanding the key PM sources:

- **Only ULEB[5] for new installs:** When people are replacing or adding a burner to their home, it must be an ULEB.
- **Phasing out non-ULEB[6] burners:** This includes using financial assistance in the form of subsidies or loans to help people transition to ULEBs faster than they would normally.
- **Outdoor burning controls:** This includes both increased regulation for outdoor burning within airsheds and introducing regulation to better protect polluted airsheds from the impacts of outdoor burning from the surrounding areas (buffer zones).

[4] All six airsheds are long-term monitoring sites in breach of the NESAQ.
[5] Ultra low-emission burners (ULEB) must meet an emissions and efficiency standard of 38 milligrams per megajoule of useful energy and have thermal efficiency of over 65%. These burners must comply with the Canterbury Method 1 (CM1) test.
[6] Non-ULEB burners may include NESAQ compliant burners (must meet an emission rate less than 1.5 g/kg and thermal efficiency of over 65%), open fires, multifuel burners and coal burners.

- **Behaviour change programme:** This addresses the way that burners are used, in order to reduce emissions. This includes education and regulation (for example, identifying gross emitters and working with them to ensure better burning practices), either by using complaints or smoky chimney monitoring.

To facilitate comparison of scenarios, a standard implementation timeframe of 2040 was chosen. While arbitrary, this date was selected based on an average wood burner lifespan of 15-20 years.

The scenarios listed above have comprised components of successful air quality improvement work in other regions, providing the largest benefit when used in combination with each other. Model inputs, limitations, sources of variation and uncertainty are summarised in appendix 1.

Health impacts

To provide an indication of the health benefits of the modelled scenarios within the six airsheds, the HAPINZ (Health and Air Pollution New Zealand) 3.0 model (Kuschel et al., 2022) was applied to Otago airsheds (Wilton and Zawar-Reza 2024; Wilton 2025). The HAPINZ model can be adjusted to change the area included, the populations exposed and the concentrations they are exposed to. The result is the number of health metrics associated with the modelled annual $PM_{2.5}$ concentrations achieved under the scenarios including premature mortality, cardiovascular and respiratory hospitalisations[7] and restricted activity days[8]. The HAPINZ model includes an estimate of social costs, which are differentiated from health costs, as they include all costs to society, not just the costs to the health system. The below HAPINZ model costs (based on 2019 prices) were used in this analysis:

- VoSL (Value of a statistical life[9]) $4,527,300 per death
- Cardiac admissions $36,666 per case
- Respiratory admissions $31,748 per case

Key limitations of the health modelling are discussed in appendix 2.

Modelling results

The impact of each pathway on air quality concentrations, probability of meeting air quality targets, and on health in terms of social costs and costs saved are highlighted in Table 2. This table only includes options with a 20-year burner phase out, which aligns with the 15 – 20-year burner lifespan, to provide direct comparability. Other options were modelled (15-year and 25-year burner phase-outs) to provide further resolution in terms of costs to council under differing implementation timeframes. The details of these pathways can be found in appendix 3.

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[7] Hospitilisations are valued based on the average number of bed nights in hospital.
[8] Valued based on the costs of lost average income per day.
[9] The VoSL used by HAPINZ is the one used to cost deaths from road crashes in New Zealand.

Table 2 Modelled impacts of each pathway on air quality and health costs of each airshed (20-year burner phase outs only)

Airshed	Alexandra	Arrowtown	Clyde	Cromwell	Milton	Mosgiel
PM2.5 % reduction required to meet WHO guideline	57%	48%	38%	57%	43%	23%
Status quo at 2040						
AQ outcome (concentration reduction by 2040)	22%	22%	17%	16%	23%	3%
Health cost 2040 ($million/year)	**29.1**	**2.1**	**20.8**		**7.5**	**46.9**
NESAQ compliance PM10	No	No	No	No	No	No
WHO compliance PM2.5	No	No	No	No	No	No
Only ULEB for new installs						
AQ outcome (concentration reduction by 2040)						15%
Health cost 2040 ($million/year)						40.7
Health outcome (costs saved by 2040 ($million/year))						6.2
NESAQ compliance PM10						No
WHO compliance PM2.5						No
Phase out non-ULEB (financial assistance)						
AQ outcome (concentration reduction by 2040)	42%	48%	30%	28%	43%	37%
Health cost 2040 ($million/year)	22.1	1.6	18.1		5.4	31.2
Health outcome (costs saved by 2040 ($million/year))	7	0.6	2.7		2.1	15.8
NESAQ compliance PM10	No	Yes	No	No	Yes	Yes
WHO compliance PM2.5	No	Yes	No	No	Yes	Yes
Phase out non-ULEB (financial assistance) + outdoor burning controls						
AQ outcome (concentration reduction by 2040)		48%	33%	47%	45%	37%
Health cost 2040 ($million/year)		1.6	14.1		5.4	31.2
Health outcome (costs saved by 2040 ($million/year))		0.6	6.7		2.1	15.8
NESAQ compliance PM10		Yes	Yes	Yes	Yes	Yes
WHO compliance PM2.5		Yes	No	No	Yes	Yes
Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme						
AQ outcome (concentration reduction by 2040)	45%	Compliance met with previous options	38%	50%	Compliance met with previous options	
Health cost 2040 ($million/year)	21		13.2			
Health outcome (costs saved by 2040 ($million/year))	7.9		7.6			
NESAQ compliance PM10	Yes		Yes	Yes		
WHO compliance PM2.5	No		Yes	Yes		
Ban all solid-fuel burners						
AQ outcome (concentration reduction by 2040)	75%	Compliance met with previous options				
Health cost 2040 ($million/year)	9.9					
Health outcome (costs saved by 2040 ($million/year))	19.2					
NESAQ compliance PM10	Yes					
WHO compliance PM2.5	Yes					

Table 3 Overview of the pathways and their combined impacts

	WHO compliance		NESAQ		Status quo	
A	**Alexandra**	Ban SFBs	**Alexandra**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme	**Alexandra** **Arrowtown** **Clyde** **Cromwell**	Only ULEB for new installs
B	**Clyde** **Cromwell**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme	**Arrowtown** **Clyde** **Cromwell** **Milton** **Mosgiel**	Phase out non-ULEB (financial assistance) + outdoor burning controls	**Milton, Mosgiel + other gazetted airsheds**	NESAQ burner compliance
C	**Arrowtown** **Milton** **Mosgiel**	Phase out non-ULEB (financial assistance)	**All other urban areas**	Only ULEB for new installs	**All other urban areas**	NESAQ burner compliance
D	**All other urban areas**	Only ULEB for new installs				
Air quality outcomes in monitored airsheds	Average PM2.5 decrease of 49%. Compliance with WHO annual PM2.5 guideline in monitored airsheds. Compliance with NESAQ in all airsheds except Clyde and Cromwell		Average PM2.5 decrease of 42%. Compliance with WHO annual PM2.5 guideline in Arrowtown and Mosgiel and come within 0.5 µg/m³ in Clyde and Milton. Compliance with NESAQ PM10 standard in all airsheds		Average PM2.5 decrease of 18%. No compliance with WHO or NESAQ for any airsheds	
Health outcomes in monitored airsheds	A 45% reduction in adverse health impacts with cost savings estimated at $48 million per year		A 31% reduction in adverse health impacts with cost savings estimated at $33 million per year		Total health cost of $106 million	
Air quality outcomes – other urban areas	Improvements and/or prevention of degradation in high growth areas				Air quality is at risk of becoming degraded in areas of urban growth	
Health outcomes – other urban areas	Total health cost of $388 million Health cost savings of $42.8 million (10% reduction)				Total health cost of $431 million	

Discussion

The modelling provides the minimum intervention required to achieve compliance with differing air quality guidelines in each airshed, and with differing implementation timeframes for three relatable scenarios[10]. Given the number of scenarios and information available, ORC is able to assess compliance under the modelled scenarios or alternative, scenarios not modelled here. Compliance pathways with potential targets are discussed below.

WHO compliance pathway

In this pathway, meeting the annual $PM_{2.5}$ WHO guideline requires a phase out of non-ULEB burners in Arrowtown, Milton and Mosgiel. This would reduce $PM_{2.5}$ concentrations by 48%, 43% and 37% respectively.

For Clyde and Cromwell, further interventions would be required, such as a behaviour change programme and ensuring outdoor burning is controlled within and outside the airshed boundaries. These interventions, in combination with a non-ULEB phase out, would reduce $PM_{2.5}$ by 38% in Clyde and 50% in Cromwell.

For Alexandra, the above combination of options only reduces $PM_{2.5}$ by 45%, compared with the 57% required to meet the WHO guideline. Therefore, the only modelled pathway to compliance would require banning wood burners. It is noted that the health benefits of improved air quality may be offset by detrimental health impacts due to having a cold home. It is therefore not recommended that ORC ban wood burners in Alexandra. The health outcomes of this pathway include social costs of $58 million, a 45% reduction, including Alexandra. If Alexandra was shifted to the same management pathway as Clyde and Cromwell, the social costs would be $69 million and a 35% reduction.

NESAQ compliance pathway

The NESAQ compliance pathway requires that all monitored airsheds have a phase out of non-ULEB as well as outdoor burning controls, except for Alexandra which also requires a behaviour change programme. The air quality outcomes would be a 45% reduction in PM2.5 and social costs of $21 million, a 28% reduction.

In comparison with the WHO pathway outlined above, the required level of intervention is very similar for Arrowtown, Milton and Mosgiel, with the exception of the addition of outdoor burning controls which would ensure the airsheds are better protected from burning beyond the boundaries of the airsheds and/or non-home heating burning.

For Clyde and Cromwell, NESAQ compliance requires less than the WHO compliance pathway. The health outcomes of this pathway include social costs of $73 million which is a 31% reduction compared to the status quo.

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[10] The first iteration of options (Wilton 2023) produced four pathways, however it was later decided three would be enough for comparison. One of the mechanisms, no burners in new dwellings, was removed from all pathways for the second iteration of scenarios (Wilton, 2025). The reason is that this would likely only be successful if the new dwellings in question are built beyond current standard level of insulation and would come at increased cost to the homeowner. Other feedback from ORC included a desire to further differentiate between the pathways in terms of cost; the original four pathways were similar in terms of implementation costs. The different time frames for burner phase-outs were introduced to address this as well as a pathway for NESAQ compliance to be modelled.

Other urban areas

The impact on health in other urban areas (including but not limited to all the other gazetted airsheds) was also modelled to assess the impact of ULEB emission criteria and behaviour change programmes. The outcome of only ULEB for new installs in other urban areas was estimated to be a 10% reduction from $431 million/year to $388 million/year.

Table 4 Estimations of health costs for other urban areas

	Other urban areas
Status quo at 2040	
Health outcome (COST $million/year)	**431**
Only ULEB for new installs	
Health cost 2040 ($million/year)	388
Health outcome (costs saved by 2040 ($million/year))	42.8
Health outcome (% cost reduction)	10%
Behaviour change programme	
Health cost 2040 ($million/year)	412
Health outcome (costs saved by 2040 ($million/year))	18.9
Health outcome (% cost reduction)	4%
Only ULEB for new installs + behaviour change prorgramme	
Health cost 2040 ($million/year)	379
Health outcome (costs saved by 2040 ($million/year))	52.4
Health outcome (% cost reduction)	12%

References

Kuschel, G., Metcalfe, J., Sridhar, S., Davy, P., Hastings, K., Mason, K., Denne, T., Berentson-Shaw, J., Bell, S., Hales, S., Atkinson, J., Woodward, A. (2022) *Health and air pollution in New Zealand 2016 (HAPINZ 3.0).*

Wilton, E. (2023) *Air Quality Management in Otago – An evaluation of management options to achieve air quality targets for PM10 and PM2.5 in Arrowtown, Alexandra, Clyde, Cromwell, Milton and Mosgiel.*

Wilton, E., Zawar-Reza, P. (2024) *Health benefits of improved air quality in Alexandra, Arrowtown, Cromwell, Clyde, Mosgiel and Milton – Assessment of impacts – HAPINZ 3.0.* Envirolink Report 2512-ORC.

Wilton, E. (2025). *Air Quality Management in Otago – Health benefits of refined regulatory options.*

Appendix 1: management scenarios

Projections inputs

The projections of impacts of the management options depends on the existing distribution of burners (burner ages and types) and how that will change in the future. The main inputs were:

- Current contaminant concentrations in ambient air.
- Population projections from district council data.
- Household appliance fleet numbers, emission sources and average fuel quantities from emission inventories (Wilton 2016 for Alexandra, Arrowtown, Milton and Mosgiel, and Wilton 2019 for Clyde and Cromwell) and census data.
- Proportion of new dwellings installing wood burners from the relationship between wood use and dwelling increases using census data.
- Retainment of non-compliant burners since the introduction of the current Air Plan and whether these numbers have changed since the emission inventories.

Sources of variation

- **Effectiveness of ULEB technology:** Real life testing shows significant variability in the emissions of burners, and this largely depends on behaviour. The modelling used an emission factor[11] of 2 g/kg which is based on a small number of in-home testing research studies. The emission factor for LEB/NESAQ compliant burners, 7.5 g/kg, is more recognised as it's based on a larger number of studies.
- **Extent of ULEBs in existing fleets:** Because the current Air Plan rules don't line up with LEB and ULEB definitions, some but not all AZ1[12] compliant burners will already be ULEBs, and this fraction is unknown. Therefore, all burners installed before 2020 in AZ1 towns are assumed to be NESAQ compliant only, and those installed after 2020 are assumed to be ULEB based on when ORC's website added an approved burners list consisting of only ULEB options for wood burners.
- **Contributions of outdoor burning within the airsheds:** The 2019 emissions inventory (Clyde and Cromwell) found that there is likely a contribution to anthropogenic emissions from outdoor burning from within the airshed, so it is possible that this applies to other airsheds as well. This does not include outdoor burning emissions that may enter the airshed from outside its boundaries.

Method assumptions

- Contribution of natural sources such as sea salt and dust requires source apportionment data to estimate background concentrations. In the absence of Otago source apportionment data, those of other New Zealand airsheds were used; Central Otago airsheds were based on Blenheim where background PM = 3.6 $\mu g/m^3$. The coastal airsheds were based on Nelson where background PM = 6.9 $\mu g/m^3$, and in addition a greater fraction of coarse PM reflective of the sea salt contributions was assumed.
- Real life emission factor of AZ1 compliant burners. These were given the same emission factor (7.5 g/kg) as LEB/NESAQ compliant burners as there is no available data to suggest otherwise.

[11] Emission factors are the measured real-life emission rates from in-situ wood burners. They differ from emission rates, which are determined by standardised testing of the burners.

[12] Air Zone 1 towns are Alexandra, Arrowtown, Clyde and Cromwell

- The estimations of PM vehicle emissions were taken from the Vehicle Fleet Emissions Model (VFEM), which suggests a decrease in emission rates by 2040 (63% for $PM_{2.5}$ and 57% for PM_{10}).
- Industrial emissions were assumed not to increase before 2040.
- The impact of behaviour change programmes was assumed to contribute a 10% improvement in air quality concentrations.

Method uncertainty

- **Calculation of $PM_{2.5}$ annual concentrations:** This is the main source of uncertainty. $PM_{2.5}$ was calculated in many cases, based on PM_{10} data. In addition, some of the sites were only monitored during winter so in these cases the summer concentrations were estimated to provide annual averages.
- **Real-life emission rates of ULEBs:** Over the years there has been a change in functionality in ULEB designs, from the early ULEBs which were manufactured to limit emissions regardless of burning behaviour, to newer ULEBs which are capable of low emission rates but only with certain burning behaviour which cannot be guaranteed. Because of these uncertainties, all the resulting management options would work well if approached iteratively.

Appendix 2: health costs

The purpose of modelling the health costs and benefits was to produce an indicative scale of change, rather than exact health costs. The limitations are listed below:

- Pollution concentration response relationships were taken from national data and applied to small populations. It was therefore assumed that the distribution of underlying health issues from larger populations are the same in smaller populations.
- The data in the HAPINZ 3.0 model was for the year 2016. This analysis produced estimated outcomes for 2021 and 2040 based on population projections, but still assumes demographics and therefore health assumptions for the 2016 situation. This is unable to be changed but has a relatively low impact on the modelled results.
- Restricted activity day calculations are likely underestimated.
- Pollution exposure assumptions are based on monitoring data, which is collected at the worst-case location within an airshed. As pollution varies spatially, this means that exposure may be overestimated, however this may be negated by concentration response relationships.

Appendix 3 other modelling results

Table 5 Modelled impacts of faster or slower burner phase outs

Airshed	Alexandra	Arrowtown	Clyde	Cromwell	Milton	Mosgiel
Slower (25 year) phase out non-ULEB (financial assistance)						
AQ outcome (concentration reduction by 2040)	38%	43%	26%	24%	32%	
Health cost 2040 ($million/year)	23.5	1.7	19		6.4	
Health outcome (costs saved by 2040 ($million/year))	5.6	0.4	1.8		1.1	
NESAQ compliance PM10	No	No	No	No	No	
WHO compliance PM2.5	No	No	No	No	No	
Faster (15 year) phase out non-ULEB (financial assistance)						
AQ outcome (concentration reduction by 2040)		48%			45%	40%
Health cost 2040 ($million/year)		1.6			5.3	30.1
Health outcome (costs saved by 2040 ($million/year))		0.6			2.2	16.8
NESAQ compliance PM10		Yes			Maybe	Yes
WHO compliance PM2.5		Yes			Yes	Yes
Faster (15 year) phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme + no burners in new dwellings						
AQ outcome (concentration reduction by 2040)			39%	59%		
Health cost 2040 ($million/year)			11.1			
Health outcome (costs saved by 2040 ($million/year))			9.7			
NESAQ compliance PM10			Yes	Yes		
WHO compliance PM2.5			Yes	Yes		

Table 6 Overview of WHO – 4 Options from Wilton 2023

	Option 1		Option 2		Option 3		Option 4	
A	**Alexandra**	Ban SFBs	**Alexandra Clyde Cromwell**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme + no burners in new dwellings	**Alexandra Clyde Cromwell**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme	**Alexandra Arrowtown Clyde Cromwell Milton**	Phase out non-ULEB (financial assistance)
B	**Clyde Cromwell**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme + no burners in new dwellings	**Arrowtown Milton**	Phase out non-ULEB (financial assistance)	**Arrowtown Milton**	Phase out non-ULEB (financial assistance)	**Mosgiel + other gazetted airsheds**	Only ULEB for new installs + behaviour change programme
C	**Arrowtown Milton**	Phase out non-ULEB (financial assistance)	**Mosgiel Air Zone 2**	Only ULEB for new installs + behaviour change programme	**Mosgiel Air Zone 2**	Only ULEB for new installs + behaviour change programme	**All other urban areas**	Only ULEB for new installs
D	**Mosgiel**	Only ULEB for new installs + behaviour change programme	**All other urban areas**	Only ULEB for new installs	**All other urban areas**	Only ULEB for new installs		
Air quality outcomes in monitored airsheds	Compliance with WHO annual PM2.5 guideline in monitored airsheds		Compliance with WHO annual PM2.5 guideline in monitored airsheds except for Alexandra which will come within 1 $\mu g/m^3$ of limit		Compliance with WHO annual PM2.5 guideline in monitored airsheds except for Alexandra, Clyde and Cromwell which will come within 1-1.5 $\mu g/m^3$ of limit		Compliance with WHO annual PM2.5 guideline in monitored airsheds except for Alexandra, Arrowtown, Clyde, Cromwell and Milton which will come within 1.5-2 $\mu g/m^3$ of limit	
Health outcomes in monitored airsheds	A 35% reduction in adverse health impacts with cost savings estimated at $38 million per year		A 27% reduction in adverse health impacts with cost savings estimated at $28 million per year		A 23% reduction in adverse health impacts with cost savings estimated at $24 million per year		A 13% reduction in adverse health impacts with cost savings estimated at $19 million per year	
Air quality outcomes - rest of Otago	Air quality is at risk of becoming degraded in areas of urban growth		Improvements and/or prevention of degradation in high growth areas					
Health outcomes - rest of Otago	Total health cost of $431 million		Total health cost of $388 million Health cost savings of $42.8 million (10% reduction)					

Table 7 Overview of short, medium and long term pathways from Wilton 2025

	Pathway 1		Pathway 2		Pathway 3	
A	**Alexandra**	Ban SFBs	**Alexandra** **Clyde** **Cromwell**	Phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme	**Alexandra** **Arrowtown** **Clyde** **Cromwell** **Milton**	Slower (25 year) phase out non-ULEB (financial assistance)
B	**Clyde** **Cromwell**	Faster (15 year) phase out non-ULEB (financial assistance) + outdoor burning controls + behaviour change programme + no burners in new dwellings	**Arrowtown** **Milton** **Mosgiel**	Phase out non-ULEB (financial assistance)	**Mosgiel** **All other urban areas**	Only ULEB for new installs
C	**Arrowtown** **Milton** **Mosgiel**	Faster (15 year) phase out non-ULEB (financial assistance)	**All other urban areas**	Only ULEB for new installs		
D	**All other urban areas**	Only ULEB for new installs				
Air quality outcomes in monitored airsheds	Compliance with WHO annual PM2.5 guideline in monitored airsheds		Compliance with WHO annual PM2.5 guideline in monitored airsheds except for Alexandra, Clyde and Cromwell, which will come within 1.5 $\mu g/m^3$ of limit. Compliance with NESAQ in all airsheds except Clyde and Cromwell		No compliance with WHO annual PM2.5 guideline or NESAQ in monitored airsheds	
Health outcomes in monitored airsheds	A 45% reduction in adverse health impacts with cost savings estimated at $49 million per year		A 32% reduction in adverse health impacts with cost savings estimated at $33 million per year		A 14% reduction in adverse health impacts with cost savings estimated at $15 million per year	
Air quality outcomes - rest of Otago	Improvements and/or prevention of degradation in high growth areas					
Health outcomes - rest of Otago	Total health cost of $412 million Health cost savings of $18.9 million (4% reduction)					