Air quality impacts assessment – Shotover Country proposed development

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Executive Summary

The main air contaminant likely to be of concern for the proposed Shotover Country development is concentrations of particles in the air less than 10 microns in diameter (PM_{10}). A National Environmental Standard (NES) for PM_{10} has been set at 50 µg m^{-3} (24-hour average). However, health impacts are likely to occur at this concentration, as there is no known safe level of exposure to PM_{10}.

The main source of PM_{10} in urban areas of New Zealand is solid fuel burning for domestic home heating (Wilton, 2002a).

The Shotover Country area is subject to regulations in Regional Plan: Air for Otago that regulate the installation of domestic heating appliances. The rule requires new domestic heating appliances to meet the requirement of 1.5 grams of particulate per kilogram of fuel burnt when tested to NZS 4013. A thermal efficiency of 65% is also required.

It is probable that the NES for air quality in the Shotover Country area would be met without any additional rules than those in the regional air plan. Some threat to the NES could exist if there were significant additional development of the plains area surrounding the proposed Shotover Country development.

If this is likely to happen or if a higher level of air quality is required it may be necessary to restrict burner numbers or only allow the installation of non-solid fuel methods or pellet fires. This would depend on the availability of some legal mechanism by which this could be achieved.

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1 Introduction

1.1 Background

Clark Fortune McDonald and Associates have engaged Environet Limited to undertake an analysis of air quality issues and provide advice on appropriate restrictions that could be implemented to avoid, remedy or mitigate air quality concerns for the proposed Shotover Country development near Queenstown.

The Shotover Country proposal involves the development of 758 residential dwellings, a primary school and approximately 2000m^2 of retail development. The proposed development is located within the flats and lower terraces of the Lower Shotover River.

This report provides an assessment of the potential for air quality problems in the Shotover Country area based on comparisons of emissions and resulting concentrations in areas with similar meteorology and topography. Recommendations for alternative heating methods to minimise air discharges are also included.

1.2 Otago Regional Council

The Regional Plan: Air for Otago became operative in January 2009. The plan incorporates Government requirements under the National Environmental Standards for Air Quality.

Three air zones have been identified in the Regional Plan: Air. Air zone one consists of the towns of Alexandra, Arrowtown, Clyde and Cromwell. Balclutha. Air zone two areas include Central Dunedin, Green Island, Hawea, Kingston, Milton, Mosgiel, Naseby, North Dunedin, Oamaru, Palmerston, Port Chalmers, Queenstown, Ranfurly, Roxburgh, South Dunedin, Waikouaiti and Wanaka. All areas outside air zone one and two are known as air zone three.

Air zone one areas have been identified as having the highest PM_{10} concentrations and new domestic heating appliances are required to meet the standard of 0.7 g/kg or less with a thermal efficiency of 65% when tested to NZS 4013. In air zone two areas as well as in air zone three areas that are less than two hectares in size, new domestic heating appliances are required to meet the standard of 1.5 g/kg or less with a thermal efficiency of 65%. The definition of domestic heating appliances includes open fires, woodburners, multifuel burners, pellet fires, coal burning heaters, or cooker including coal range. This means that with current technology, the installation of open fires, multi fuel burners and appliances that burn coal are not allowed in the above locations.

Most areas outside air zones one and two have good dispersal and low population densities that mean that these areas are unlikely to have high emissions. However the Shotover Country area is adjacent to the Queenstown area that is in air zone two.

The Shotover Country area sits within air zone three. Residential sections will be less than 2 hectares in size, therefore domestic heating appliances must meet the standard of 1.5 g/kg or less with a thermal efficiency of 65% when tested to NZS 4013.

2 Methodology

The methodology for assessing the air quality aspects of the proposed development is:

1) Identify and justify key issues based on air quality monitoring and emission inventories in existing urban areas of New Zealand.
2) Evaluate the topography of the area in the context of the potential for air quality issues. Evaluate air quality monitoring data for similar geographical areas in the Otago Region.
3) Evaluate emissions data for existing Otago urban areas with air quality issues.
4) Estimate emissions data for the proposed development based on a range of scenarios (i.e., variations in housing densities and home heating methods).
5) Provide an assessment of the potential air quality issues having reference to National Environmental Standards for air quality, the potential for health impacts and likely visual impacts.
6) Identify possible restrictions and their likely impact on air quality.
7) Assess the impacts of the Regional Plan: Air for Otago on the proposed development.
8) Provide advice on internal insulation standards and heat sources as an alternative to solid fuel burners if necessary.

3 Air Quality Impacts

3.1 Key Issues

New Zealand air quality monitoring indicates that suspended particulate (PM_{10}) is the main air contaminant of concern in urban areas. Suspended particulate refers to particles in the air less than 10 microns in diameter.

The National Environmental Standard for PM_{10} of 50 µg m^{-3} (24-hour average, one allowable exceedence per year) is regularly exceeded in over 30 urban areas of New Zealand. In Otago, concentrations of PM_{10} have exceeded 50 µg m^{-3} in Alexandra, Arrowtown, Balclutha, Clyde, Cromwell, Dunedin, Lawrence, Milton and Oamaru. The main source of PM_{10} in urban areas of New Zealand is solid fuel burning for domestic home heating (Wilton, 2002a).

Concentrations of other key air contaminants such as nitrogen dioxide, carbon monoxide and sulphur dioxide do not normally exceed the NES concentrations in urban areas of New Zealand. The main exceptions are carbon monoxide in ambient air in Christchurch and traffic peak sites in Auckland, and nitrogen dioxide at traffic peak sites in Auckland (Wilton, 2002b). Another contaminant that could potentially exceed ambient air quality guidelines in urban areas of New Zealand is benzo(a)pyrene (BAP) as concentrations measured in Christchurch have been estimated at in excess of 10 times the annual guideline of 0.3 nanograms per cubic metre (ng m^{-3}). Limited monitoring has been carried out for BAP in New Zealand.

The health effects associated with PM_{10} exposure range from minor nose and throat irritations to more severe impacts such as hospital admissions and premature mortality. The population base susceptible to the different impacts varies by effect with a smaller subsection comprising of the elderly and those with pre-existing conditions most at risk of impacts such as premature mortality. Although the NES for

PM_{10} is set at 50 µg m^{-3} (24-hour average), there is no known threshold for PM_{10} below which concentrations do not impact on health.

Particles in the air are also the main cause of degraded visibility or haze in urban areas (Wilton & Sturman, 2002). The very small particles (0.3-0.7 µm in diameter) are the most effective in scattering light, thus creating visual air pollution.

The main air contaminant likely to be of concern for the proposed development is particles in the air - PM_{10}.

3.2 Air pollution potential for the Shotover Country Development

3.2.1 Topography

The Shotover Country area is located at the gateway to Frankton and within the urban catchment extending from Frankton to Lake Hayes. The site adjoins the Shotover River to the west and the established Lake Hayes Estate subdivision to the east and is approximately three kilometres from Frankton, Queenstown. The site is approximately 120 hectares in area.

The study area boundary follows a naturally formed terrace to the north, east and south or the site and is bound by the Shotover River to the west. The Remarkables mountain range is south of the Shotover Country area. The Coronet Peak range is to the north of the area.

The site is in close proximity to other residential neighbourhoods including Lake Hayes Estate and Quail Rise.

No air quality monitoring has been carried out in the Shotover Country area. It is possible that some degradation in air quality may exist as a result of emissions from Frankton and its surrounds. These are likely to be limited to days during the winter when meteorological conditions are conducive to elevated concentrations of PM_{10}.

No meteorological monitoring in the Shotover Country area has been carried out for the purposes of this assessment.

3.2.2 Air quality monitoring in Otago

Air quality monitoring for PM_{10} takes place at a number of locations in the Otago Region. Those near to the proposed development include Queenstown and Arrowtown. While concentrations in excess of the NES have not been recorded in Queenstown, PM_{10} concentrations in Arrowtown regularly exceed the 50 µg m^{-3} limit.

In 2009 air quality monitoring sites were located in Alexandra, Arrowtown, Balclutha, Clyde, Cromwell, Central Dunedin, Lawrence, Milton, Oamaru and South Dunedin. Table 3.1 shows the maximum measured PM_{10} concentrations for these locations in 2009.

Table 3.1: Maximum measured PM_{10} concentrations in Central Dunedin, Alexandra, Arrowtown, Balclutha, Clyde, Cromwell, Lawrence, Milton, Mosgiel, Oamaru and South Dunedin 2009*

Location	Highest daily PM_{10} concentration (August 2009)
Alexandra	137 µg m^{-3}
Arrowtown	117 µg m^{-3}
Balclutha	67 µg m^{-3}
Clyde	103 µg m^{-3}
Cromwell	110 µg m^{-3}
Central Dunedin	68 µg m^{-3}
Lawrence	66 µg m^{-3}
Milton	144 µg m^{-3}
Mosgiel	96 µg m^{-3}
Oamaru	62 µg m^{-3}
South Dunedin	56 µg m^{-3}

* Air quality monitoring results are provisional at the time of preparing this report.

The number and size of locations experiencing degraded air quality in the Otago Region is high relative to many other Regions in New Zealand. This is likely to reflect the prevalence of meteorological conditions more conducive to elevated pollution rather than variations in emissions.

3.2.3 Pollution potential

The pollution potential for the Shotover Country area is likely to depend largely on the prevalence and strength of temperature inversions and wind speed under the conditions conducive to elevated pollution. There is potential for poor air quality because of the surrounding topography, but the potential is unlikely to be as extreme as in Arrowtown owing to the larger surrounding plains.

4 Emissions and concentrations assessment

4.1 Urban areas of Otago

Table 4.1 shows the number and proportion of households using different heating methods in Cromwell, Alexandra, Mosgiel and Arrowtown (Wilton, 2005a). These data were obtained for 2005 based on a domestic home heating survey of around 150 households in each area (sample error ~8%). These locations were selected for the basis of this study because they were the areas most similar in size to the proposed development that had sufficient monitoring data for the analysis.

The proportion of households using wood burners in these towns ranges from around 32% in Mosgiel to 56% in Cromwell. Multi fuel burners are used by around 20% of households. The proportion of households relying on solid fuel heating methods ranges from 65-84%. A large number of households use more than one method of heating in their main living area.

An estimate of the average daily emissions of PM_{10} from domestic home heating in Cromwell, Mosgiel, Arrowtown and Alexandra is shown in Table 4.2. This estimate has been made using the method described in Wilton (2005b).

Table 4.1: Home heating methods in Cromwell, Mosgiel, Arrowtown and Alexandra

	Cromwell		Mosgiel		Arrowtown		Alexandra	
	%	HH	%	HH	%	HH	%	HH
Electricity	47%	509	59%	1,639	51%	365	59%	1,106
Total Gas	13%	143	16%	442	27%	192	13%	236
Flued gas	3%	36	6%	161	14%	99	4%	69
Unflued gas	10%	108	10%	281	13%	94	9%	167
Oil	3%	29	4%	111	3%	24	5%	87
Open fire	4%	43	10%	276	15%	111	2%	37
Open fire - wood	4%	43	10%	276	15%	106	2%	37
Open fire – coal	1%	14	7%	203	5%	38	1%	12
Total Woodburner	56%	602	32%	884	46%	332	47%	870
Pre 1995 woodburner	19%	206	11%	309	16%	116	23%	428
1995-2000 woodburner	15%	159	6%	177	15%	106	13%	249
Post 2000 woodburner	22%	238	14%	398	15%	111	10%	193
Multi-fuel burners	25%	265	23%	626	22.7%	163	18%	336
Multi-fuel burners-wood	25%	265	23%	626	22.7%	163	18%	336
Multi-fuel burners-coal	18%	194	11%	313	16.0%	115	9%	162
Pellet burners	1%	7	1%	37	0%	-	1%	12
Total wood	84%	911	65%	1,787	83%	601	67%	1,243
Total coal	19%	208	19%	516	21%	154	9%	174
Total		1,083		2,763		721		1,864

Table 4.2: Average daily PM_{10} emissions for Cromwell, Mosgiel, Arrowtown and Alexandra

	Cromwell kg/ day	Mosgiel kg/ day	Arrowtown kg/ day	Alexandra kg/ day
Average daily PM_{10}	215	608	181	377

4.2 Emissions from the proposed Shotover Country development

An estimate of emissions from the proposed Shotover Country development can be made based on assumptions about proportions of dwellings that might install solid fuel burners and using estimates of daily fuel use from areas such as Cromwell, Mosgiel, Arrowtown and Alexandra.

The proposed development includes 758 residential dwellings with opportunities for integrated community housing and educational facilities. Table 4.3 shows daily PM_{10} estimates for a range of scenarios based on the following assumptions:

- An average emission factor for wood burners complying with the NES design criteria for solid fuel burners of three grams of PM_{10} per kilogram of fuel burnt.
- An average daily wood use of 25 kilograms[1].

Table 4.3: Daily PM_{10} emissions for different burner installation rates

	Shotover Country 758 households kg/day
All dwellings install one solid fuel burner	61
70% of dwellings install one solid fuel burner	43
50% of dwellings install one solid fuel burner	31

4.3 Concentration estimates

Table 4.3 shows that under the worst-case scenario emissions for the proposed development could be in the order of 61 kilograms of PM_{10} per day. This estimate is likely to be worst-case and is unlikely to occur as it assumes all sections would install a solid fuel burners for domestic heating.

A more realistic estimate is based on a 70% solid fuel uptake and results in 43 kilograms of particles per day. This is much less than currently emitted in Alexandra and just less than a quarter of that emitted in Arrowtown. Both of the latter locations currently exceed the NES for PM_{10}.

Table 4.4 shows the ratio of maximum measured PM_{10} concentration for Cromwell, Mosgiel, Arrowtown and Alexandra to estimated PM_{10} emissions. The location with the highest concentration to emissions ratio is Arrowtown. Assuming the monitoring data is representative for each location, a high concentration to emissions ratio is indicative of meteorological conditions that are more conducive to elevated air pollution.

It would seem unlikely that the Shotover Country area has a pollution potential as severe as Arrowtown because surrounding topography provides less shelter from wind. However, to provide a conservative assessment of emissions Arrowtown was selected to provide a worst-case indication of concentrations because it gave the highest concentration to emissions ratio. It is not being suggested that meteorological conditions in Arrowtown provide a proxy to estimate actual concentrations for the Shotover Country area. However, the ratio of concentrations to emissions for Arrowtown is likely to provide an indication of the impact of worst-case meteorological conditions and these should provide an upper limit concentration estimate for Shotover Country for different emission scenarios.

Additional considerations when estimating air quality impacts include:

[1] Based on the average for Cromwell, Mosgiel, Arrowtown and Alexandra from the 2005 domestic home heating survey.

- Potential contributions from other sources associated with the development.
- Background PM_{10} emissions from windblown dusts including the Shotover Riverbed.
- Contributions to PM_{10} concentrations from neighbouring urban areas.

Other potential source contributions from within the urban area include motor vehicle emissions, outdoor rubbish burning and emissions from activities such as lawn mowing. These sources are unlikely to exceed seven kilograms of PM_{10} per day for the proposed Shotover Country development.

The contribution of background sources such as windblown dust on days when PM_{10} is elevated as a result of anthropogenic emissions is likely to be minimal. This is because the windy conditions required to generate significant natural source emissions are not conducive to elevated PM_{10} concentrations from sources such as domestic heating.

Because of the relative proximity of Frankton, Queenstown and other subdivisions it is probable that some emissions from these areas will contribute to PM_{10} concentrations in the Shotover Country area. This contribution is uncertain and an estimate of around 10 µg m^{-3} has been used in this assessment.

Table 4.5 shows the estimated PM_{10} concentrations for the proposed Shotover Country development using the Arrowtown concentration to emissions ratio, the domestic heating emissions estimates and an additional seven kilograms per day from other sources. These concentrations are expressed as micrograms of PM_{10} per cubic metre of air (µg m^{-3}).

Table 4.4: Concentration to emissions ratio for Cromwell, Mosgiel, Arrowtown and Alexandra

	Cromwell kg/ day	Mosgiel kg/ day	Arrowtown kg/ day	Alexandra kg/ day
Concentrations/ emissions ratio	0.5	0.2	0.6	0.4

Table 4.5: Upper limit concentration estimates for proposed Shotover Country development (assuming worst-case meteorology for Arrowtown)

	Estimated maximum daily PM_{10} µg m^{-3}	Assumed background contribution µg m^{-3}	Total µg m^{-3}
No additional controls on burners			
All dwellings install solid fuel burners	44	10	54
70% of dwellings install solid fuel burners	32	10	42
50% of dwellings install solid fuel burners	24	10	34

5 Air Quality Management

One of the main factors to consider in managing air quality in the proposed development is the desired or acceptable level of air quality. This report presents air quality management options relative to three main air quality objectives. A conservative estimate of concentration targets for each of these objectives is estimated as follows:

1) Maintenance of probable existing pristine air quality – minimal degradation in ambient air quality – (<16 µg m^{-3} – 24 hour average)
2) Slight degradation in air quality – concentrations within the NES but some visibility degradation likely on occasion – (<33 µg m^{-3}, 24-hour average)
3) PM_{10} concentrations within but potentially close to the NES on occasion – (<40 µg m^{-3}, 24-hour average).

It would seem likely that PM_{10} concentrations in the Shotover Country area would meet objective three and most probably objective two in the absence of any additional regulation. This is because existing ORC legislation would restrict the installation of new solid fuel burners to those with relatively low PM_{10} discharges.

There are a number of management measures that could be implemented to limit PM_{10} emissions in the proposed development, should a higher standard of air quality or a greater confidence of meeting air quality objectives be desired. Domestic home heating is targeted as the source with the greatest potential for impact.

For the Shotover Country area, the proposed legislation specifies that new installations of domestic heating appliances on properties less than 2 hectares must meet an emission limit of 1.5 grams of particles per kilogram of fuel burnt when the appliance is tested to NZS 4013. This legislation will assist in limiting emissions from the proposed development. Other measures that would limit emissions include:

- Setting limitations on the numbers of burners that can be installed.
- Prohibiting the installation of all solid fuel burners.
- Reducing energy requirements though improved home insulation.

5.1 Emission reduction scenarios

Table 5.1 shows the effectiveness of a range of management options in limiting the PM_{10} emissions. These are based on the assumption of a linear relationship between emissions and concentrations. Measures evaluated exclude the impact of insulation because of uncertainties in the effectiveness of this measure in reducing emissions.

The main options for limiting emissions from the proposed development include:

- Restricting the numbers of burners that can be installed.
- Prohibiting the installation of wood burners (but allowing pellet burners).

While a restriction on the installation of solid fuel burners to include pellet burners could be achieved through a covenant or, possibly, plan provisions, a restriction on the number of burners that could be installed would be more problematic to implement.

Table 5.1: Upper limit concentration estimates (24-hour average) for emission reduction scenarios.

	Shotover Country 758 households µg m^{-3}	Assumed background µg m^{-3}	Total µg m^{-3}
No installations of wood or coal burners (allow pellet burners)			
All dwellings install pellet fires	14	10	24
70% of dwellings install pellet fires	11	10	21
50% of dwellings install pellet fires	9	10	19
Limiting the number of solid fuel burners	**Number of burners (no background)**	**Assumed background µg m^{-3}**	**Number of burners (assuming background)**
Objective 1 – 16 µg m^{-3}	200 burners	10	30 burners
Objective 2 – <33 µg m^{-3}	520 burners	10	340 burners
Objective 3 – <40 µg m^{-3}	660 burners	10	470 burners

The selection of suitable management measures to limit PM_{10} emissions from the proposed development depends on the desired air quality. It is probable that the NES would be met without any further legislation than the proposed ORC rules. However if a higher degree of air quality is required it may be necessary to restrict burner numbers or only allow pellet fires.

6 Energy Efficiency

6.1 Home Energy Rating Scheme

The Energy Efficiency Conversation Authority (EECA) has developed the Home Energy Rating Scheme (HERS). The voluntary scheme was launched in December 2007. The aim of the programme is to make New Zealanders aware of the energy performance of their houses. An accredited assessor inspects the home to determine its energy performance over a range of criteria. Using an energy rating tool, homes are given a home energy rating that reflects its performance.

There is an opportunity for the Shotover Country partnership to work with the Queenstown Lakes District Council and EECA to provide a working example of the HERS scheme as a key feature in the design of residential buildings in the development.

6.2 Solar power

The government is undertaking a series of initiatives that examine the role of alternative energy in New Zealand's energy sector. These include bioenergy, biofuels, solar and wind generated energy. Solar power for water heating is most significant in relation to energy efficiency in households.

EECA has undertaken work to find out how to increase the uptake of solar heating in homes. The total cost of installing a solar water heating system in a residential property ranges between $4,000 and $8,000.

The average savings on electricity for water heating from a solar water heating system are estimated at between $400 and $500 a year. This represents approximately a 50% reduction in energy consumption for water heating for each year. Payback in purely financial terms takes a number of years. However, the savings continue once the cost of the initial installation is paid back, so long term there can be significant financial advantages as well as reduction in greenhouse emissions.

EECA offers a maximum of $1000 towards the installation of a solar hot water heating system. The grant is offered through solar water heating suppliers who meet certain energy performance, price and installation standards (http://www.energywise.govt.nz).

The adoption of solar water heating could be promoted in the Shotover Country proposed development as a means to promote energy efficiency.

7 Alternative heating options

In addition to energy efficiency measures there are a number of alternative methods to solid fuel burners that could be used. These include heatpumps, pellet fires and flued gas fires.

Table 7.1 shows a comparison between installed costs, efficiencies, and running costs for different home heating appliances. In our view the most attractive methods of home heating for the proposed development would be:

- Heat pumps – for those who are interested in energy efficiency and an easy and quick heating option.
- Pellet fires – for those who desire the more earthy/ rustic theme consistent with the proposed development.
- Flued gas fires – for those who desire convenience with an ambience similar to a wood burner with no reliance on electricity supply.

Table 7.1: Home heating costs (from Community Energy Action, August 2008)

Fuel	Heating Type	Energy Efficiency	Cost (to install)	Capacity (kw)	Fuel cost (av)* $	Cost: $ per kWh	Cost per hr ($ per kWh x capacity (kw))
Electricity	Fan heater	100%	$30	2	0.21	0.21	0.42
	Oil column	100%	$30	1	0.21	0.21	0.21
			$190	2.4	0.21	0.21	0.50
	Radiant (bar)	100%	$35	1.5	0.21	0.21	0.31
			$140	2.4	0.21	0.21	0.50
	Nightstore	80%	$1050	2.5	0.15	0.18	0.46
			$1150	3.4	0.15	0.18	0.62
	Heatpump (wall)	300%	$1,700	3.2	0.21	0.07	0.22
			$2,650	8.6	0.21	0.07	0.60
	Heatpump (floor)	300%	$2,400	3.4	0.21	0.07	0.24
			$3,400	8.3	0.21	0.07	0.58
	Heatpump (central)	250%	$2,900	5.6	0.21	0.07	0.39
	Central ground-source heat pump	400%	$15,000	15	0.21	0.08	1.25
			$30,000	15	0.21	0.05	0.78
Gas	Flued gas	68%	$2,700	4.2	2.65	0.30	1.28
			$3,300	8.2	2.65	0.30	2.50
	Unflued gas	90%	$185	4	3.18	0.28	1.10
			$196	6	2.28	0.198	1.19
	Gas Central Heating	95%	$12,000	15	2.65	0.22	3.27
Solid fuel	Logburner - Wood	Free-standing 79%	$2,845	16	60.00	0.05	0.73

Wood Pellet		Enclosed 68%	$3,295	14	60.00	0.05	0.74
	Pellet Fire	85%	$4,000	5	0.47	0.10	0.52
		85%	$5,000	10	0.47	0.10	1.04
	Central heat-pellet	85%	$18,000	15	0.47	0.10	1.56
Diesel	Diesel - cabinet	93%	$4,500	9.5	1.44	0.16	1.48
	Diesel - central heat	95%	$14,000	15	1.44	0.15	2.29

*electricity = price per kwh (including GST)
*gas = price per kg (including GST)
*wood price per m^3 (including GST)
*pellets price per kg (including GST)
*diesel = price per litre (including GST)

8 Recommendations

It is probable that the NES for air quality in the Shotover Country area would be met without any additional planning mechanisms than the regulations in the Regional Air Plan that allows wood burners that meet the emission criteria of 1.5 grams of particles per kilogram of fuel burnt with a thermal efficiency of 65% to be installed. Some threat to the NES could exist if there were significant additional development of the plains area surrounding the Shotover Country development.

If a higher degree of air quality is required it may be necessary to restrict burner numbers or only allow pellet fires. This would depend on the availability of some legal mechanism by which this could be achieved. Limiting the number of wood burner installations to 340 or less should be sufficient to ensure concentrations are kept within two thirds of the NES. Depending on the preferred heating methods of the householders, regulation may not be necessary to achieve this.

The promotion of energy efficiency measures such as the Home Energy Rating Scheme and installation of solar heating in new houses are can contribute towards an environmentally sustainable development.

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