Management of PM_{10} in Masterton, Upper Hutt and Wainuiomata (2008)

A report prepared for Greater Wellington by Environet Ltd

Greater Wellington
Te Pane Matua Taiao

Management of PM_{10} in Masterton, Upper Hutt and Wainuiomata

An assessment of management options to achieve National Environmental Standards – September 2008

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Executive Summary

Concentrations of PM_{10} exceed National Environmental Standards (NES) for PM_{10} in a number of urban areas in the Wellington region including Masterton and Wainuiomata. The NES is set at 50 µg m^{-3} (24-hour average) with one allowable exceedence per year.

The NES requires the establishment of a straight line path to compliance with the NES by 2013 for non-complying airsheds. For Masterton and Wainuiomata maximum PM_{10} concentrations are around 69 µg m^{-3} (2005) and 57 µg m^{-3} (2001). Highest PM_{10} concentrations in all areas are measured during the winter months. The reductions in PM_{10} concentrations required to meet the NES are 19% and 11% for Masterton and Wainuiomata and are based on the second highest PM_{10} concentrations measured during 2003 and 2001 respectively. The reductions required to meet the Long Term Council Community Plan (LTCCP) target of 33 µg m^{-3} (24-hour average) are 47% and 41% for Masterton and Wainuiomata respectively.

Concentrations of PM_{10} in excess of the NES are not currently expected to occur in Upper Hutt, however, increases in PM_{10} emissions could compromise this. Moreover, a reduction in emissions of around 27% would be required for Upper Hutt to meet the LTCCP target of 33 µg m^{-3}.

The main source of PM_{10} emissions in these areas is solid fuel burning for domestic home heating. In Masterton domestic heating contributes around 94% of the daily winter PM_{10} with 4% from outdoor burning, 2% from motor vehicles, and less than 1% from industry. In Upper Hutt 87% of PM_{10} comes from the domestic heating sector, 9% from outdoor burning, 4% from motor vehicles and less than 1% from industry. In Wainuiomata solid fuel burning is estimated to contribute around 91% of the PM_{10}, with outdoor burning contributing 4%, motor vehicles contributing 3% and industry 2%. The inventories do not account for the potential contribution of natural sources such as soil or industrial emissions from processes such as sanding.

The impact of management options to reduce PM_{10} concentrations in Masterton, Wainuiomata and Upper Hutt are examined in this report.

The report finds that for Masterton and Wainuiomata, it may be possible to meet the NES by 2013 without intervention if the natural attrition rate for burners is 15 years. However if more certainty is required then other measures such as incentives or regulations appear necessary. Further management including the use of incentives or regulation would be required to meet the LTCCP target.

In Upper Hutt it is possible that the LTCCP target of 33 µg m^{-3} will be met in the absence of further management options. However a number of interventions are recommended to improve the certainty of achieving this target.

The required reductions in PM_{10} concentrations are typically derived from the second highest measured PM_{10} concentration for any year, for areas where sufficient monitoring has been conducted. In Upper Hutt, air quality data from the new monitoring site is only available from 2006. It is therefore possible that monitoring data does not capture worst case PM_{10} concentrations. Management measures for this area may therefore need reviewing should higher PM_{10} concentrations be measured.

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Air quality monitoring in the Wellington region shows PM_{10} concentrations in Masterton and Wainuiomata exceed the National Environmental Standard (NES) for PM_{10} on occasion during the winter months. The Ministry for the Environment requires the NES to be met by 2013 or the Council will be unable to grant resource consents for discharges to air in non-complying airsheds. The NES for PM_{10} is set at 50 µg m^{-3} (24-hour average). Air quality monitoring in Upper Hutt at a new site since 2006 has not recorded any breaches.

The Greater Wellington Regional Council has introduced an air quality target of 33 µg m^{-3} (24-hour average) in the Long Term Council Community Plan. Achieving this target may require further policy intervention by the Council in Masterton, Wainuiomata and Upper Hutt.

Emission projections for a number of management scenarios designed to reduce PM_{10} concentrations have been undertaken for Masterton, Wainuiomata and Upper Hutt. The purpose of this report is to analyse the effectiveness of these management options to reduce PM_{10}.

2 Air quality monitoring

2.1.1 Masterton

Air quality monitoring for PM_{10} has been carried out in Masterton since October 2002. The main method of monitoring is the Tapered Elemental Oscillating Microbalance (TEOM). In addition, gravimetric monitoring using a high volume sampler and a one day in three monitoring regime was carried out from April 2003 to March 2005 and an FH 62 beta attenuation monitor (BAM) has been used since November 2006. The latter was intended as a trial method to evaluate the extent of volatilisation often associated with the use of TEOM samplers when used without an FDMS system.

Figure 2.1 shows a good relationship between winter TEOM and BAM concentrations with the TEOM under reporting by around 11% relative to the BAM (TEOM = 0.9BAM – 0.4, r^2 = 0.94). The lower concentrations measured by the TEOM samplers occurs as a result of the volatilisation of the lower molecular weight organic compounds occurring as a result of the heated sample line of the TEOM. This was set at 40 degrees Celsius as per good practice for TEOM operation in New Zealand (MfE, 2000).

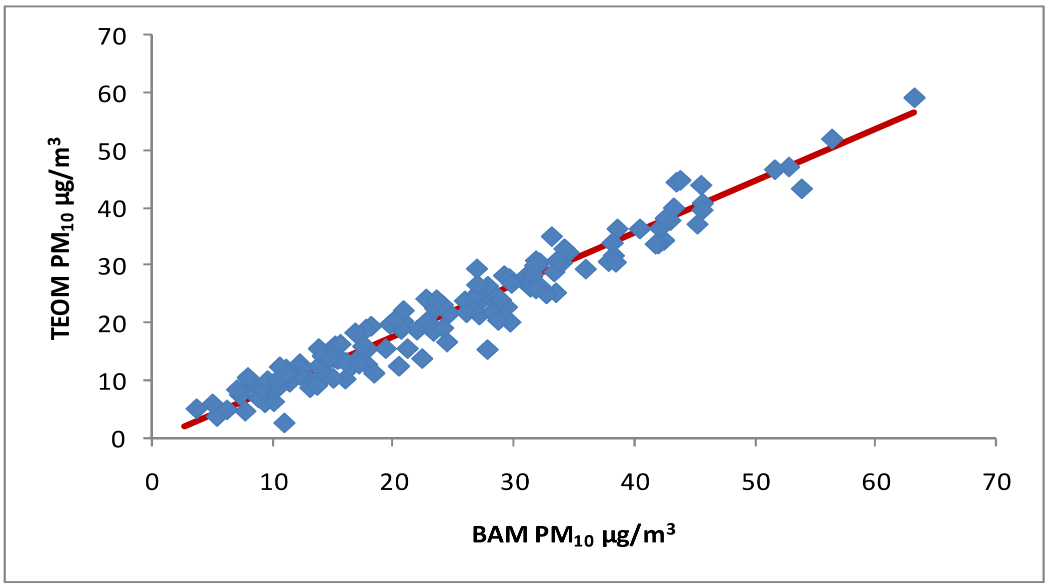

Figure 2.1: Relationship of TEOM versus BAM PM_{10} concentrations with reduced major axis line - TEOM = 0.9BAM – 0.4, r^2 = 0.94

It is recommended that historical TEOM data are adjusted to account for the volatile component to ensure that future air quality management does not underestimate the reductions in PM_{10} required to meet the NES. Table 2.1 compares the maximum and second highest PM_{10} concentrations measured to those adjusted based on the relationship with the BAM. This suggests that the maximum PM_{10} concentrations may have been around 69 µg m^{-3} and that the highest annual second highest concentration occurred during 2003 and is likely to have been around 62 µg m^{-3}. The highest annual second highest PM_{10} concentration is typically used to calculate the reduction required in PM_{10} concentrations in areas where there is an adequate amount of PM_{10} data.

Table 2.1: Comparison of measured TEOM PM_{10} to data adjusted for BAM equivalency

	2002	2003	2004	2005	2006	2007	2008
Maximum -TEOM	19	62	54	62	53	43	59
No > 50 µg m^{-3}	0	3	3	3	4	0	4
Adjusted Maximum	21	69	60	69	59	48	66
Second Highest		62	60	53	57		58

2.1.2 Wainuiomata

Air quality monitoring for PM_{10} has been carried out in Wainuiomata since April 2001. The main method of monitoring historically was the gravimetric high volume sampler which was operated until October 2007, initially based on a one day in six sampling regime increasing to one day in two. The high volume sampler was operated for the 24-hour period from mid day to mid day. A continuous FH 62 BAM sampler was installed at the monitoring site in 2006 and has replaced the gravimetric monitoring method as the main sampling method at this site. The latter is a continuous method and provides estimates of hourly averages. Reporting of PM_{10} concentrations from the BAM are for the period midnight to midnight as specified in the NES.

The highest PM_{10} concentration measured at the Wainuiomata monitoring site was 69 µg m^{-3} and was measured during June 2006 using the high volume sampler. The highest second highest PM_{10} concentration was 56 µg m^{-3} and was measured during 2001. It should be noted that the averaging period used during this time may report slightly higher concentrations than for the period from midnight to midnight because it better coincides with the timeframe of a typical pollution event.

2.1.3 Upper Hutt

Air quality monitoring for PM_{10} has been carried out in Upper Hutt since May 2000, originally at a site in near the Trentham Fire Station and more recently at a newer site in Savage Park. While the main method of monitoring historically has been the TEOM, a BAM sampler was installed at Savage Park in November 2006. The latter instrument and site are now used for reporting air quality and is used for air quality management. The highest PM_{10} concentration measured at this site was 45 µg m^{-3} and was measured in June 2008.

3 Reductions required in PM_{10} concentrations

3.1 Setting the starting points for the straight line path

A number of methods have been proposed for determining the reductions required in PM_{10} concentrations to meet the NES and for determining compliance with the "straight line paths" (SLiP) in managing air quality. The reductions required in PM_{10} concentrations to meet the NES could be estimated based on existing monitoring data. This is the most robust method, particularly in locations where there are many years of monitoring results available. The more data that are available, the higher the probability that the data captures the worst-case meteorological conditions that give rise to elevated PM_{10} concentrations. In the case of Masterton and Wainuiomata, there is sufficient monitoring data from which to evaluate the starting point for the SLiP. No SLiP is required for Upper Hutt because this area is not considered in breach of the NES.

The recommended approach is to exclude the maximum PM_{10} concentrations measured each year and to then evaluate the highest remaining concentration. The maximum concentration is excluded because the NES allows for one breach of 50 µg m^{-3} (24-hour average) per year.

In Masterton it is recommended that a value of 62 µg m^{-3} be used to represent the starting point of the SLiP. This is based on the second highest PM_{10} concentration estimated based on the TEOM to BAM equivalent conversion detailed in section 2.1. In Wainuiomata it is recommended that a value of 56 µg m^{-3} be used to represent the starting point of the SLiP. This is based on measurements made using the high volume sampler during 2001. It should be noted that this is a precautionary starting point as concentrations in Wainuiomata do not normally exceed 50 µg m^{-3} on more than one occasion per year.

The reduction required in PM_{10} concentrations to meet an air quality target of 50 μgm^{-3} (24-hour average), can be calculated using Equation 3.1.

$$R = 100(1 - \frac{t}{c}) \qquad \text{Equation 3.1}$$

where

R = the percentage reduction

t = the air quality target (e.g., 50 μgm^{-3})

c = the concentration identified as representing the starting point of the SLiP

Based on Equation 3.1 the required reduction to meet the NES in Masterton and Wainuiomata is 19% and 11% respectively.

3.2 Reductions required to meet the Long Term Council Community Plan (LTCCP) target

The air quality target for PM_{10} specified in the LTCCP is 33 µg m^{-3} (24-hour average) by 2016. It should be noted however, that while the NES allows for one breach per year, the LTCCP target does not specify this. Thus the reduction required to meet the latter should be based on the likely maximum PM_{10} concentration for each location.

Table 1.1 suggests a likely maximum PM_{10} concentration for Masterton of around 69 µg m^{-3}. The reduction required to meet the LTCCP based on this concentration is 52%.

In Wainuiomata, the maximum measured PM_{10} concentration is 71 µg m^{-3}. The reduction required to meet the LTCCP based on this concentration is 54%.

The maximum measured PM_{10} concentration in Upper Hutt is 45 µg m^{-3} and was measured at Savage Park using the BAM sampler during June 2007. The reduction required to meet the LTCCP based on this concentration is 27%.

3.3 Relationship between emissions and concentrations

For the purposes of this report, a linear relationship between emissions and concentrations is assumed. This relationship can be confirmed using air dispersion modelling, which would also provide a more detailed assessment of the impact of the emissions reductions proposed in this report on PM_{10} concentrations. Dispersion modelling is also of value in determining the spatial distribution in PM_{10} concentrations.

Xie et. al., (2005) evaluated PM_{10} concentrations in Masterton using modelling. Emission inputs into the model were based on a screening method and were not suitable for air quality management purposes. Results supported the use of a linear relationship between emissions and concentrations for Masterton.

4 Sources of PM_{10}

4.1 Masterton Emission Inventory – 2008

An emission inventory was completed for Masterton in 2008 (Wilton and Baynes, 2008). The inventory quantified emissions to air of PM_{10}, $PM_{2.5}$, CO, SOx, NOx and CO_2 and included domestic home heating, motor vehicles, outdoor burning and industry. The contribution of natural sources such as sea spray and soil were not included as these sources cannot be identified in a robust manner using an inventory approach. Estimates of the contribution to PM_{10} concentrations from sea spray and soil have been evaluated using receptor modelling by Davy (2007). Results of that study found that around 4% of PM_{10} on average on high pollution days originated from sea spray and 12% from soil.

The inventory showed around 66% of households in Masterton relied on wood burners for domestic home heating with 4% using open fires and 5% using multi fuel burners. Around 831 kilograms of PM_{10} is discharged to air in Masterton on an average winter's day. Figure 4.1 shows the domestic heating contribution to daily winter PM_{10} emissions in Masterton is 94%, with outdoor burning 4%, motor vehicles producing around 2% of the PM_{10} emissions, and industry less than 1%.

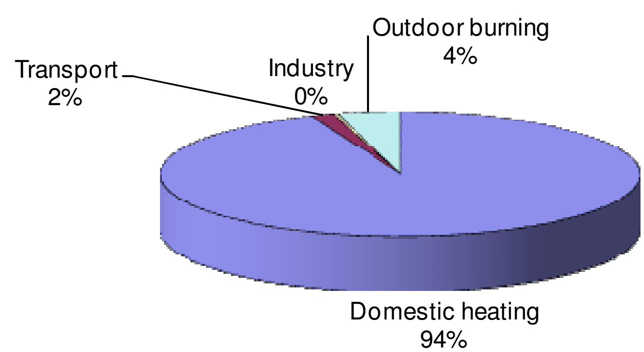

Figure.4.1: Sources of PM_{10} emissions in the urban areas of Masterton in 2008

4.2 Upper Hutt Emission Inventory – 2006

An emission inventory for Upper Hutt was completed in 2006 (Wilton, 2006). The inventory quantified emissions to air of PM_{10}, $PM_{2.5,}$ CO, SOx, NOx and CO_2. Sources included in the inventory were domestic home heating, motor vehicles, outdoor burning and industry. The results of the inventory found that just over one tonne of PM_{10} is discharged to air in Upper Hutt on an average winter's day. Domestic home heating was the main source contributing 87% of the daily winter time PM_{10} (Figure 4.2). Other sources included outdoor burning and motor vehicles which contributed 9% and 4% respectively. The industrial contribution to PM_{10} emissions in Upper Hutt was negligible and was less than 1% of the total PM_{10}. Some minor sources not included in the inventory include (PM_{10}) sea spray and soil. Results from the Davy (2007) receptor modelling study found that that around 20% of PM_{10} on average on high pollution days originated from sea spray and 3% from soil.

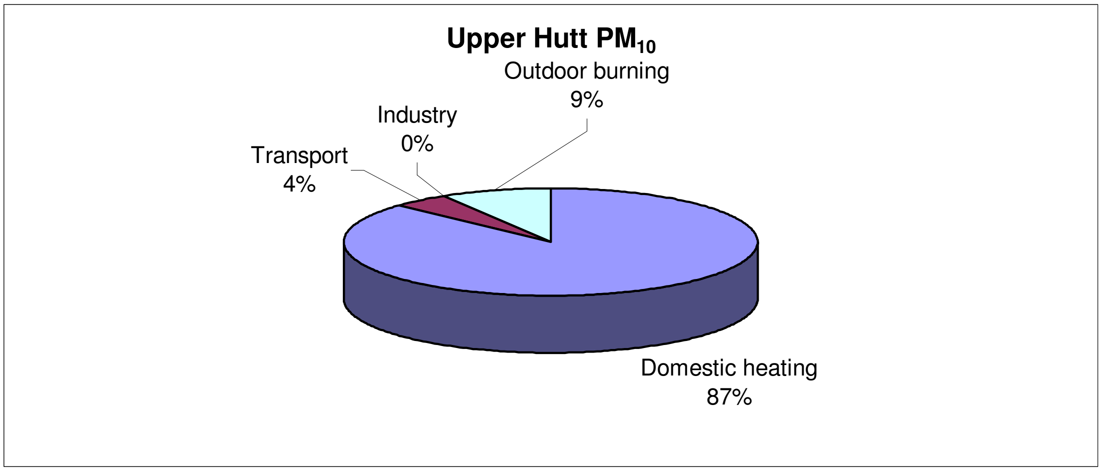

Figure 4.2: Sources of PM_{10} emissions in the urban areas of Upper Hutt in 2006

4.3 Wainuiomata Emission Inventory – 2006

An emission inventory for Wainuiomata was also carried out during 2006 and was based on the same parameters of the Upper Hutt inventory (Wilton, 2006). The inventory found that around 385 kilograms of PM_{10} were discharged to air in Wainuiomata on an average winter's day. The main source was solid fuel burning for domestic home heating, which contributed 91% of the PM_{10} (Figure 4.3). Other sources included outdoor burning (4%), motor vehicles (3%) and industry (2%).

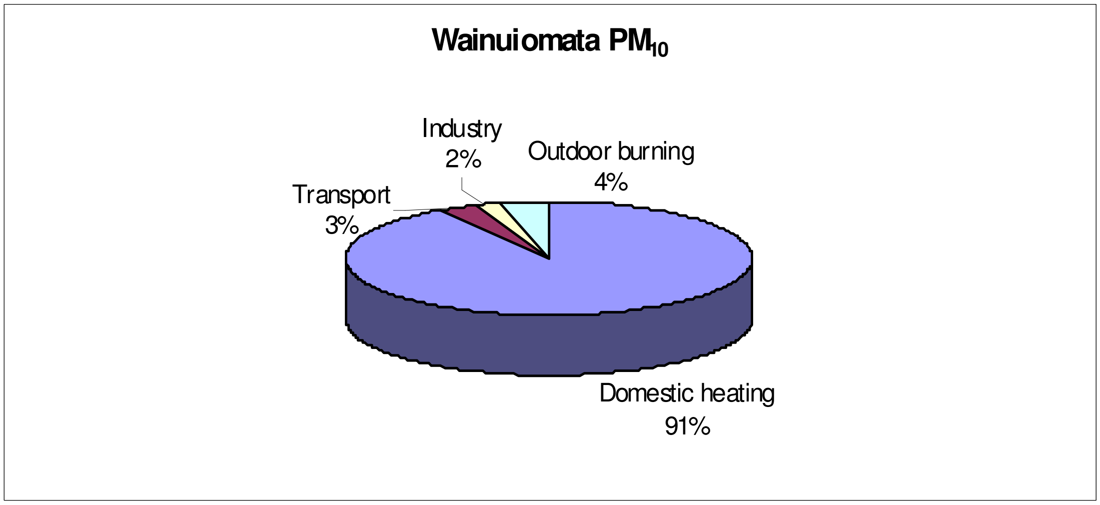

Figure 4.3: Sources of PM_{10} emissions in the urban areas of Wainuiomata in 2006

5 Management options for PM_{10} - Masterton

5.1 Masterton baseline projections

Estimates of trends in PM_{10} concentrations by source are shown in Figure 5.1. These are based on the assumptions outlined in Table 5.2. This indicates a significant decrease in PM_{10} from domestic home heating as a result of households replacing older more polluting burners with NES authorised wood burners. The magnitude of this improvement relative to the reduction required in PM_{10} is shown in Figure 5.2.

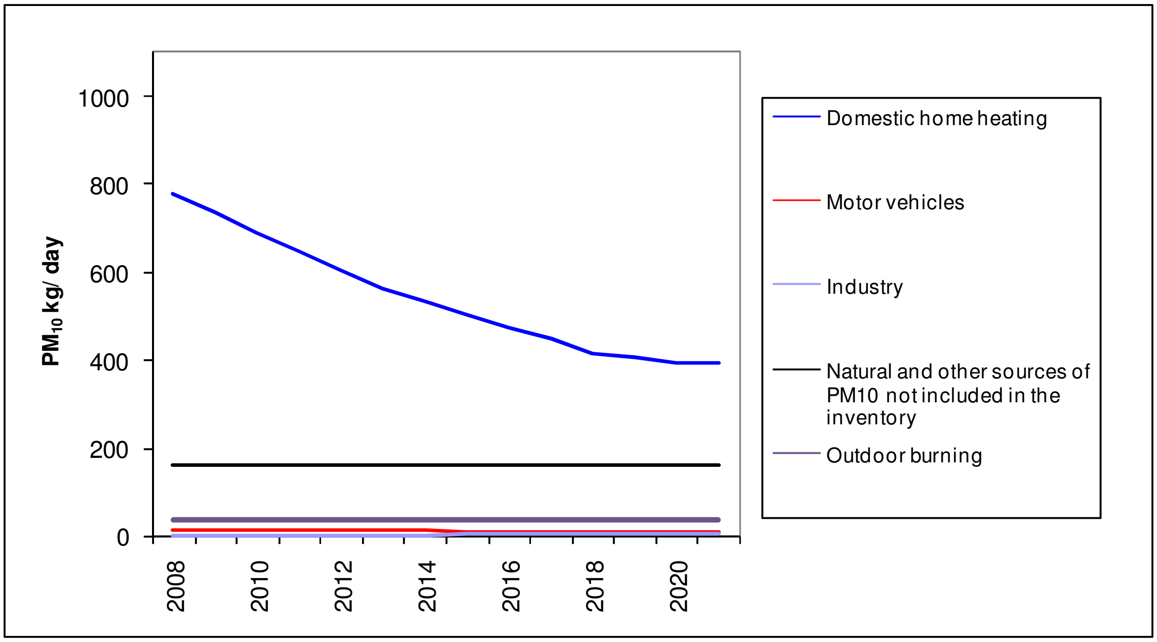

Figure 5.1: Estimates in trends in PM_{10} concentrations by source for Masterton.

While it appears possible that the NES may be met by 2013 in the absence of further air quality management, this relies on the assumption that older burners are replaced 15 years after installation. In reality a reasonable proportion of households are likely to keep wood burners beyond their "average" useful life. Additional air quality management is therefore required to achieve the NES by 2013. This could include regulating the replacement of older burners to 15 years after installation. Other management options would be required to achieve the LTCCP targets. Options that allow for the ongoing use of wood as a fuel are likely to be favoured by the Masterton community because of the relatively high price of electricity in this area (Mitchell, pers comm. 2008).

Figures 5.3 to 5.5 show the impact of different management options in achieving the NES and LTCCP. While a number of options appear feasible for NES attainment, the LTCCP target would require the implementation of additional measures. The figures also show the SLiP to comply with the NES.

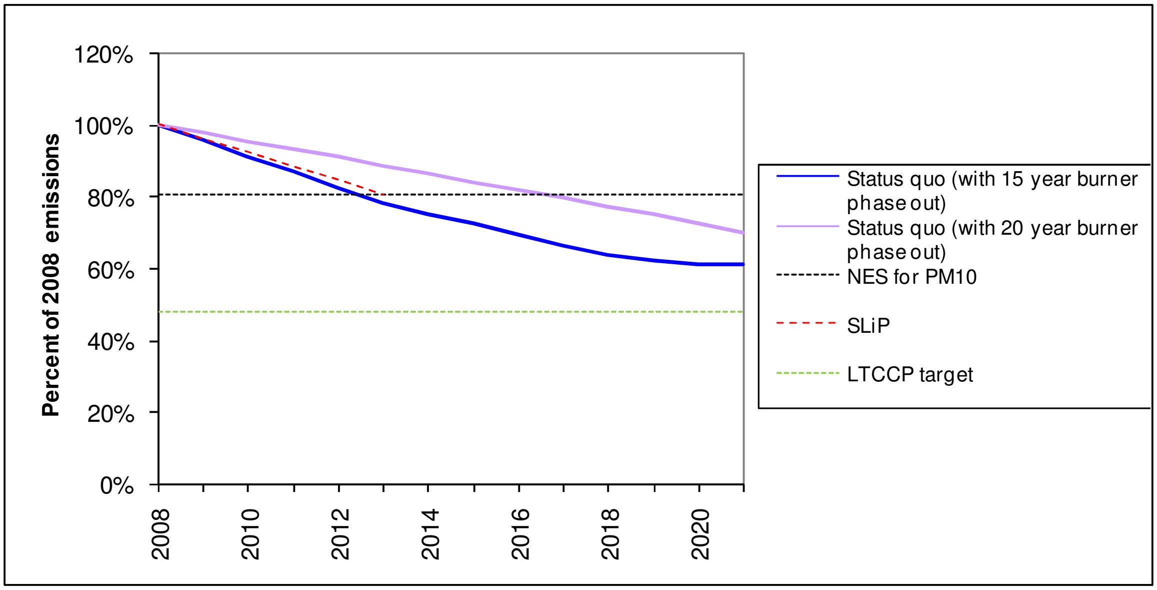

Figure 5.2: Status quo projections for Masterton

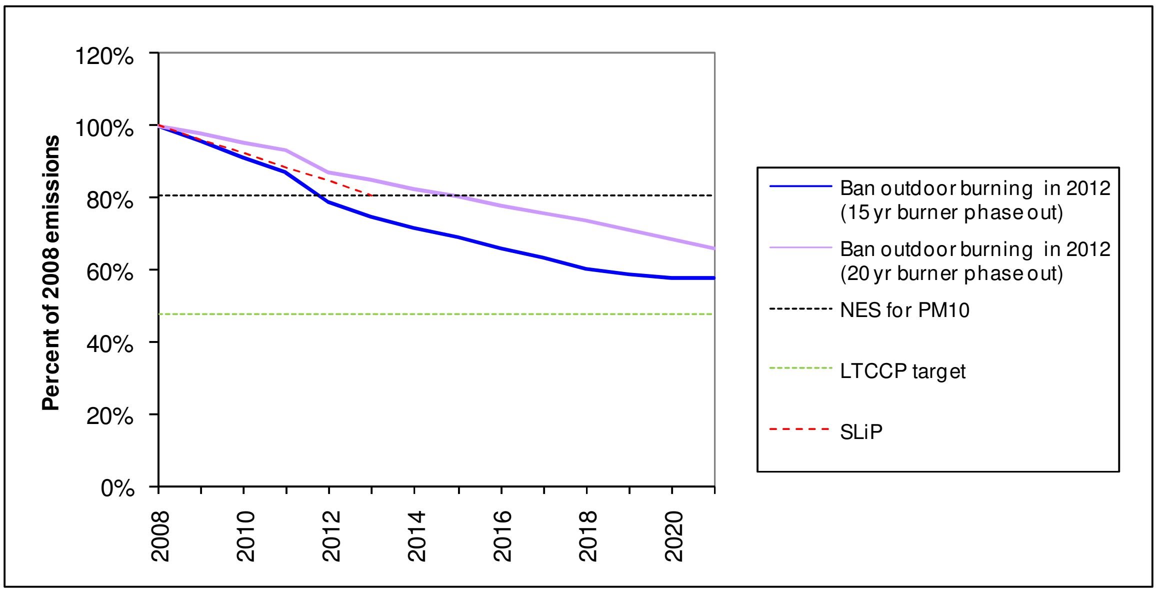

Figure 5.3: Ban outdoor burning in 2012 in Masterton

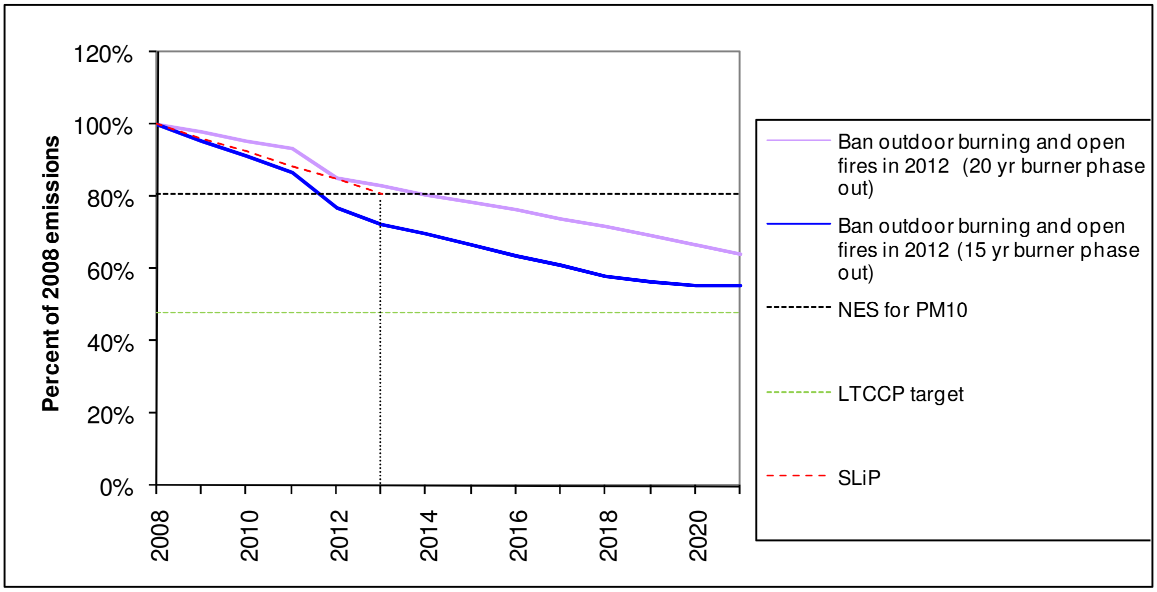

Figure 5.4: Ban open fires and outdoor burning in 2012 in Masterton

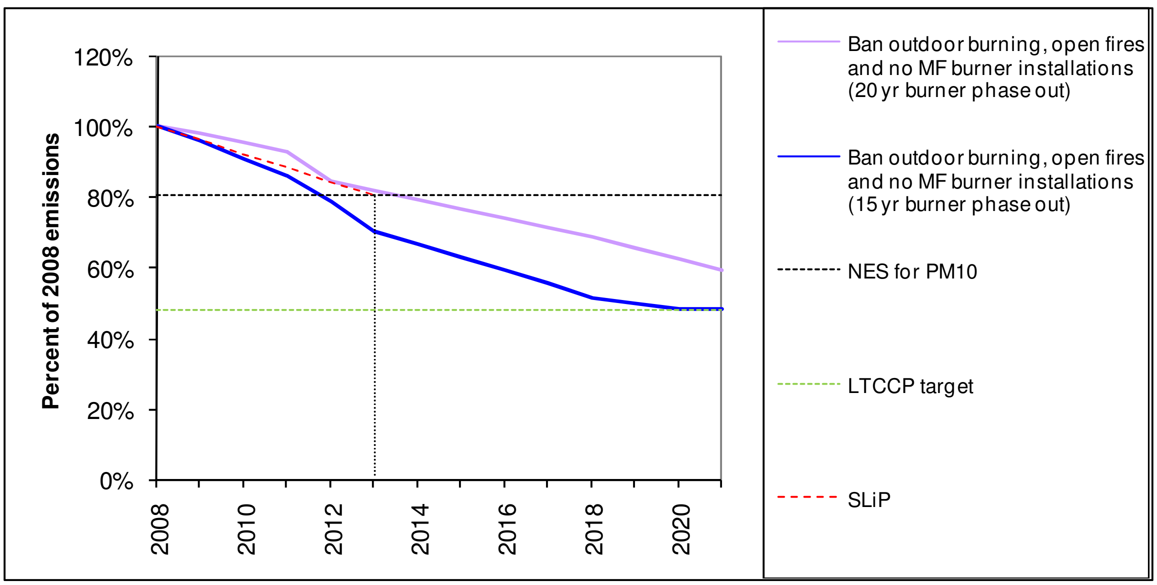

Figure 5.5: Ban open fires and outdoor burning in 2012 and no new multi fuel burner installations from 2010 in Masterton.

Figure 5.6 shows the effectiveness of an incentives programme in addition to an open fire ban and outdoor burning ban in 2012. The incentives would need to be effective in converting 50% of households replacing burners at the end of their useful life to choose non-solid fuel alternatives. This option is likely to result in the NES being met by 2013, particularly if the replacement of wood burners after 15 or 20 years was mandatory. This option may also result in achievement of the LTCCP target by 2016, particularly if a regulatory15 year replacement of older burners was included.

A further evaluation into the effectiveness of an end of life incentives programme found that even if all burners were converted to non-solid fuel at the end of their useful life, the maximum reduction achievable was estimated to be 35% for an assumed burner life of 20 years.

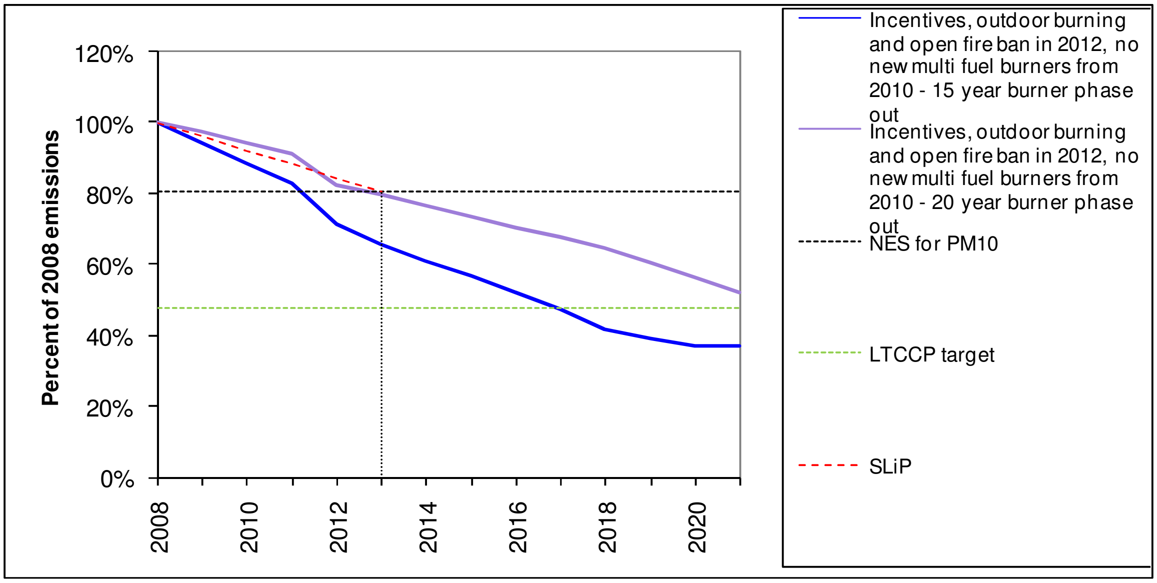

Figure 5.6: Incentives for clean heat replacements at the end of the useful life of a burner which achieves a 50% conversion to non solid fuel, no new multi fuel installations from 2010**,** a ban on outdoor rubbish burning and open fires in 2012 in Masterton.

5.2 Masterton assumptions

Table 5.1 outlines the average fuel use and emission factors used for different appliance and fuel type categories. Table 5.2 specifies further assumptions underpinning the emissions projections and management options assessments.

Table 5.1: Average emission factors and fuel use

	Emission Factor g/kg	Fuel Use kg
Open fire - wood	10	9
Open fire - coal	21	6
Wood burner -pre 1998	11	18
Wood burner - 98-03	7	18
Wood burner -Post 2003	5	18
Woodburner 1.5 g/kg	3	18
Multifuel – wood	13	19
Multifuel – coal	28	13
Oil	0.3	4.7
Gas	0.03	1.3
Pellet	2	5

Table.5.2: Assumptions underlying the assessment of the effectiveness of management options for reducing PM_{10} emissions

1	A decrease in PM_{10} emissions from motor vehicles of around 31% by 2021 based on projected increases in VKTs combined with NZTER predictions on PM_{10} emission reductions from motor vehicles.
2	The industry contribution to PM_{10} emissions is less than 1% and a 10% increase in emissions from industry with time.
3	Current outdoor burning emissions occur throughout the week and weekend.
4	Emission factors for burners as per Table 5.1.
5	Average fuel use for NES authorised burners of 17.8 kg per night as per the 2008 Masterton emission inventory survey.
6	Average fuel use for other burners as per the 2008 Masterton emission inventory survey (Table 5.1).
7	A proportional reduction in concentrations for any given reduction in emissions.
8	No variations in the impact of emissions occurring at different times of the day.
10	No change in the number of households in Masterton from 2008 to 2021.
11	Only 50% of households replacing open fires, if prohibited, will install solid fuel burners*.
12	An emission factor for 1.5 g/kg burners of 3 g/kg.
13	A 10% reduction in the number of open fires from 2008 to 2021.
14	The size of an average outdoor rubbish fire is 150 kilograms per burn.
15	A small proportion (0.25% per year) of houses currently using other heating methods will convert to solid fuel
16	For options including an open fire or outdoor burning ban these are effective from 2012
17	5% of new burner installations will be multi fuel burners.
18	All houses replacing wood burners and multi-fuel burners replace with NES-compliant models
19	For options including a pilot incentives programme encouraging clean heat alternatives at the end of a burners useful life, the incentives are assumed to

	be effective from 2010
20	16% of the PM_{10} on high pollution days is from sources not included in the emission inventory

*This is based on an evaluation of heating method in households that use open fires which shows a reasonable proportion (40%) also have an alternative solid fuel burner

5.2.1 Masterton Summary

The two most effective options for increasing the certainty of achieving the NES in Masterton appear to be:

1. A ban on open fires and outdoor burning in 2012 and no new multi fuel burner installations from 2010. There is some risk around the natural attrition burner replacement rate with a higher risk of not meeting the NES if the replacement rate for wood burners was 20 years. If greater certainty was required then additional regulation for a 15 year replacement period would be an option.
2. An incentives programme which achieves a 50% conversion to non solid fuel at the end of the life of solid fuel burners in addition to no new multi fuel installations from 2010 a ban on outdoor rubbish burning and open fires in 2012.

It may be possible that the LTCCP target is met by 2016 through:

1. The introduction of an incentives programme which achieves a 50% conversion to non solid fuel in addition to a ban on the installation of multi fuel burners from 2010 and a ban on outdoor rubbish burning and open fires in 2012. However, if further certainty was required then replacement of solid fuel burner at the end of a specified useful life (e.g., 15 years) could be made compulsory or an incentives programme could be widened to target a greater proportion of households to switching to non solid fuel and cleaner heating options.

Alternatively, prohibiting the use of open fires and outdoor burning in 2012 and not allowing new multi fuel burner installations is likely to meet the NES by 2013 but is less likely to meet the LTCCP target.

6 Management options for PM_{10} - Wainuiomata

6.1 Wainuiomata baseline projections

Projected baseline emissions for PM_{10} in Wainuiomata are shown in Figure 6.1. These are based on the assumptions outlined in Table 6.2. Results show a significant decrease in PM_{10} from domestic home heating as a result of households replacing older more polluting burners with NES authorised wood burners.

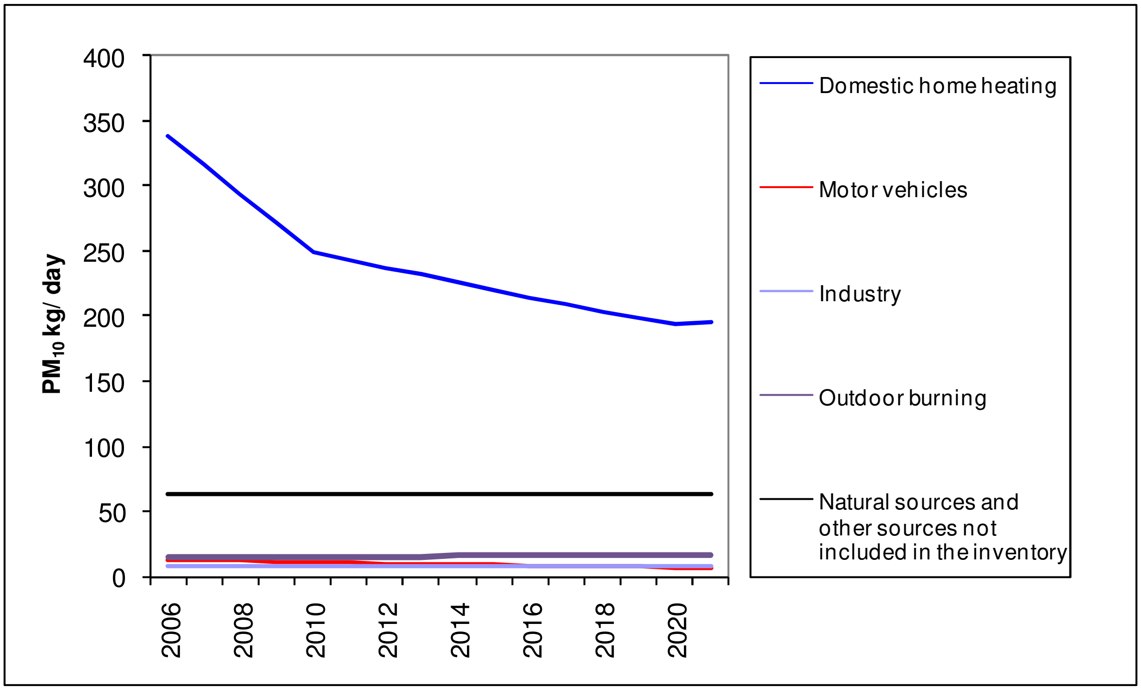

Figure 6.1: Projected baseline emissions for PM_{10} in Wainuiomata.

Figure 6.2 shows baseline projections for Wainuiomata relative to the reductions required to achieve the NES and the LTCCP.

It seems very likely that the NES would be met by 2013 in the absence of further air quality management. Additional air quality management would be required to achieve the LTCCP target of 33 µg m^{-3} by 2016.

Figures 6.3 to 6.5 show the impact of different management options in achieving the LTCCP.

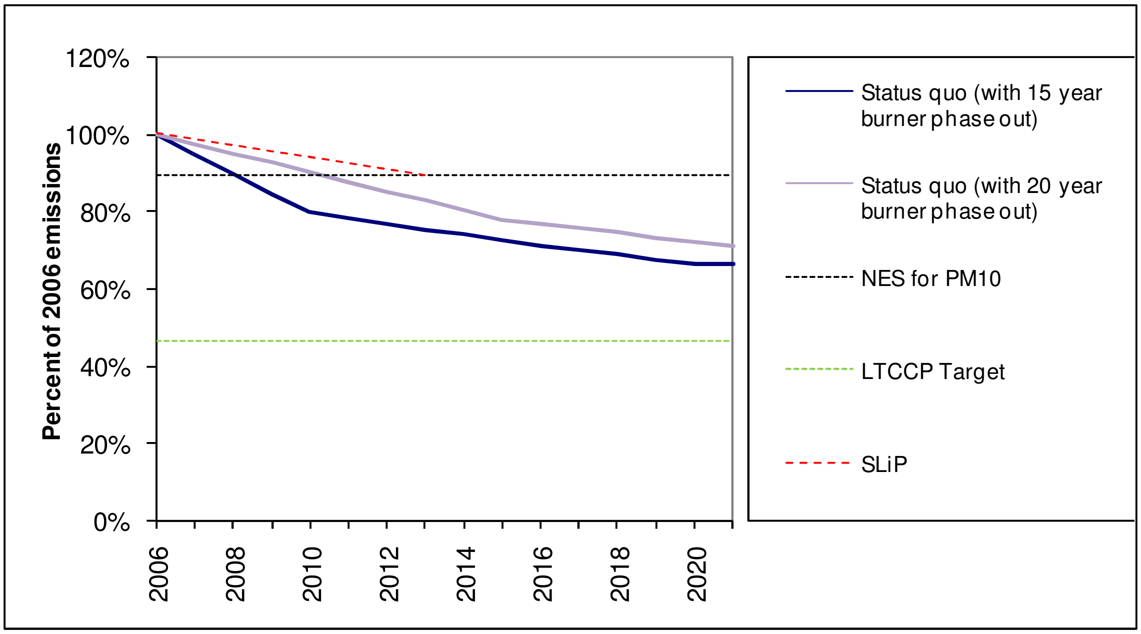

Figure 6.2: Status quo projections for Wainuiomata

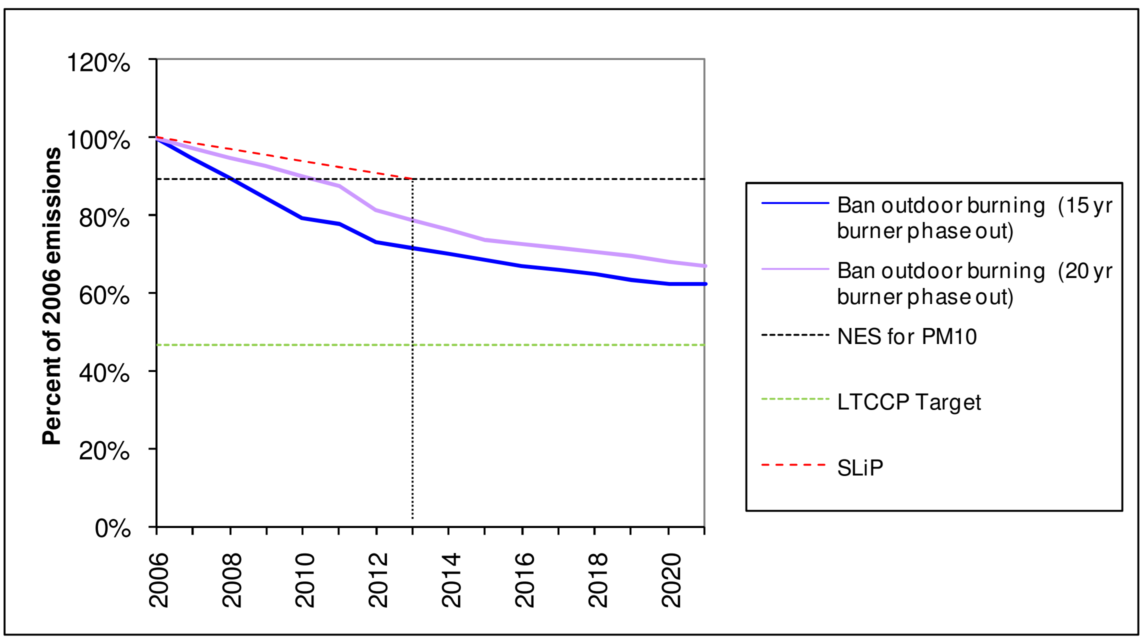

Figure 6.3: Ban outdoor burning in 2012 in Wainuiomata

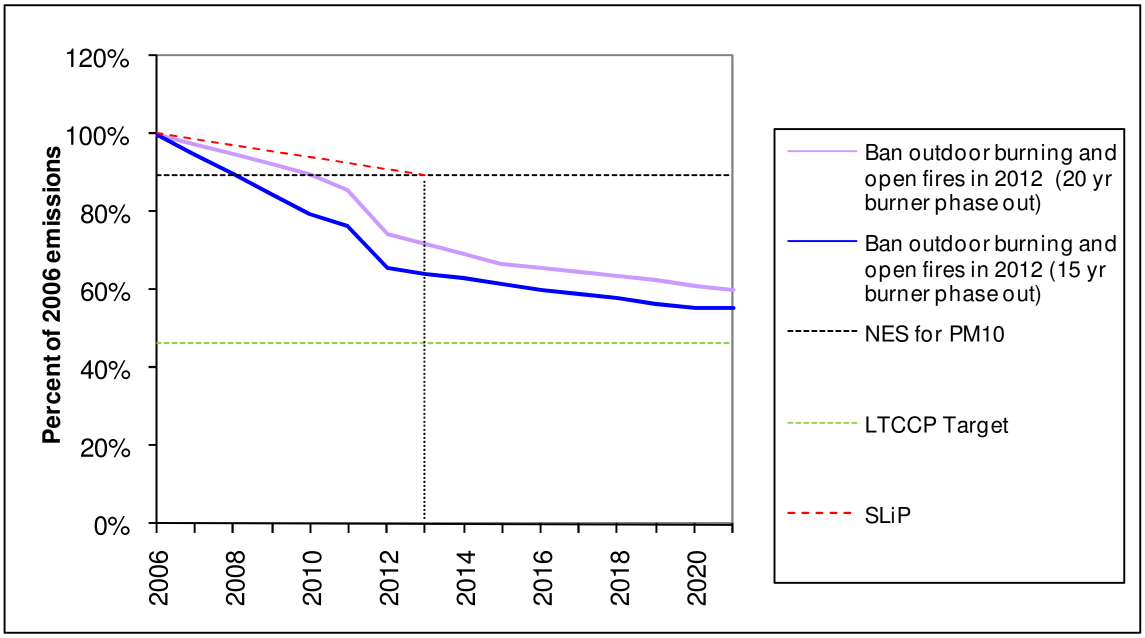

Figure 6.4: Ban open fires and outdoor burning in 2012 in Wainuiomata

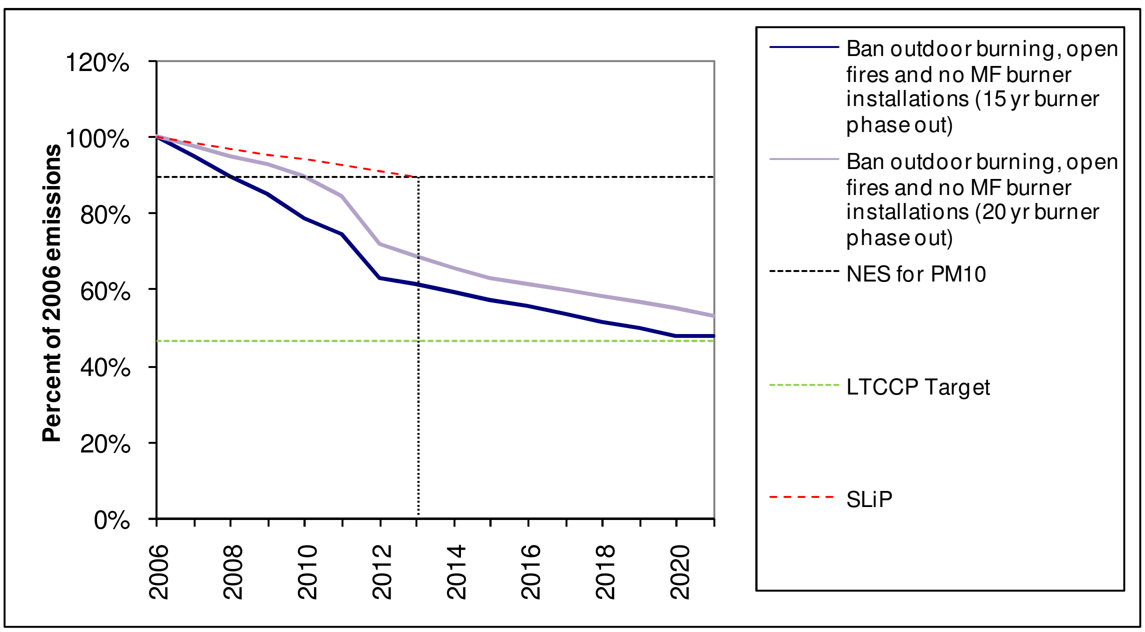

Figure 6.5: Ban open fires and outdoor burning in 2012 and no new multi fuel burner installations from 2010 in Wainuiomata

Figure 6.6 shows the effectiveness of an incentives programme in addition to an open fire ban and outdoor burning ban in 2012. The incentives would need to be effective in converting 50% of households replacing burners at the end of their useful life to choose non-solid fuel alternatives. This option may result in achievement of the LTCCP target by 2016, particularly if a regulatory15 year replacement of older burners was included.

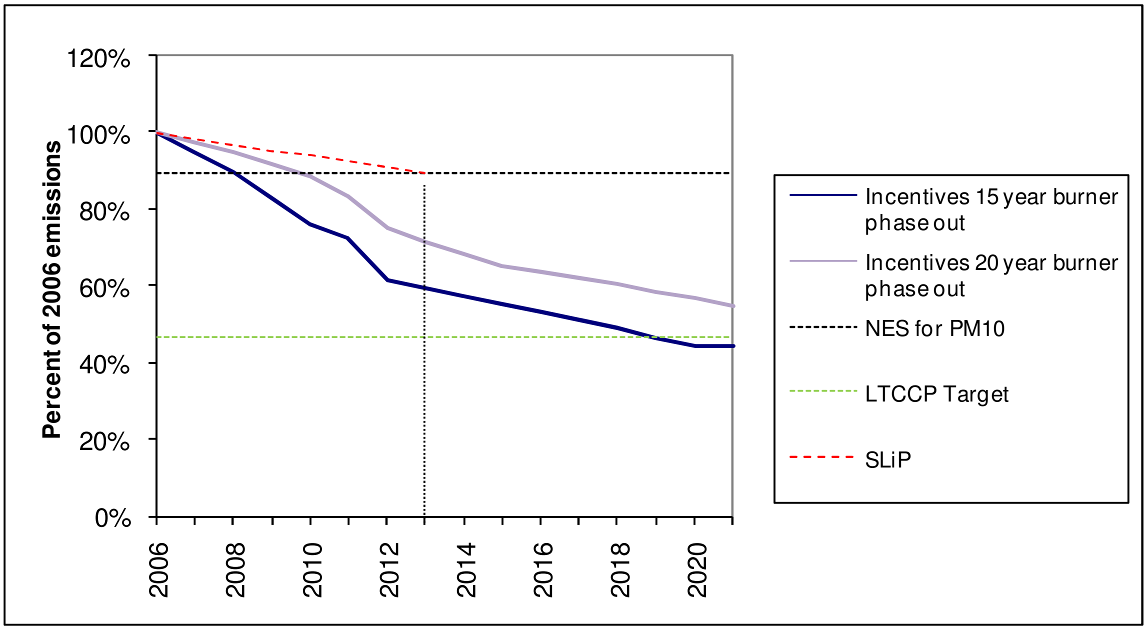

Figure 6.6: Incentives for clean heat replacements which achieve a 50% conversion to non solid fuel at the end of the useful life of a wood or multi fuel burner and a ban on outdoor rubbish burning and open fires in 2012.

6.2 Wainuiomata assumptions

The average daily fuel use and emission factors for domestic heating used in the air emission inventory (Wilton, 2006) and these projections are detailed in Table 6.1. Table 6.2 specifies the assumptions underpinning the emissions projections and management options assessments.

Table 6.1: Average emission factors and fuel use

	Emission Factor g/kg	Fuel Use kg
Open fire - wood	10	12
Open fire - coal	21	4
Wood burner -pre 1996	11	17
Wood burner - 96-01	7	17
Wood burner -Post 2001	5	17
Woodburner 1.5 g/kg	3	17
Multifuel – wood	13	19
Multifuel – coal	28	3
Oil	0.3	1.4
Gas	0.03	1.0
Pellet	2	4

Table 6.2: Assumptions underlying the assessment of the effectiveness of management options for reducing PM_{10} emissions

1	A decrease in PM_{10} emissions from motor vehicles of around 50% by 2021 based on projected increases in VKTs combined with NZTER predictions on PM_{10} emission reductions from motor vehicles.
2	The industry contribution to PM_{10} emissions is less than 2% and a 10% increase in emissions from industry with time.
3	Current outdoor burning emissions occur throughout the week and weekend.
4	Emission factors for burners as per Table 6.1.
5	Average fuel use for NES authorised burners of 16.5 kg per night as per the 2008 Masterton emission inventory survey.
6	Average fuel use for other burners as per the 2006 Wainuiomata emission inventory survey (Table 6.1).
7	A proportional reduction in concentrations for any given reduction in emissions.
8	No variations in the impact of emissions occurring at different times of the day.
10	A 13% increase in households from 2006 to 2021.
11	Only 50% of households replacing open fires, if prohibited, will install solid fuel burners*.
12	An emission factor for NES authorised burners of 3 g/kg.
13	A 10% reduction in the number of open fires from 2006 to 2021.
14	The size of an average outdoor rubbish fire is 150 kilograms per burn.
15	A small proportion (.25% per year) of houses currently using other heating methods will convert to solid fuel
16	For options including an open fire or outdoor burning ban these are effective from 2012
17	10% of new burner installations will be multi fuel burners.
18	All houses replacing wood burners and multi-fuel burners replace with NES-compliant models
19	For options including a pilot incentives programme encouraging clean heat alternatives at the end of a burners useful life, the incentives are assumed to

	be effective from 2010
20	16% of the PM_{10} on high pollution days is from sources not included in the emission inventory**

*This is based on an evaluation of heating method in households that use open fires which shows a reasonable proportion (40%) also have an alternative solid fuel burner

** Based on results for Masterton as no source apportionment studies for Wainuiomata had been completed at the time this work was conducted

6.2.1 Summary

It is likely that the NES will be met in Wainuiomata without further management intervention. More certainty in meeting the NES could be achieved through a variety of management options including banning open fires and back yard burning and prohibiting the installation of multi fuel burners.

The most effective option for achieving the LTCCP target in Wainuiomata appears to be:

1. An incentives programme which achieves a 50% conversion to non solid fuel alternatives at the end of their useful life, a ban on outdoor rubbish burning and open fires in 2012 and no new multi fuel burner installations from 2010.

7 Management options for PM_{10} - Upper Hutt

7.1 Upper Hutt baseline projections

Projected baseline emissions for PM_{10} in Upper Hutt are shown in Figure 7.1. These are based on the assumptions outlined in Table 7.2. Results show a significant decrease in PM_{10} from domestic home heating as a result of households replacing older more polluting burners with NES authorised wood burners.

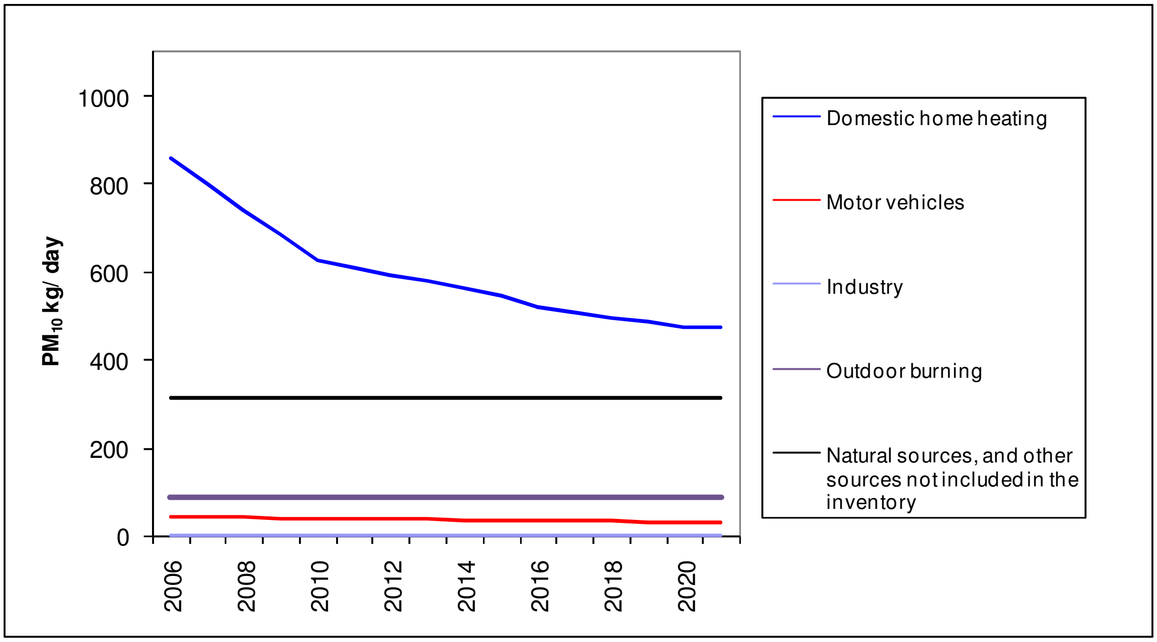

Figure 7.1: Projected baseline emissions for PM_{10} in Upper Hutt

Figure 7.2 shows baseline projections for Upper Hutt relative to the reductions required to achieve the LTCCP.

In Upper Hutt PM_{10} concentrations exceeding the NES have not been recorded, therefore it is not necessary to undertake any emissions projects to reduce PM_{10} for compliance with the NES.

It seems possible that the LTCCP would be met by 2016 in the absence of further air quality management. If increased certainty is required options that may result in achievement of the LTCCP include a ban on outdoor burning (Figure 7.3), a ban on the use of open fires (Figure 7.4) or incentives to encourage 25% of households to switch to non solid fuel alternatives (Figure 7.5).

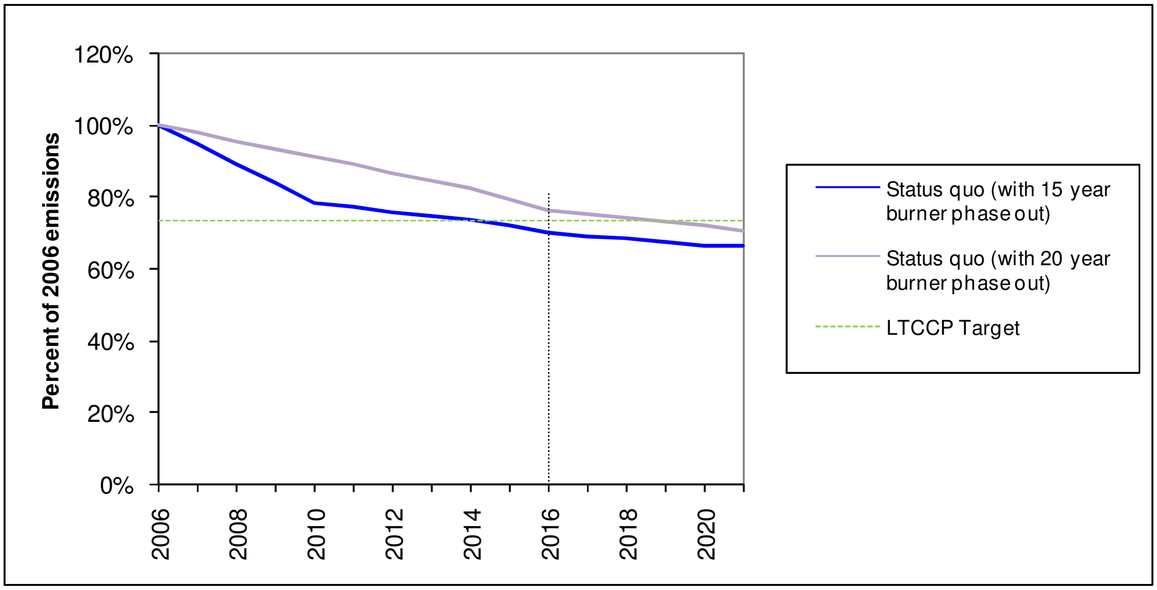

Figure 7.2: Status quo projections for Upper Hutt

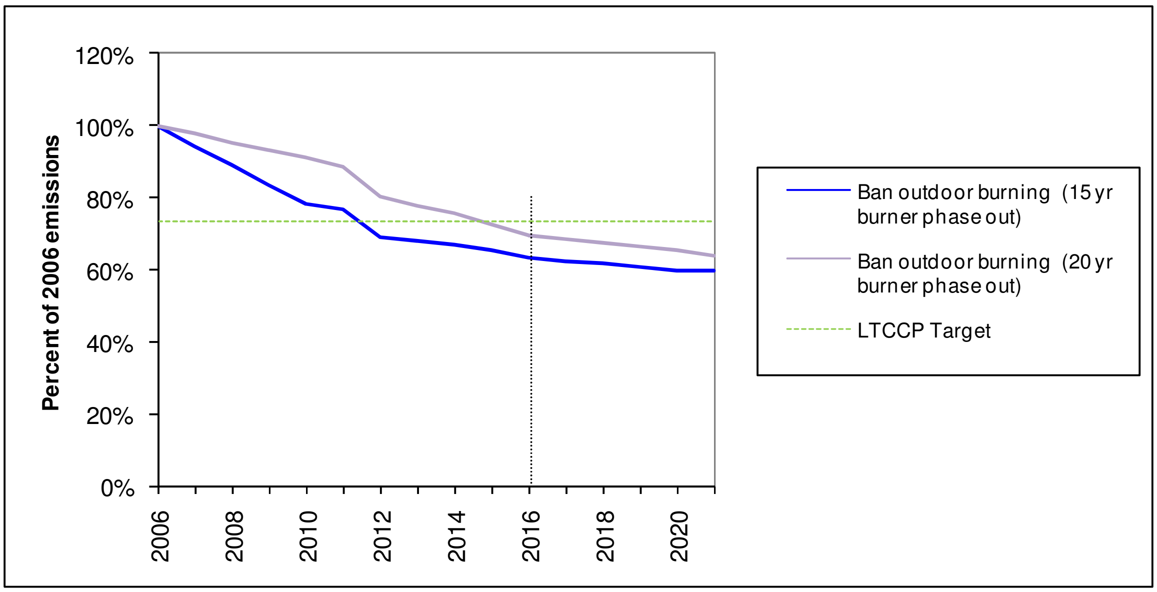

Figure 7.3: Ban outdoor burning in 2012 in Upper Hutt

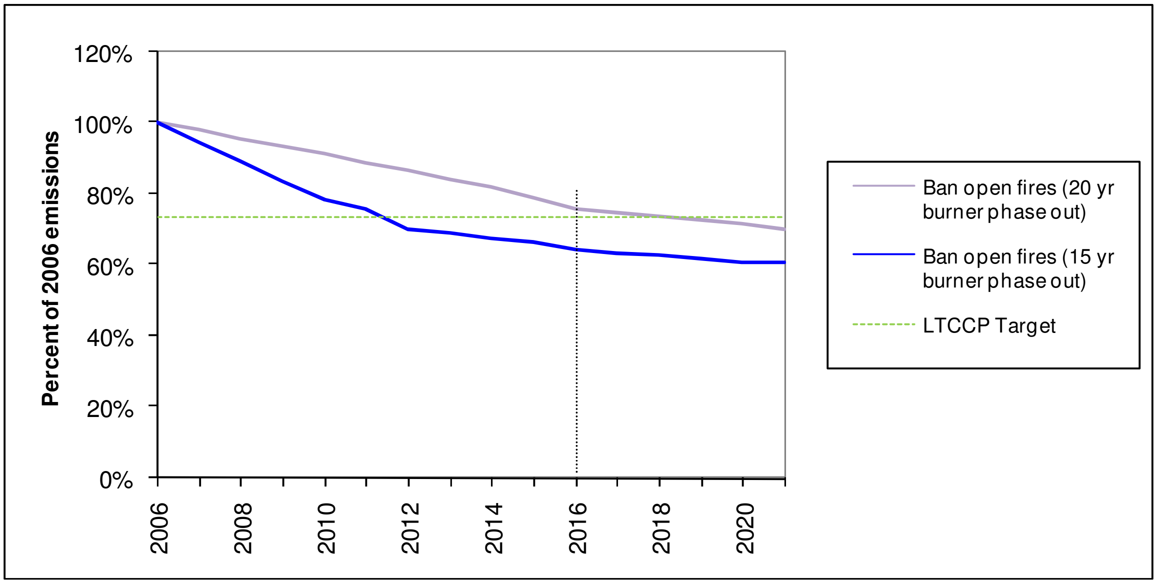

Figure 7.4: Ban the use of open fires in 2012 in Upper Hutt

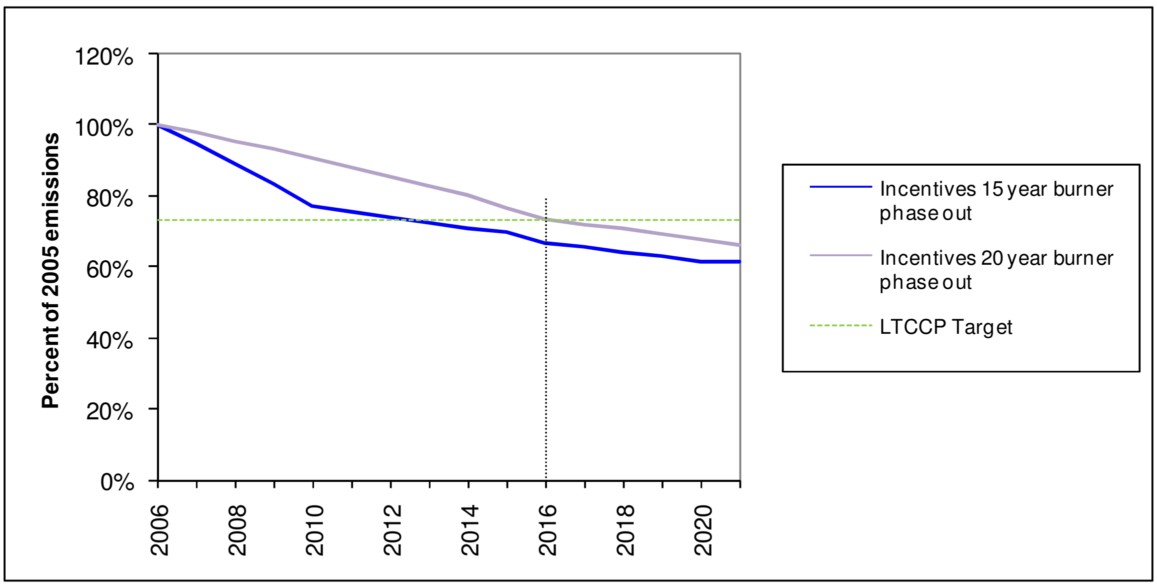

Figure 7.5: Incentives for clean heat replacements at the end of the useful life of a burner (25% of households using wood burners, open fires or multi fuels convert to clean heat options) in Upper Hutt

7.2 Upper Hutt assumptions

The average daily fuel use and emission factors for domestic heating used in the air emission inventory (Wilton, 2006) and these projections are detailed in Table 7.1. Table 7.2 specifies the assumptions underpinning the emissions projections and management options assessments.

Table 7.1: Average emission factors and fuel use

	Emission Factor g/kg	Fuel Use kg
Open fire - wood	10	15
Open fire - coal	21	6
Wood burner -pre 1996	11	22
Wood burner - 96-01	7	22
Wood burner -Post 2001	5	22
Woodburner 1.5 g/kg	3	22
Multifuel – wood	13	10
Multifuel – coal	28	4
Oil	0.3	1.4
Gas	0.03	1.0
Pellet	2	10

Table.7.2: Assumptions underlying the assessment of the effectiveness of management options for reducing PM_{10} emissions

1	A decrease in PM_{10} emissions from motor vehicles of around 35% by 2021 based on projected increases in VKTs combined with NZTER predictions on PM_{10} emission reductions from motor vehicles.
2	The industry contribution to PM_{10} emissions is less than 1% and a 10% increase in emissions from industry with time.
3	Current outdoor burning emissions occur throughout the week and weekend.
4	Emission factors for burners as per Table 7.1.
5	Average fuel use for NES authorised burners of 22 kg per night as per the 2006 Upper Hutt emission inventory.
6	Average fuel use for other burners as per the 2006 Upper Hutt emission inventory survey (Table 6.1).
7	A proportional reduction in concentrations for any given reduction in emissions.
8	No variations in the impact of emissions occurring at different times of the day.
10	A 4% decrease in households from 2006 to 2021.
11	Only 50% of households replacing open fires, if prohibited, will install solid fuel burners*.

12	An emission factor for NES authorised burners of 3 g/kg.
13	A 10% reduction in the number of open fires from 2006 to 2021.
14	The size of an average outdoor rubbish fire is 150 kilograms per burn.
15	A small proportion (.25% per year) of houses currently using other heating methods will convert to solid fuel
16	For options including an open fire or outdoor burning ban these are effective from 2012
17	9% of new burner installations will be multi fuel burners.
18	All houses replacing wood burners and multi-fuel burners replace with NES-compliant models
19	For options including a pilot incentives programme encouraging clean heat alternatives at the end of a burners useful life, the incentives are assumed to be effective from 2010
20	23% of the PM_{10} on high pollution days is from sources not included in the emission inventory.

*This is based on an evaluation of heating method in households that use open fires which shows a reasonable proportion (40%) also have an alternative solid fuel burner

7.2.1 Summary

It is possible that the LTCCP would be met in Upper Hutt by 2016 in the absence of further intervention. This relies on the natural attrition of older burners and replacement with lower emission NES compliant burners after a 15 year life. A number of management options are available if more certainty of meeting the LTCCP is required. These include a ban on the use of open fires, the implementation of an incentives programme to encourage the replacement of burners with clean heating alternatives, a ban on multi fuel installations from 2010 or the banning of outdoor rubbish burning.

The reductions required in PM_{10} concentrations to meet the LTCCP for Upper Hutt are based on monitoring results from 2006 to 2008. Because this monitoring period is limited relative to the other sites, it is possible that worst case PM_{10} have not been recorded. It is recommended that PM_{10} concentrations in Upper Hutt be closely monitored and management options to achieve air quality targets be revised should higher PM_{10} be measured.

8 Conclusions

Projections on a number of management options to reduce PM_{10} levels in Masterton, Wainuiomata and Upper Hutt have been presented in this report.

In Masterton, it may be possible to meet the NES by 2013 without intervention if burners are replaced through natural attrition 15 years after installation. However there is a high degree of risk in relying on this. Management options that provide a higher degree of certainty of achieving the NES in Masterton include:

- Mandatory replacement of solid fuel burners 15 years after installation
- An incentives programme which achieves a 50% conversion to non solid fuel alternatives, a ban on multi fuel installations from 2010 and a ban on outdoor rubbish burning and open fires.

The following management option may meet the LTCCP target of 33 µg m^{-3} (24-hour average) 2016, in Masterton:

- The introduction of an incentives programme which achieves a 50% conversion to non solid fuel in addition to a ban on the installation of multi fuel burners from 2010 and a ban on outdoor rubbish burning and open fires in 2012. However, if further certainty was required then replacement of solid fuel burner at the end of a specified useful life (e.g., 15 years) could be made compulsory or an incentives programme could be widened to target a greater proportion of households to switching to non solid fuel and cleaner heating options.

In Wainuiomata, it is very likely that the NES would be met by 2013 in the absence of further air quality management. More certainty in meeting the NES could be achieved through a variety of management options including banning open fires and back yard burning and prohibiting the installation of multi fuel burners.

To meet the LTCCP target by 2016 in Wainuiomata additional management is required. The most feasible option for achieving this appears to be:

- An incentives programme which achieves a 50% conversion to non solid fuel beginning in 2010 for clean heat replacements at the end of 15 years burner use and a ban on outdoor rubbish burning and open fires in 2012.

In Upper Hutt PM_{10} concentrations exceeding the NES have not been recorded, therefore it was not necessary to undertake any emissions projects to reduce PM_{10} for compliance with the NES.

It seems possible that the LTCCP would be met by 2016 in Upper Hutt the absence of further air quality management. However to improve certainty of meeting the LTCCP, either of the following management option are recommended.

- A ban on the use of open fires in 2012 with a 15 year mandatory replacement of wood burners not complying with the NES.

- Incentives for clean heat replacements resulting in 25% of households converting to cleaner heat options.

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