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PREPARED FOR

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Management options for reducing particulate concentrations in Richmond 2021

EXECUTIVE SUMMARY

In Richmond concentrations of PM_{10} continue exceed the National Environmental Standard (NES) of 50 µgm-3 (24-hour average, one allowable exceedance per year). Compliance with the NES for PM_{10} in Richmond was required by September 2020. In 2021 the NES was breached on three occasions with a total of four measured exceedances. Trend analysis suggests a decrease in PM_{10} concentrations from 2005 to 2010 but a tapering of reductions in PM_{10} since 2010.

The Tasman District Council adopted Variation 51 to the Tasman Resource Management Plan (TRMP) (operative November 2008) which contained measures to reduce concentrations of PM_{10} in the Richmond airshed. These included a ban on outdoor rubbish burning in the urban area and the removal of solid fuel burners not complying with the NES design criteria for wood burners at the time a house is sold. In addition, rules precluded in the installation of solid fuel burners, with the exception of pellet burners, in new dwellings and dwellings that previously did not use solid fuel for home heating. Scientific evaluations (Wilton, 2017, Wilton, 2018) indicate that additional management measures are required to meet the current NES for PM_{10} and proposed NES for $PM_{2.5}$ (Ministry for the Environment, 2020).

This report evaluates the likely effectiveness of current air quality management strategies and potential alternative strategies to reduce PM_{10} and $PM_{2.5}$ concentrations and the likelihood of the latter strategies resulting in compliance with the NES and potential future $PM_{2.5}$ standards. This information will be used to inform development of the discharges to air section (specific to the Richmond airshed) of the Aorere ki uta, Aorere ki tai – Tasman Environment Plan (second generation resource management plan).

The analysis updates previous assessments to include the most recent science as well as mitigation options such as the introduction of ultra-low emission burners (ULEB) and other technologies not previously available.

Results confirm previous evaluations that additional management measures would be required for ongoing compliance with the NES for PM_{10} in Richmond. A suite of options that are likely to result in compliance with the PM_{10} NES have been identified. The requirement that all new burner installations meet the ULEB criteria appears one of the most effective strategies. When this measure is combined with the phase out of burners not compliant with the NES design standard and behaviour change to improve the operation of existing burners, compliance with the NES for PM_{10} and an annual $PM_{2.5}$ standard of 8 or 10 µg/m^3 is anticipated. Adoption of management measured based on achieving compliance with the existing NES for PM_{10} with a buffer than allows for uncertainties in the analysis is recommended given uncertainties in the proposed NES for $PM_{2.5}$.

If a daily NES for $PM_{2.5}$ is introduced at the level (25 µg/m^3) proposed by the Ministry for the Environment (2020) additional management measures may be required to achieve compliance by 2035. These could include the phase out of pre 2010 wood burners for example and could be considered at a later date once there is more certainty around this standard.

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1 INTRODUCTION

In Richmond, concentrations of PM_{10} breach the National Environmental Standards (NES) of 50 µgm-3 (24-hour average). Breaches occur during the winter months when increased emissions from domestic home heating combine with meteorological conditions conducive to elevated concentrations. The number of breaches has decreased from more than 20 per year from 2005 to 2010 to less than ten per year with maximum measured concentrations reducing from around 133 µg/m^3 (2005) to around 76 µg/m^3 (2018) over the same period.

The Tasman District Council adopted Variation 51 to the Tasman Resource Management Plan (TRMP) (operative November 2008) which contained measures to reduce concentrations of PM_{10} in the Richmond airshed. These included a ban on outdoor rubbish burning and the removal of solid fuel burners not complying with the NES design criteria for wood burners at the time a house is sold. Additionally, the NES design criteria for wood burners was introduced nationally in 2005 and requires all wood burners to meet the specified emission and efficiency criteria. The natural attrition replacement of older burners with lower emission burners has also occurred over this period and in 2019 around 40% of burners did not comply with the standard. The TRMP prohibits the installation of new burners (except pellet fires) in new dwellings and dwellings that do not have an existing burner. Under the current measures for Richmond open fires and multi fuel burners can continue to be used in households that have not been sold since TRMP Variation 51 was notified.

An evaluation of the effectiveness of these measures was carried out in 2017 to determine if additional management measures were likely to be required (Wilton, 2017). Additionally, an evaluation of trends in PM_{10} concentrations in Richmond confirmed reductions in concentrations had occurred prior to 2010 but found no significant reductions in concentrations from 2010 to 2017 (Wilton, 2018). Collectively these reports conclude that additional management measures are likely required to meet the NES for PM_{10} and potentially for $PM_{2.5}$ depending on the specifics of that standard.

Technological advancements that may assist with achieving reductions in PM_{10} and $PM_{2.5}$ emissions from domestic home heating include new technology burners and electrostatic precipitators. It is recognised that the current TRMP rule provisions have not kept up to date with technological advancements in home heating. Technological advancements currently used elsewhere in New Zealand include the ultra-low emission burner (ULEB) and the Oekotube electrostatic precipitator. Environment Canterbury introduced the ULEB certification to drive technology improvements and initial testing of these burners suggests emissions significantly lower than real life testing of NES compliant burners. Additionally, the Oekotube electrostatic precipitator, which can be fitted to existing devices and which will remove a portion of the particulate prior to discharge, has been authorised by Environment Canterbury for use with NES compliant burners to give a ULEB equivalent.

The objectives of this report are to assess the effectiveness of management measures for Richmond to reduce PM_{10} concentrations to meet the NES (50 µg/m^3 24-hour average) and to reduce $PM_{2.5}$ concentrations to meet potential future NES. This information will be used to inform development of the discharges to air section (specific to the Richmond airshed) of the Aorere ki uta, Aorere ki tai – Tasman Environment Plan (second generation resource management plan).

2 AIR QUALITY IN RICHMOND

2.1 Standards and concentrations of PM_{10}

The NES for PM_{10} is a daily average concentration of 50 µg/m^3 with one allowable exceedance per year. The NES was introduced in 2005 and Richmond was required to be compliant with the NES from September 2020. In 2021 four exceedances and three breaches of the NES occurred in the Richmond airshed. There is no annual average NES for PM_{10}.

Concentrations of PM_{10} have been measured continuously in Richmond since 2006. Prior to this, sampling based on one day in six and one day in three frequencies were carried out from 2000 to 2005. Figure 2.1 shows the winter average, 75th percentile and maximum daily PM_{10} concentrations from 2000 to 2021. This suggests higher concentrations over the period 2000 to 2005 with decreases occurring from around 2005 to 2010 and a tapering in reductions from 2010 to 2021.

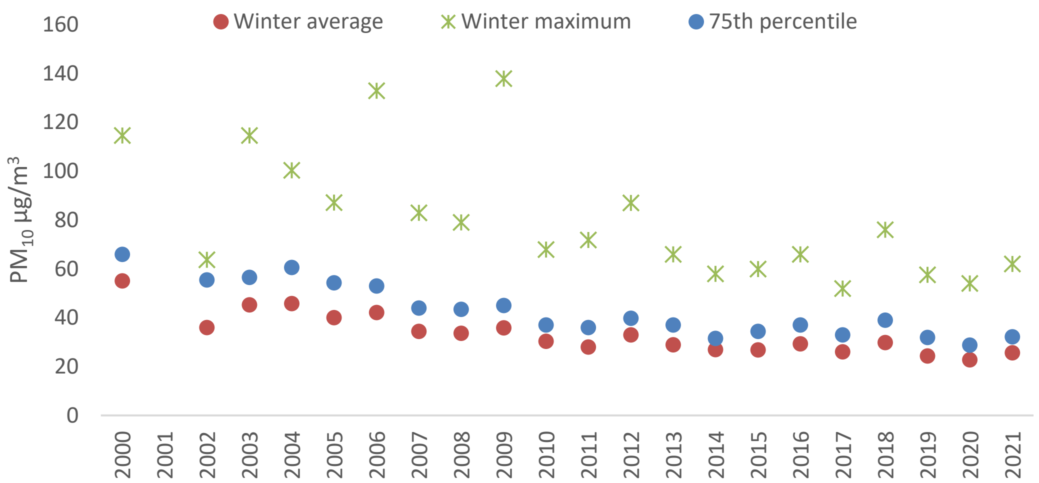

Figure 2-1: Trends in winter average, 75th percentile and maximum daily PM_{10} concentrations from 2000 to 2021

2.2 Standards and concentrations of $PM_{2.5}$

The annual average $PM_{2.5}$ concentrations for Richmond for the years 2016 to 2021 ranged from 9.7 µg/m^3 to 12.1 µg/m^3.

Concentrations of $PM_{2.5}$ were estimated for the years 2006 to 2015 using the relationship of $PM_{2.5}$ = 0.54 PM_{10} – 1.2 for non-winter months (September to April) and the relationship of 1.05 PM_{10} – 7.5 for the winter months (Wilton, 2017) and the resulting estimates are shown in Table 3.1 along with more recent estimates and measured concentrations. Table 3.1 also shows the reductions required for each indicator to meet either the 2004 NES (for PM_{10}) or the WHO guideline for annual average $PM_{2.5}$. Reductions required need to be considered in the context of trends in concentrations with more recent values at times when reductions have tapered being more relevant in terms of further improvements required.

Based on concentrations of $PM_{2.5}$ over the last five years a reduction of up to 17% would be required to meet an annual average concentration of 10 µg/m^3 or by up to 34% to meet an annual average concentration of 8 µg/m^3 should the revised NES include a standard of these magnitudes.

Table 2.1: Summary annual PM_{10} and $PM_{2.5}$ (estimated) data for Richmond

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Estimated (E) or measured (M)	E	E	E	E	E	E	E	E	E	E	M	E	M	M	M	M
Annual average $PM_{2.5}$ (estimated based on ratios to PM_{10})	16.4	13.7	13.6	14.5	12.5	11.4	12.6	11.9	8.5	10.8	10.0	10	12.1	9.9	9.7	9.7
Annual average PM_{10}	23	21	21	22	20	18	19	19	14	18	19	16.7	18.8	17.6	15.1	17.0
Reduction to meet annual average $PM_{2.5}$ of 10 µg/m^3	39%	27%	26%	31%	20%	12%	21%	16%		7%			17%			
Reduction to meet annual average $PM_{2.5}$ of 8 µg/m^3	51%	42%	41%	45%	36%	30%	37%	33%	6%	26%	20%	21%	34%	19%	17%	17%
Fourth highest daily $PM_{2.5}$											43		33	38	40	39
Reduction in daily $PM_{2.5}$ (25 µg/m^3)											42%		24%	34%	37%	37%

2.2.1 24-hour average $PM_{2.5}$ concentrations

The maximum daily $PM_{2.5}$ concentrations measured in Richmond during 2016 was 46 µg/m^3. This value is almost double the 2006 WHO guideline and proposed $PM_{2.5}$ NES for 24-hour average $PM_{2.5}$ of 25 µg/m^3.

The current proposed daily NES for $PM_{2.5}$ is based on the WHO (2006) value. The WHO justification for this value is just a few paragraphs (compared with tens of pages for the annual value) and is, in our view, scientifically substandard, particularly for a New Zealand context. In the justification they note absence of adequate concentration response relationships for time series studies for $PM_{2.5}$ (they are predominantly PM_{10}) and as a result the authors determine that a value of 25 µg/m^3 would be appropriate based on relationships between daily and annual concentrations (which would have to be assumed to be generic). No detail on the latter relationships (between fourth highest daily $PM_{2.5}$ and annual $PM_{2.5}$) is provided (despite the level of detail gone to with the annual standard justification) which is not surprising given the relationship will differ by location and by year depending on the relative prevalence of different meteorological conditions. That is, it is not generic, at least not in a New Zealand context. The lack of a generic relationship between daily and annual $PM_{2.5}$ can be seen in Table 3.1 where the lowest daily $PM_{2.5}$ value of 33 µg/m^3 occurs on the year with the highest annual average concentrations (12.1 µg/m^3) and no consistent relationship between annual and daily concentrations is observed even within a single location.

A value of 25 µg/m^3 had been used for a daily $PM_{2.5}$ guideline prior to WHO (2006) (e.g., Australian NEPM in 2003) with the value initially derived based on the concentration response relationships for PM_{10} (with 50 µg/m^3 guideline) and an average $PM_{2.5}$ to PM_{10} ratio of 50%. It appears WHO (2006) have opted to retain this value (in the absence of better information) and have searched for a potential justification for it specifically not related to PM_{10}[1].

It is our view that the basis of the proposed $PM_{2.5}$ NES is highly questionable particularly for a New Zealand context and has some anomalies that may result in a less stringent revised WHO guideline or proposed NES if a more robust approach, which also considers the relative risk between the daily and annual standard, is taken.

Adoption of management measures to achieve the proposed $PM_{2.5}$ NES would seem premature in our view. We suggest an approach of adopting measures to achieve compliance with the existing NES for PM_{10} or an annual NES for $PM_{2.5}$ of 8 µg/m^3 (whichever is more stringent) with a buffer that allows for uncertainties in the analysis. We propose identification of additional management options that could be imposed, at a late date, to achieve compliance with the proposed NES for $PM_{2.5}$ if this were to be adopted.

To that end, based on the data in Table 3.1 we estimate a reduction required in daily $PM_{2.5}$ of 42% based on a worst case fourth highest concentration of 43 µg/m^3 (2016).

2.3 Relationship between $PM_{2.5}$ and PM_{10} concentrations

Figure 2.2 shows the relationship between 30-minute average $PM_{2.5}$ and PM_{10} concentrations (expressed as a ratio) by wind speed and direction for Richmond for each month from 2017 to 2020. Typically, a range of sources will contribute to PM_{10} at any given time resulting in colours in the green, yellow, orange range. However, the prevalence of red shows that during the months of May to September a high ratio source of particulate (biomass burning) is dominant during low wind speed episodes. The exception is July when some medium and high wind speed sources contribute when the wind is blowing from the south-west. Similarly shades in the blue indicate coarse mode particulate is predominant under high speeds at times.

[1] Relying on the PM_{10} standard health justification would mean the standard had no justification over and above the PM_{10} standard.

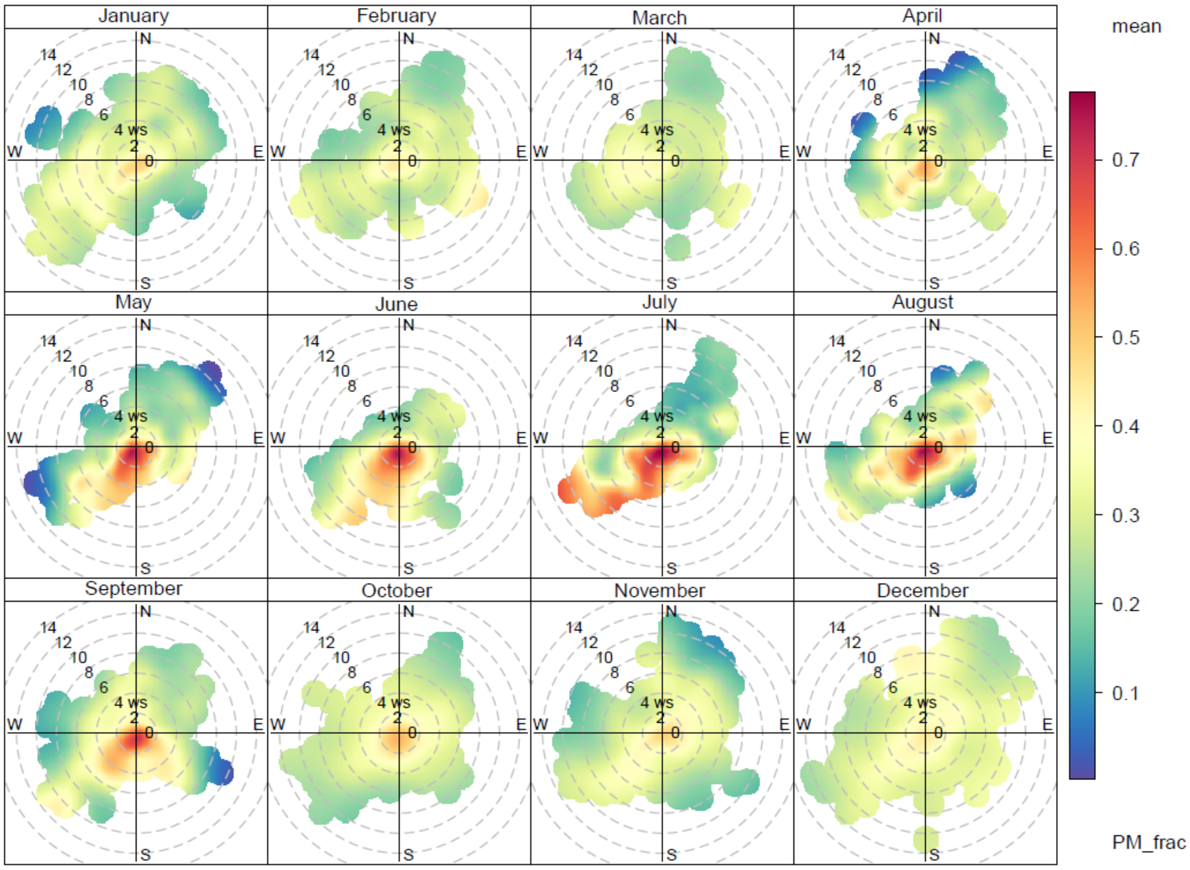

Figure 2-2: Relationship between $PM_{2.5}$ to PM_{10} ratio and wind speed and direction by month of year (2017-2020).

3 MANAGING PM_{10} CONCENTRATIONS IN RICHMOND

Additional management of PM_{10} concentrations in Richmond would be required to meet the NES for PM_{10} which is set at 50 µg/m^3 (24-hour average) with one allowable exceedance per year. The NES was introduced in 2005 and Richmond was required to be compliant with the NES by September 2020. Air quality monitoring data for 2021 confirms scientific evaluations (e.g., Wilton, 2018) that improvements in PM_{10} in Richmond are insufficient to achieve the NES and that additional management measures are likely required.

The area for assessing the impact of management options was the revised (2019) emission inventory area which includes additional areas and around 5% more dwellings than the 2010 inventory area. Previous inventory data were adjusted for differences in dwelling numbers.

Management options evaluated in this report target domestic home heating as the main source of particulate concentrations in Richmond. They include phase out of more polluting burners, variations to emissions standards (including testing protocols) for new burner installations and behaviour change programmes. Some measures also include an evaluation with and without existing regulations which prohibit the installation of burners into new dwellings and existing dwellings not using solid fuel for heating methods.

The introduction of a new emission standard can result in a relatively low impact method of reducing emissions provided the cost of the new burner is not excessive relative to the status quo. Ultra-low emission burners (ULEB) have reduced in price and are now available for a range of different heat outputs and burner types. Options including a new standard for burners assume that all new burner installations (occurring as a result of natural attrition or regulatory measures) meet the new emission standard.

Burner phase outs refer to a regulatory approach of not allowing the use of wood burners that do not meet specific emission criteria. In the first instance the phase-out will typically apply to burners not compliant with the NES design criteria for wood burners. As all burners installed on properties less than two hectare were required to comply with the NES criteria from September 2005 burners not complying with that standard are now typically at least 16 years old. Thus, phase out timeframes could be shorter than if NES burners were being phased out. The latter would likely require a staged approach with a minimum useful burner life being available to households before it is phased out.

Behaviour change programmes are another method considered for reducing emissions from solid fuel burning for domestic heating. These programmes aimed at reducing the prevalence of high emitters by assisting households with high emissions to burn better. They require significant and ongoing resourcing to be effective but can be implemented relatively quickly.

3.1 Baseline PM_{10} evaluation

Figure 3.1 shows an updated assessment of the effectiveness of existing management measures for daily PM_{10} in Richmond. The assessment includes updates such as integration of the 2019 air emission inventory, natural source contributions and industry. The contribution of outdoor burning located outside of the airshed was unable to be quantified and is likely to contribute to PM_{10} in Richmond on a variable basis. Management of the latter requires separate consideration.

The reduction in PM_{10} concentrations required for Richmond was assessed for 2006 based on worst case concentrations measured. These suggested a reduction in daily PM_{10} of around 55% (of 2006 levels) was required to meet the NES for PM_{10}. Whilst a specific evaluation of the prevalence of worst-case meteorological conditions has not been carried out for Richmond, a comparison of PM_{10} concentrations to the projections line in Figure 3.1 supports the position of the 2006 NES target line as worst-case meteorological conditions for the period 2006 to 2021[2].

[2] The 2009 PM_{10} concentration of 76 µg/m^3 (second highest PM_{10}) for example, indicates a 34% reduction required. At this point PM_{10} is estimated to be reduced to 83% of 2006 values. The 34% reduction in 2009 values equates to a 2006 reduction of 45% suggesting that the original 2006 value represents worst case meteorological conditions.

The primary mechanisms for improvements in PM_{10} concentrations under the status quo are the natural attrition replacement of wood burners with lower emission NES compliant burners at the end of their useful life and the point of sale rule which requires burner replacement with NES compliant burner at the time a house is sold. The latter was estimated to have a diminishing impact over time as a result of the length of time between sales for a reasonable proportion of dwellings. Moreover, it is uncertain whether the small number of households that would now transition under this rule do so in reality owing to limited enforcement.

The baseline scenario might also be influenced by any measures adopted as National Environmental Standards relating to solid fuel burner emissions performance. The Ministry for the Environment (2020) has included a revised design standard for wood burners in 2020 consultation on proposed NES. The proposed standard is a lowering of the emission criteria for wood burners from 1.5 g/kg to 1.0 g/kg. In our view this is unlikely to result in improved real-life emissions from wood burners and as such we have not included any benefits from this proposal in the baseline scenario or management options evaluations[3].

Thus, the baseline scenario (TRMP projections) includes the following measures:

- New burner installations meet the emission criteria specified in the NES design criteira for wood burners.
- Non complying burners, open fires and multi fuel burners are replaced at the time a house is sold.
- New dwellings and existing dwellings using other heating methods can not install solid fuel burners (excluding pellet fires).

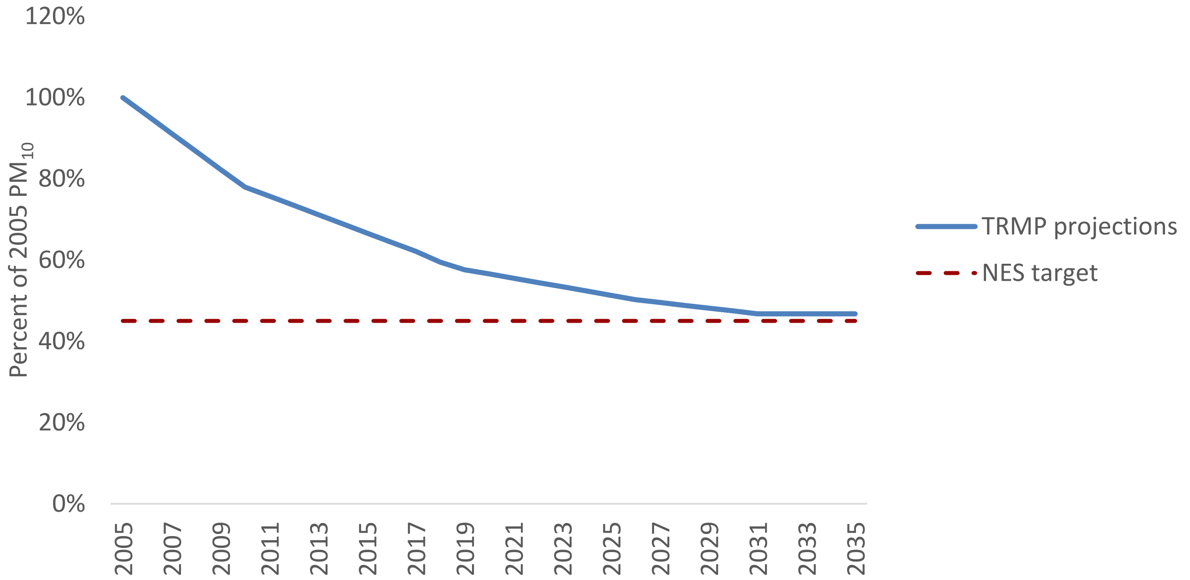

Figure 3-1: Baseline projections for PM_{10}

3.2 New installs are NES compliant burners with phase outs and behaviour change

The existing wood burner installation requirements are as specified in the NES design criteria for wood burners as burners meeting an emission limit of 1.5 g/kg and 65% efficiency when tested to NZS 4013. Figure 3.2 shows the estimated impact of retaining this standard for new installations of burners (only allowed in household replacing

[3] We note the absence of justification in Ministry documents and the only material we have found in support of this having a benefit has not technical peer review and substantive methodological issues including derivation of a statistical relationship (between NZS 4013 results and real-life emissions) based on a limited data set and including adjusting data for the impact of wood moisture. The latter approach is methodologically inaccurate as wood moisture is a behavioural/ operational variable that impacts real life emissions.

existing burners) and phasing out open fires and older burners not meeting the standard with and without a behaviour change programme. This suggests the combination of options may be sufficient to achieve compliance with the NES (assuming phase outs are completed by 2030). However, existing rules prohibiting wood burner installations in new dwellings and existing dwellings using other heating methods would be required to continue.

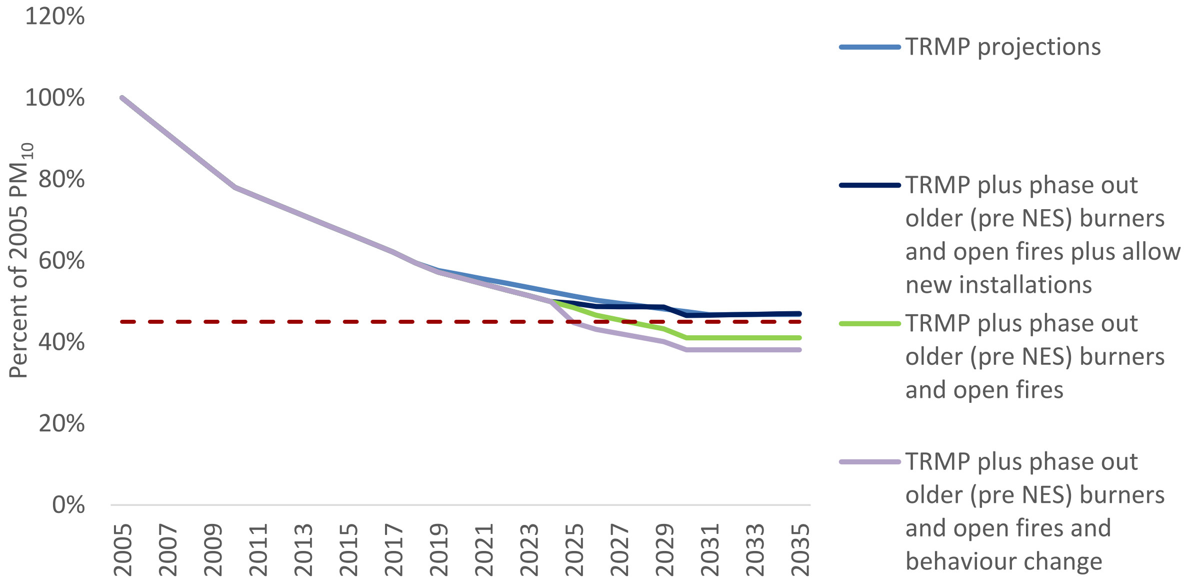

Figure 3-2: Phase out open fires and older burners not meeting the NES design standard for wood burners, with and without behaviour change to improve burner operation

3.3 Scenario evaluations for ULEB installations

A range of management measures were evaluated including more lenient and more stringent measures and combinations of measures.

Figure 3.3 compares the impact of allowing new dwellings and existing dwellings not using solid fuel burners to install ultra-low emission burners (ULEB) whilst allowing households replacing existing burners to continue to install NES compliant burners. This less stringent measure has been assessed based on the base assumptions detailed in section 3.4 as well as the assumption that 20% of the increase in dwelling numbers from 2008 to 2022 (existing dwellings that were unable to install a wood burner) subsequently install a ULEB (split evenly over a 5-year period from 2023) as well as 20% of new dwellings from 2023. This indicates a slight increase in PM_{10} as a result of the additional load from these households. The evaluation could include allowing the Oekotube as a secondary measure as this has been deemed equivalent to ULEB in terms of emissions.

Other measures evaluated in Figure 3.3 include the requirement that all new wood burner installations (including replacement burners) from 2023 are ULEB, with and without the ability to install in existing and new dwellings. For these scenarios burners that did not comply with the ULEB criteria would not be able to be installed.

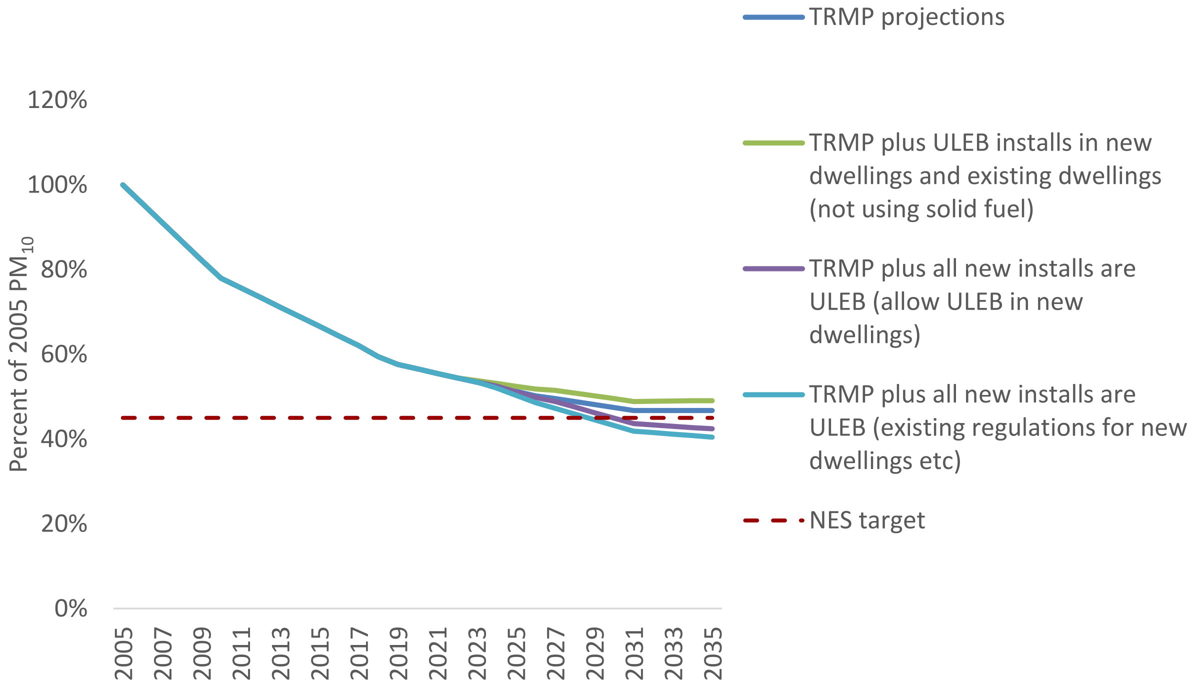

Figure 3-3: Ultra low emission burner evaluations – with and without installations into new and existing dwellings not using solid fuel

3.4 Scenario evaluations for ULEB installations with phase outs

Figure 3.4 shows the likely impacts of phasing out wood burners that do not meet the NES design criteria (pre 2006 burners) and open fires in conjunction with the requirement that all new burner installation are ULEB. Under these scenarios all replacement and new burners are ULEB (from 2023) and older burners and open fires are phased out by 2030 and 2026 respectively.

If the regulation were to allow the Oekotube to be installed on a NES compliant burner the burner in reality would remain in the dwelling (rather than be phased out) but would then be considered a ULEB from an emission perspective.

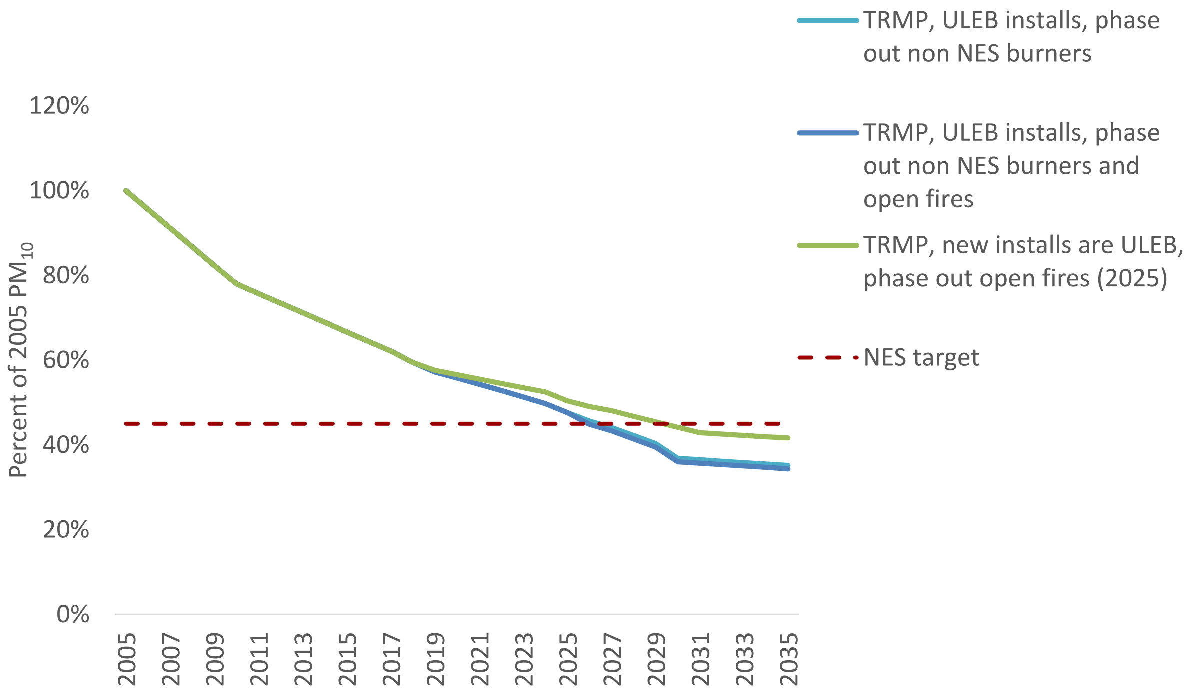

Figure 3-4: Ultra low emission burner evaluations with phase out of burners not meeting the NES design criteria for wood burners and phase out of open fires

3.5 Scenario evaluations for ULEB installations with behaviour change and phase outs

An appropriately designed and implemented behaviour change programme to improve the operation of NES compliant wood burners is likely to result in improvements in average burner emissions. Figure 3.5 shows the estimated impact if a behaviour change programme was effective in reducing average burner emissions by 10% in conjunction with other options evaluated above.

A programme like that operated by the Nelson City Council and based on the behaviour change work developed by Environment Canterbury may give rise to the estimated improvements. These programmes differ to historical education regimes such as the distribution of pamphlets and information and require additional resourcing.

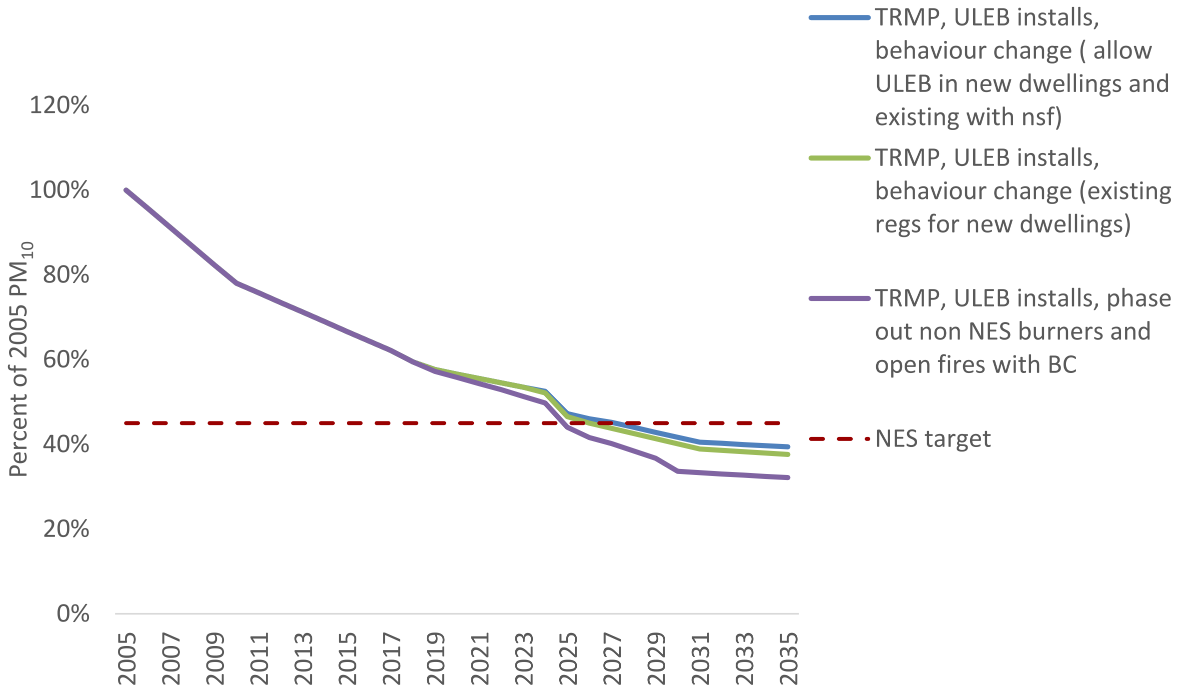

Figure 3-5: Ultra low emission burner evaluations with behaviour change programmes with and without phase outs and allowing new and existing dwellings to install burners.

3.6 Method, assumptions and limitations

The method for assessing the projected PM_{10} is as detailed in Wilton (1998). The base assumptions underpinning the projections analysis are:

- A reduction in PM_{10} concentrations based on the second highest PM_{10} concentrations for the worst-case year (in this case 2006).
- Households using heating methods and fuel quantities and other source emissions based on 2005, 2010 and 2019 air emission inventories.
- Emission factors for burners as per the 2019 air emission inventory.
- Natural source contributions based on 8% of winter PM_{10} for 2005 (Ancelet & Davy, 2016)
- Emission factors for ULEB of 2.0 g/kg. This is higher than the value of 1.0 g/kg used previously and supported by the real-life testing of ULEB. The reason for the higher emission factor is the more recent technology authorised under the programme which has not been tested for real life emissions. These include burners with technologies similar to NES compliant burners and our view is that it is unlikely that the real life emissions assessed previously would be replicable to all these models.
- Nelson Pine Industries contribution based on 0.5% of worst case daily PM_{10} concentrations in Richmond (Gimson, 2015).
- Outdoor burning emissions quantified as part of the inventory are included as a source in the analysis but any contribution from the wider area is not included in the assessment. This is a limitation of the study as the contribution from fires on the Waimea plains is likely to contribute to NES breaches. This can be addressed through management of this source or by implementing additional buffers in the selection of management options and reviewing the impact on PM_{10} concentrations.

Introduction of a ULEB criteria requires reliance on the existing testing regime for ULEB being implemented by Environment Canterbury. A limitation to the application of this is limited ongoing investment in post implementation validation including the real-life testing of authorised burners to ensure anticipated outcomes are realised. Early models of burners authorised under this approach were found to have lower real-life emissions. These burners were all the same technology (down draught) whereas a range of technologies including burners that are not fundamentally different to NES compliant burners have now been authorised as ULEB. No real life testing of the alternative technologies has been carried out to confirm that they can perform at the level of the previous ULEBs tested.

4 MANAGING $PM_{2.5}$ CONCENTRATIONS IN RICHMOND

In 2020 the Ministry for the Environment proposed NES for $PM_{2.5}$ with an annual average of 10 µg/m^3 and a daily average of 25 µg/m^3 with three allowable exceedances per year (Ministry for the Environment, 2020). The standards were based on the 2006 WHO guidelines for $PM_{2.5}$ (World Health Organization, 2006). The 2006 WHO standards are under review, most notably with the $PM_{2.5}$ annual standard being high in light of increasing health evidence (WHO, 2013).

A further consideration with the standards is the relativity in the level of protection provided with the proposed daily standard being significantly more stringent than the annual standard in terms of relative risk. It would seem likely that a thorough review of the proposed $PM_{2.5}$ NES would result in revised recommendations including a lowering of the annual average and reconsideration of the proposed daily $PM_{2.5}$ standard to make any assumptions made by WHO (20060) in the derivation of the daily level appropriate for a New Zealand context.

4.1 Daily winter $PM_{2.5}$ concentrations

Monitoring data for $PM_{2.5}$ in Richmond suggests a worst case fourth highest daily $PM_{2.5}$ concentration of around 43 µg/m^3. A reduction in daily winter $PM_{2.5}$ of around 42% is therefore required to meet the proposed NES of 25 µg/m^3.

Figure 4.1 shows the estimated impact of a range of management options evaluated for PM_{10} to meet the NES on daily winter $PM_{2.5}$ relative to the proposed NES of 25 µg/m^3 (three allowable exceedances). This suggests that a combination of requiring new installations meet the ULEB criteria, the phase out of open fires and older burners not complying with the NES for PM_{10} and a behaviour change programme targeting the operation of wood burners effective in improving overall emissions by 10% may not be sufficient to meet the proposed NES for $PM_{2.5}$. Additional options that could be considered to provide additional benefits which would likely result in the proposed NES being met include increased effectiveness of the behaviour change programme (high degree of uncertainty) and phasing out a portion of older burners that meet the NES design criteria for wood burners. For example, burners installed prior to 2010 could be phased out in 2030 with replacement burners being ULEB. As noted in the previous section the behaviour change programme requires appropriate design and sufficient resourcing.

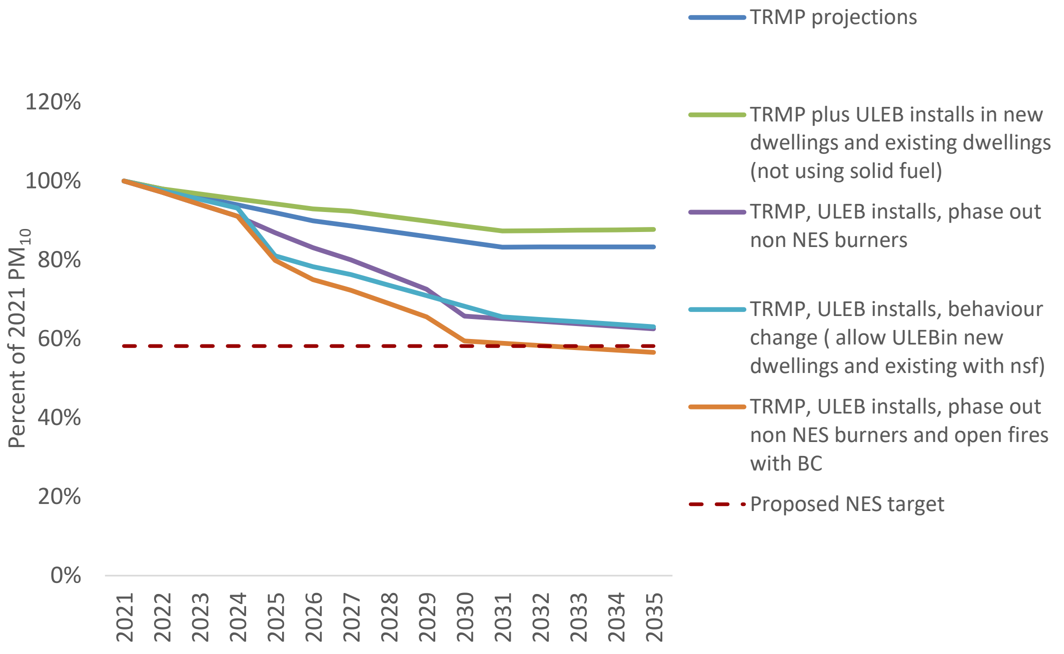

Figure 4-1: Projected daily winter $PM_{2.5}$ for the current TRMP and a range of management measures targeting domestic home heating.

Assumptions underpinning the evaluation are as detailed for PM_{10} with the exception of the use of $PM_{2.5}$ (as opposed to PM_{10}) emission estimates for all sources.

4.2 Annual average $PM_{2.5}$ concentrations

A previous evaluation of annual average $PM_{2.5}$ concentrations in Richmond (Wilton, 2017) estimated that 2012 was likely to have the likely worst case annual average $PM_{2.5}$ concentration for the years 2011 to 2016. This was estimated at 12.6 µg/m^3 based on PM_{10} data. Monitoring of $PM_{2.5}$ since has indicated a maximum annual average $PM_{2.5}$ of 11.3 µg/m^3 since monitoring commenced in 2016. Based on the latter, a reduction in annual average $PM_{2.5}$ of 12% would be required to meet an annual average concentration of 10 µg/m^3 and a reduction of 29% would be required to meet an annual average $PM_{2.5}$ standard of 8 µg/m^3.

An assessment of the impact of management options for reducing daily winter PM_{10} on annual average $PM_{2.5}$ was carried out using the methodology detailed in Wilton (2017). Additional sources outside of the airshed were factored into the evaluation as per the daily winter PM_{10}. These included outdoor burning on the Waimea Plains and other outlying areas and Nelson Pine industries.

Figure 4.2 shows the estimated annual average $PM_{2.5}$ concentrations associated with the status quo air plan projections and a range of management options evaluated previously. A reduction in annual average $PM_{2.5}$ is estimated to occur as a result of the natural attrition phase out of pre-NES compliant burners, the existing point of sale rule and other measures included in the current plan. Additional management measures are likely required for compliance with an annual NES for $PM_{2.5}$.

The analysis suggests that measures that include the requirement that new burner installations meet the ULEB emission criteria could result in annual average $PM_{2.5}$ concentrations less than 8 µg/m^3.

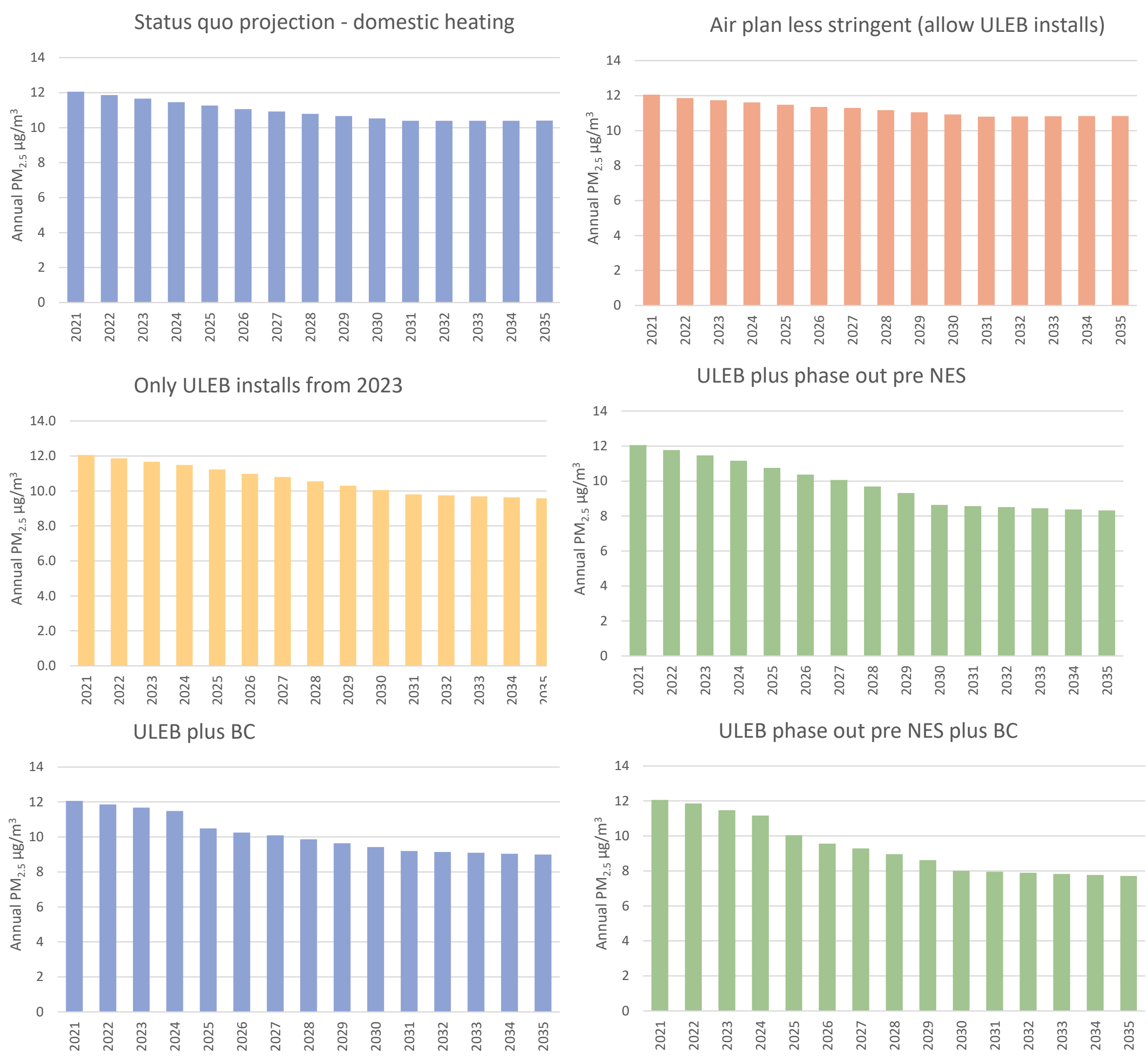

Figure 4-2: Projected annual average $PM_{2.5}$ for a range of management options

5 CONCLUSIONS

The analysis shows that the main determinant of the degree of stringency required for air quality management in Richmond is the daily $PM_{2.5}$ concentration if the 25 µg/m^3 (three allowable exceedances) proposed by MfE is adopted (Ministry for the Environment, 2020). The measures required to achieve this standard would likely be:

- Limit all new installations of solid fuel burners in Richmond to those meeting the ULEB criteria
- Phase out open fires and older burners not meeting the NES design criteria for wood burners
- Behaviour change programme targeting operation of wood burners that can improve overall domestic heating emissions by 10%.

However, uncertainties exist around the derivation of the proposed standard for daily $PM_{2.5}$. The analysis indicates that any measures that are implemented to achieve the reductions required in daily PM_{10} to meet the existing NES should result in annual average $PM_{2.5}$ concentrations less than 8 µg/m^3 by around 2030. It is therefore recommended that management measures be adopted based on the current NES for PM_{10} in the first instance.

There are a range of management options combinations that could be considered to achieve compliance with the NES for PM_{10}. These predominantly include:

- Phase out open fires and older burners not meeting the NES design criteria for wood burners and implement a behaviour change programme that achieves a 10% reduction in domestic heating emissions.
- Limit burner installations to ULEB and implement a behaviour change programme.
- Limit burner installations to ULEB and phase out open fires and pre-NES compliant burners.

Selection of measures requires consideration of other variables including costs, equity and other factors as well as the buffer required to compensate for potential uncertainties in the analysis.

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