MARLBOROUGH DISTRICT COUNCIL

Annual Air Quality Monitoring Report Blenheim 2021

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Executive Summary

The main air pollutant of concern in urban areas of New Zealand is particulate. The main measures of particulate are PM_{10} (particles less than 10 microns in diameter) and $PM_{2.5}$ (particles less than 2.5 microns in diameter). Both size fractions were measured at the Redwoodtown monitoring site during 2021. Historically monitoring for PM_{10} had also been carried out at Middle Renwick Road (MRR). This monitoring ceased in 2019. The main source of particulate in Blenheim during the winter is solid fuel burning for domestic home heating.

Monitoring data for PM_{10} were compared to the National Environmental Standard for Air Quality (NES) of 50 µg m^{-3} (24-hour average), the proposed NES for $PM_{2.5}$ (annual and 24-hour averages) and to the Ministry for the Environment's air quality guidelines and indicator categories. Comparisons are made with historical data to determine the likelihood of trends in concentrations.

Concentrations of PM_{10} exceeded 50 µg/m^3 in Blenheim on 16 occasions during 2021 resulting in 15 breaches of the NES for PM_{10} (the NES allows for one exceedance per year). This is the greatest number of exceedances since continuous monitoring for PM_{10} commenced in 2006. The maximum measured concentration during 2021 was 78 µg/m^3 and compares with a 2020 maximum concentration of 66 µg m^{-3} and is similar to maximum concentrations measured during 2017 (74 µg/m^3) and 2015 (79 µg/m^3). The annual average PM_{10} concentrations for 2022 was 19 µg/m^3 and compares with a guideline value of 20 µg/m^3.

An evaluation of the data indicates irregularities in the 2021 exceedances with a greater contribution of coarse mode (PM_{10}-$PM_{2.5}$) particulate than is typical at this site. Analysis concludes that an additional source contributing to the exceedances and that in the absence of this source the number of exceedances of 50 µg/m^3 would likely have been only one. A potential source could relate to earthworks associated with the development of land approximately one kilometre from the monitoring site.

Concentrations of $PM_{2.5}$ exceeded 25 µg/m^3 (24-hour average proposed NES) on 38 occasions. In 2020 the number of exceedances of this value was 45. The maximum measured $PM_{2.5}$ concentration was 43 µg/m^3 and is lower than the 2020 maximum of 54 µg/m^3. The annual average $PM_{2.5}$ concentration was 10.8 µg/m^3 and is slightly lower than the 2020 average of 11.8 µg/m^3.

Management measures to reduce PM_{10} concentrations to meet the NES have been included in the Proposed Marlborough Environment Plan (notified June 2016). Measures are based on a 2012 assessment which predicted concentrations would reduce from 2012–2018 in the absence of regulation. Potential reasons for the reductions not occurring include higher than anticipated emissions from newer burners and underestimated population increase in the airshed area from 2006-2013. Further evaluation of the effectiveness of the management options given the downward trend did not occur suggests that additional measures, for example targeting the operation of burners, would likely be required to achieve the NES for PM_{10}. If the 24-hour average proposed NES for $PM_{2.5}$ were introduced, significant reductions in daily winter $PM_{2.5}$ concentrations would be required to be compliant and consequent air quality management required to meet this target would be likely be significant. If the NES for $PM_{2.5}$ were reduced further in line with the 2021 WHO guideline revisions significant additional air quality management would likely be required.

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1. Introduction

The main air contaminant of concern in Blenheim and other urban areas of New Zealand is particulate or particles in the air. The main indicator of particulate used historically has been PM_{10}, particles in the air less than 10 microns in diameter and this size fraction forms the basis of the National Environmental Standard (NES). For the past decade, however, the scientific community has been of the view that the smaller of these particles, those less than 2.5 microns in diameter are a stronger indicator of health impacts and with the proposed introduction of NES for $PM_{2.5}$ monitoring of this contaminant is now common.

Table 1.1 shows the contaminant, the concentration, averaging period and allowable exceedances as required by the NES (Ministry for Environment, 2004). The NES for PM_{10} is set at 50 µg m^{-3} with one allowable exceedance per 12-month period. Compliance with this target was required by September 2016 in Blenheim. This has not been achieved. All other areas in Marlborough must remain compliant with the NES.

In 2020 the Ministry for the Environment proposed revisions to the NES for particulate, with the addition of an annual average $PM_{2.5}$ of 10 µg/m^3 and a daily average $PM_{2.5}$ NES of 25 µg/m^3. The existing NES for PM_{10} (24-hour) was proposed to be retained. This signals the need for $PM_{2.5}$ monitoring in addition to PM_{10} monitoring. Monitoring of $PM_{2.5}$ has been carried out in Blenheim since 2017.

In 2021 the World Health Organisation (WHO) released revised guidelines for PM_{10} and $PM_{2.5}$ including annual and daily guidelines for the latter. The revised WHO annual $PM_{2.5}$ guideline value of 5 µg/m^3 and daily guideline of 15 µg/m^3 are significantly lower than the 2020 proposed NES values. The WHO also includes revised PM_{10} guidelines of 15 µg/m^3 (annual average) and 45 µg/m^3 (daily average). As it is unclear which if any of the WHO guidelines the Ministry for the Environment will adopt for the NES review, the 2020 proposed NES values for $PM_{2.5}$ are used for the reporting values for $PM_{2.5}$ concentrations in this report.

This report summarises concentrations of PM_{10} and $PM_{2.5}$ that were measured in Blenheim during 2021.

Air quality monitoring in the Marlborough Region includes monitoring of PM_{10} at the MRR monitoring site from 2000 to 2019, intermittent monitoring of PM_{10} at the Redwoodtown Bowling Club site, survey PM_{10} monitoring in Renwick during 2000 and 2002, monitoring for PM_{10} in Picton during 2008 and 2009, visibility surveys and passive sampling for nitrogen oxides and sulphur oxides. From 2007 to early 2008, PM_{10} concentrations were measured at the Croquet Club in Redwoodtown in addition to the main monitoring site at the Bowling Club. A site on Brooklyn Street in Redwoodtown was temporarily used to measure PM_{10} concentrations during 2004.

Air quality monitoring data in other urban areas of New Zealand indicates that it would seem unlikely that concentrations of NES contaminants other than particulate would be in breach in Blenheim. Concentrations of other contaminants even in large urban areas are typically within the NES and guideline concentrations. Because emissions of other contaminants in Blenheim are far lower than large urban areas such as Christchurch, it would seem unlikely that concentrations of other key urban air pollutants would be in breach of the NES or air quality guidelines. The exception to this may be benzo(a)pyrene concentrations, which appear to occur well in excess of guideline concentrations in Christchurch.

The Ministry for the Environment also provides guidelines for ambient air quality (Ministry for Environment, 2002). Table 1.2 shows the ambient air quality guidelines and Table 1.3 details the air quality indicator categories to assist in the presentation and management of air quality in New Zealand. Air quality monitoring data in this report are presented relative to air quality guidelines and these indicator categories. These categories provide a useful perspective on the overall air quality and provide a valuable tool for evaluating trends in concentrations over time.

Table 1.1: National Environmental Standards for Ambient Air Quality (MfE, 2004)

Contaminant	NES values		
	Concentration	Averaging Period	Allowable exceedances / year
Particles (PM_{10})	50 µg m-3	24-hour	1
Nitrogen dioxide	200 µg m-3	1-hour	9
Sulphur dioxide	350 µg m-3	1-hour	9
Sulphur dioxide	570 µg m-3	1-hour	0
Ozone	150 µg m-3	1-hour	0

Table 1.2: Ambient air quality guidelines for New Zealand (MfE, 2002)

Contaminant	2002 guideline values	
	Concentration	Averaging Period
Carbon monoxide	30 mg m-3 10 mg m-3	1-hour 8-hour
Particles (PM_{10})	50 µg m-3 20 µg m-3	24-hour Annual
Nitrogen dioxide	200 µg m-3 100 µg m-3	1-hour 24-hour
Sulphur dioxide [b]	350 µg m-3 120 µg m-3	1-hour 24-hour
Ozone	150 µg m-3 100 µg m-3	1-hour 8-hour
Hydrogen sulphide [c]	7 µg m-3	1-hour
Lead d	0.2 µg m-3 (lead content of PM10)	3-month moving, calculated monthly
Benzene (year 2002) Benzene (year 2010)	10 µg m-3 3.6 µg m-3	Annual Annual
1,3-Butadiene	2.4 µg m-3	Annual
Formaldehyde	100 µg m-3	30-minutes
Acetaldehyde	30 µg m-3	Annual
Benzo(a)pyrene	0.0003 µg m-3	Annual
Mercury (inorganic) [d] Mercury (organic)	0.33 µg m-3 0.13 µg m-3	Annual Annual
Chromium VI [d] Chromium metal and chromium III	0.0011 µg m-3 0.11 µg m-3	Annual Annual

Contaminant	2002 guideline values	
	Concentration	Averaging Period
Arsenic (inorganic) [d] Arsine	0.0055 µg m-3 0.055 µg m-3	Annual Annual

Notes for Table 1.2:

[a] All values apply to the gas measured at standard conditions of temperature (0° C) and pressure (1 atmosphere).

[b] The sulphur dioxide guideline values do not apply to sulphur acid mist.

[c] The hydrogen sulphide value is based on odour nuisance and may be unsuitable for use in geothermal areas.

[d] The guideline values for metals are for inhalation exposure only; they do not include exposure from other routes such as ingestion. These other routes should be considered in assessments where appropriate.

Table 1.3: Environmental Performance Indicator categories for air quality (MfE, 2002)

Category	Value relative to guideline	Comment
Excellent	Less than 10% of the guideline	Of little concern: if maximum values are less than a tenth of the guideline, average values are likely to be much less
Good	Between 10% and 33% of the guideline	Peak measurements in this range are unlikely to affect air quality
Acceptable	Between 33% and 66% of the guideline	A broad category, where maximum values might be of concern in some sensitive locations but generally they are at a level which does not warrant urgent action
Alert	Between 66% and 100% of the guideline	This is a warning level, which can lead to exceedances if trends are not curbed
Action	More than 100% of the guideline	Exceedances of the guideline are a cause for concern and warrant action, particularly if they occur on a regular basis

An emission inventory for Blenheim was updated in 2017 to provide a more recent estimate of the sources of PM_{10} and other contaminant emissions (Wilton, 2017). The results of the inventory indicated that domestic home heating was the main source of PM_{10} emissions, contributing to around 90% of the daily wintertime PM_{10}. Motor vehicles contributed to 1% of PM_{10} emissions, outdoor burning contributed to 8% and industry contributed to 1% of total wintertime emissions. The inventory is to be updated in 2022.

2. Methodology

Air quality monitoring of particulate in Blenheim during 2021 was carried out at the Redwoodtown Bowling Club site in Blenheim. Two 5014i beta attenuation monitors (BAM) were used to measure PM_{10} and $PM_{2.5}$.

Prior to 2016, meteorological data, including wind speed, wind direction were obtained from a NIWA site on the outskirts of Blenheim. Ambient temperature data was collected at the Bowling Club site in Redwoodtown. All meteorological data (wind speed, temperature and wind direction) are now monitored at the Redwoodtown monitoring site.

2.1. Air quality monitoring sites

Figure 2.1 shows the Redwoodtown Bowling Club site which has been operational since 2002, the NIWA metrological monitoring site, which was used for meteorological data prior to 2016 and the MRR site, which was discontinued in 2019 and provides a historical record of PM_{10} in Blenheim.

In 2007 a site at the Croquet Club was established for the purposes of evaluating the relationship between Brooklyn Street area PM_{10} and PM_{10} concentrations measured at the Bowling Club. This was considered important because PM_{10} concentrations of the magnitude measured during 2004 at Brooklyn Street had not been measured at the Bowling Club and because the reductions required in PM_{10} concentrations in Blenheim had been dependent on the Brooklyn Street results. The results from work undertaken in 2007 and reported in the '2007 Air Quality Monitoring Report' (Wilton, 2008) indicated that the Brooklyn Street site was likely to be affected by localised sources of PM_{10} and should not be used for air quality management purposes. Details of the Croquet Club site are outlined in '2008 Air Quality Monitoring Report' (Wilton & Baynes, 2009).

Figure 2.1: Location of air quality sites and NIWA metrological site in Blenheim

2.1.1. Redwoodtown monitoring site

In 2010 air quality monitoring took place at the main air quality monitoring site at the Blenheim Bowling Club on Weld Street in Redwoodtown. Figures 2.2 and 2.3 show the surrounding area and the location of the monitoring site within the Bowling Club grounds. Summary site details are given in Table 2.1.

Figure 2.2: Aerial photo of the Redwoodtown air quality monitoring site (note: blue arrow depicts monitoring site).

Figure 2.3: PM_{10} monitor at the Redwoodtown - Bowling Club air quality monitoring site.

Table 2.1: Site summary details for the Redwoodtown - Bowling Club air quality monitoring site.

Site name	Redwoodtown – Bowling Club
Site contact details	Marlborough District Council
Description of site	The site is located at the Blenheim Bowling Club, which is to the south-east of central Blenheim. The surrounding area includes a bowling green, gravel petanque area and paved areas.
Site category	Residential neighbourhood
Purpose of site and sources	To measure worst-case ambient air concentrations of PM_{10} in Blenheim. The main source during the winter months is solid fuel burning for domestic heating. The site is downwind of a large residential area for meteorological conditions conducive to poor air quality.
Proposed duration of monitoring	Ongoing
Contaminants monitored	PM_{10}
Site co-ordinates	E1679764 N5402328
Date of site installation	Monitoring from 2000-2003. Permanent site since 2005.
Meteorological characteristics of area	Low wind speeds occur regularly during the winter months. Temperature inversions are likely.
Sample frequency	Continuous
Inlet height	3.5 metres
Averaging period	24-hour and hourly

2.2. Quality assurance

Operation of the BAM is carried out by Marlborough District Council (MDC) staff. Ten minute data is recorded by the instrument and logged by an iQuest iRIS 350 datalogger. The BAM filter spot is moved on every eight hours. Results are telemetered hourly to MDC and stored in the hilltop database. Annual calibrations are carried out by Lear Siegler.

3. Air quality monitoring in Blenheim

3.1. PM_{10} concentrations

There were 16 exceedances of 50 µg/m³ at the Redwoodtown air quality monitoring site during 2021 (Figure 3.1). The NES allows one exceedance of 50 µg m⁻³ per year before a breach occurs. The NES was therefore breached on 15 occasions in Blenheim during 2021 and this is the greatest number of breaches of the NES since continuous monitoring commenced at Redwoodtown in 2006.

The maximum PM_{10} concentration for 2021 was 78 µg/m³ and was measured on 4 June. This is only slightly higher than other maximum concentrations recorded at the site over the past five years (range 57 µg/m³ to 74 µg/m³) and lower than the 2015 maximum of 79 µg/m³.

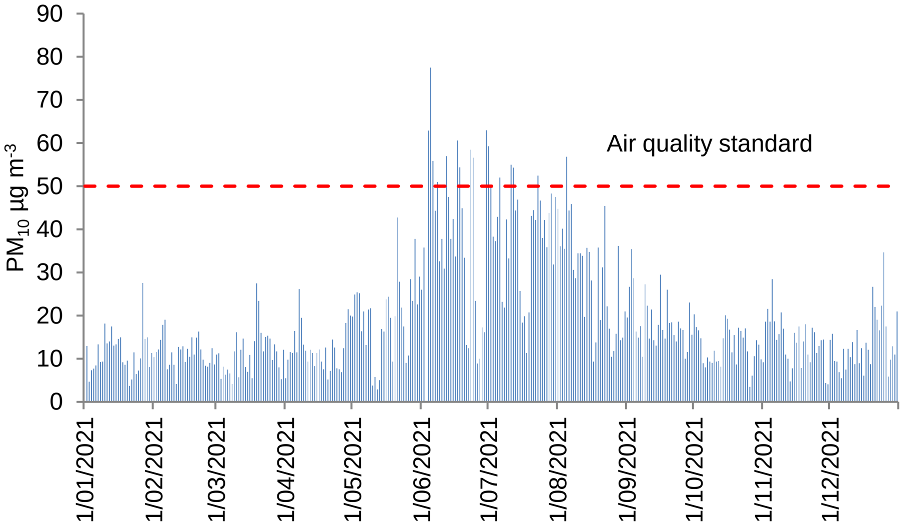


Figure 3.1: 24-hour average PM_{10} concentrations measured at the Redwoodtown - Bowling Club site during 2021.

Daily PM_{10} concentrations measured from 2006 to 2021 relative to the MfE air quality indicator categories (shown in Table 1.3) are illustrated in Figure 3.2. Similarly, monthly variations in the distribution of PM_{10} concentrations for 2021 are shown in Figure 3.3. The distribution of PM_{10} concentrations by season are similar to other years with the winter months showing the greatest proportion of days in the "acceptable", "alert" and "action" categories and fewer days in the "good" category.

Figure 3.4 compares the number of days when 50 µg/m³ was exceeded in 2021 to previous years along with the maximum concentration and the second highest concentration. It is important to note, that comparisons between years does not take into account year to year variations in the impact of meteorology. This issue is examined further in section 4 of this report.

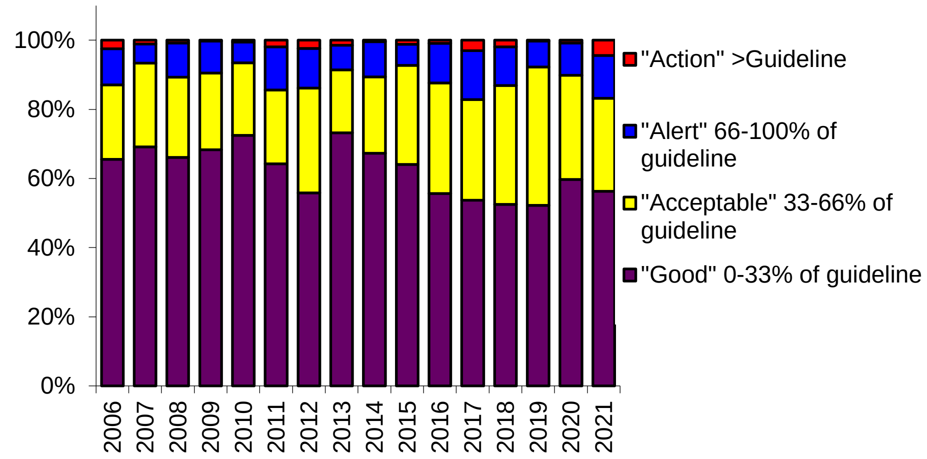


Figure 3.2: Comparison of PM_{10} concentrations measured at Redwoodtown from 2006 to 2021 to air quality indicator categories.

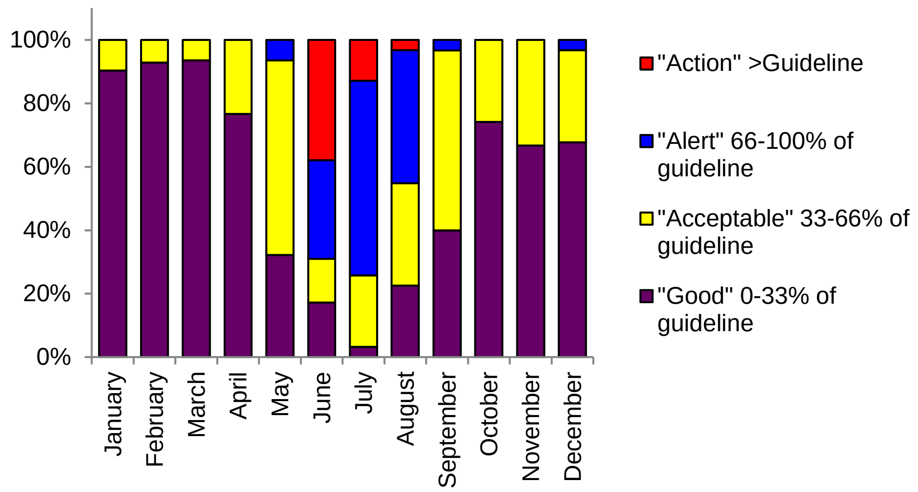


Figure 3.3: Comparison of daily PM_{10} concentrations each month during 2021 to air quality indicator categories.

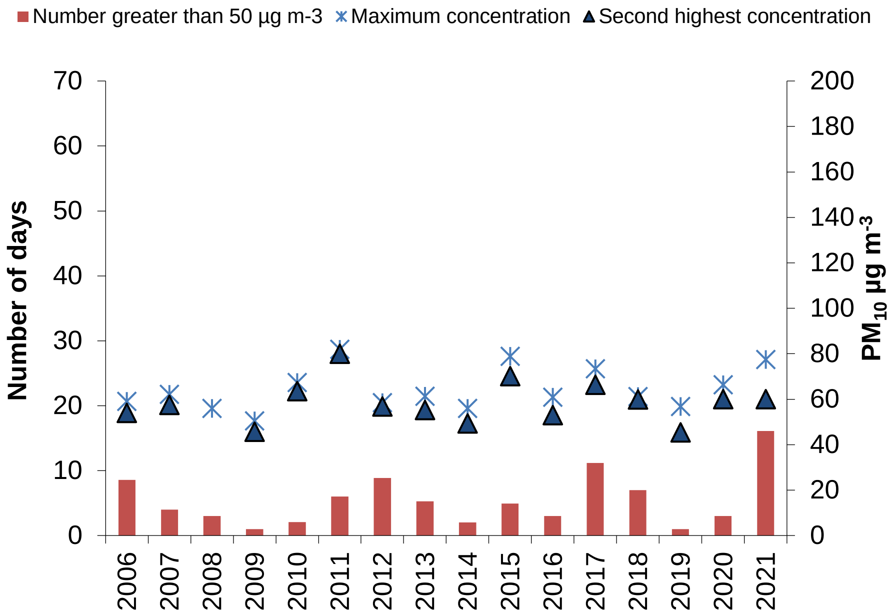


Figure 3.4: Number of days when 50 µg m^{-3} was exceeded, the maximum concentration and the second highest concentration from 2006 to 2021.

The annual average PM_{10} concentration for 2021 was 19 µg m^{-3}. This is the at the upper end of the normal range for this monitoring site (14-19 µg/m^3). The Ministry for the Environment specifies an annual average guideline for PM_{10} of 20 µg m^{-3}. The NES does not currently include an annual average concentration for PM_{10} although this currently being reviewed as part of the proposed revisions to the NES. The revised WHO guidelines specify an annual average for PM_{10} of 15 µg/m^3.

Summary statistics for PM_{10} monitoring results from the Redwoodtown Bowling Club site from 2002 to 2021 are provided in Table 3.1. Data from 2016 has been adjusted for gravimetric equivalency. From 2005 monitoring was conducted from January to December and in 2004 air quality monitoring took place at a site in Brooklyn Street.

Table 3.1: Summary of PM_{10} concentrations measured at Redwoodtown from 2002-2021

	2002	2003	2004	2005	2006*	2007*	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016	2017	2018	2019	2020	2021
Monitoring method	Hi-vol	Hi-vol	Hi-vol	Hi-vol	BAM	BAM	BAM	BAM	BAM	BAM	BAM/Hi-vol	BAM	BAM/Hi-vol	BAM/Hi-vol	BAM	BAM	BAM	BAM	BAM	BAM
"Good" 0-33% of guideline	18%	22%	46%	63%	66%	69%	66%	68%	72%	64%	56%	72%	67%	64%	56%	54%	53%	52%	60%	56%
"Acceptable" 33-66% of guideline	62%	30%	22%	17%	21%	24%	23%	22%	21%	21%	31%	18%	22%	29%	32%	29%	34%	40%	30%	27%
"Alert" 66-100% of guideline	10%	26%	20%	17%	10%	6%	10%	9%	6%	13%	11%	7%	10%	6%	12%	14%	11%	7%	9%	12%
"Action" >Guideline	10%	22%	12%	3%	3%	1%	1%	0%	1%	2%	2%	1%	0%	1%	1%	3%	2%	0%	1%	4%
Percentage of valid data	14%	7%	22%	32%	68%	99%	99%	98%	96%	87%	91%	98%	70%	91%	95%	99%	99%	99%	100%	100%
Annual average (µg m^{-3})	-	-	22	18	17	15	17	15	14	16	19	14	16	17	18	20	19	18	18	19
Measured PM_{10} concentrations above 50 µg m^{-3}	5	6	10	3	6	5	3	1	2	6	8	5	1	4	3	11	7	1	3	16
Extrapolated PM_{10} concentrations above 50 µg m^{-3}	16	34	31	9	10	4	3	1	2	6	9	5	2	5	3	11	7	1	3	16
Second highest PM_{10} concentration (µg m^{-3})					54	58	56	46	64	80	57	55	51	70	53	66	60	46	60	60
Annual maximum (µg m^{-3})	58	60	81	58	59	62	56	46	67	82	59	61	56	79	61	74	61	57	66	78
Number of records	50	27	82	115	247	360	363	357	352	319	331	351	254	331	346	361	360	362	364	364

*not adjusted for gravimetric equivalency

3.2. $PM_{2.5}$ concentrations

In 2020 the Ministry for the Environment proposed a daily NES for $PM_{2.5}$ of 25 µg/m^3 and an annual NES of 10 µg/m^3 (Ministry for the Environment, 2020). $PM_{2.5}$ is generally accepted as the main air quality indicator for particulate in terms of health impacts with the long-term exposure period being the most significant in terms of impact on health. In 2021 WHO released revised guidelines for $PM_{2.5}$ of 5 µg/m^3 (annual average). During 2021 an annual average $PM_{2.5}$ concentration of 10.8 µg/m^3 was measured at Redwoodtown.

During 2021 there were 38 exceedances of the 24-hour average reporting guideline for $PM_{2.5}$ of 25µg/m^3 at the Redwoodtown air quality monitoring site (Figure 3.5). This is lower than the 45 exceedances recorded in 2020 and the high of 72 exceedances measured in 2017. The maximum measured $PM_{2.5}$ concentration for 2021 was 43 µg/m^3 and was recorded on 4 June. The corresponding PM_{10} concentrations was 78 µg/m^3. Figure 3.6 shows the changes in the annual average, maximum and fourth highest daily $PM_{2.5}$ concentrations at Redwoodtown since monitoring commenced in 2017.

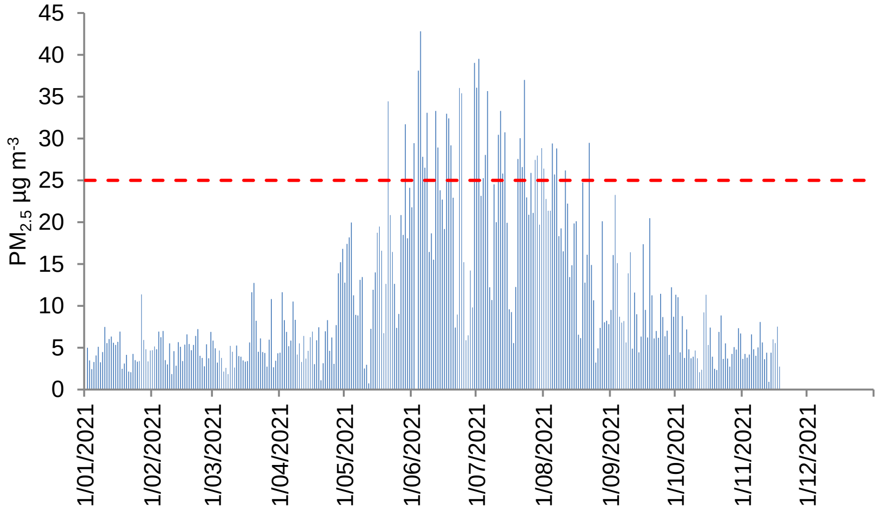


Figure 3.5: 24-hour average $PM_{2.5}$ concentrations measured at the Redwoodtown - Bowling Club site during 2021.

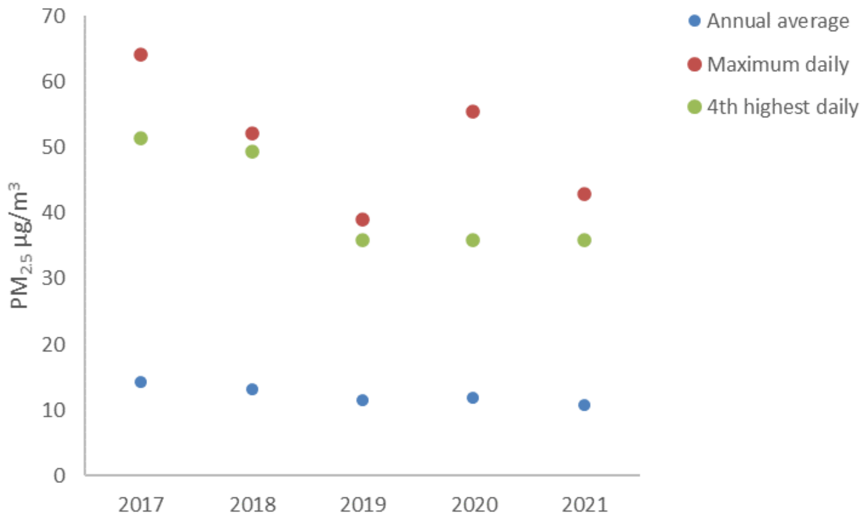
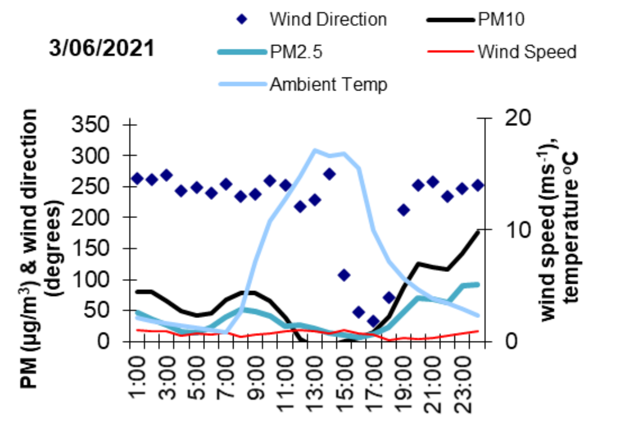
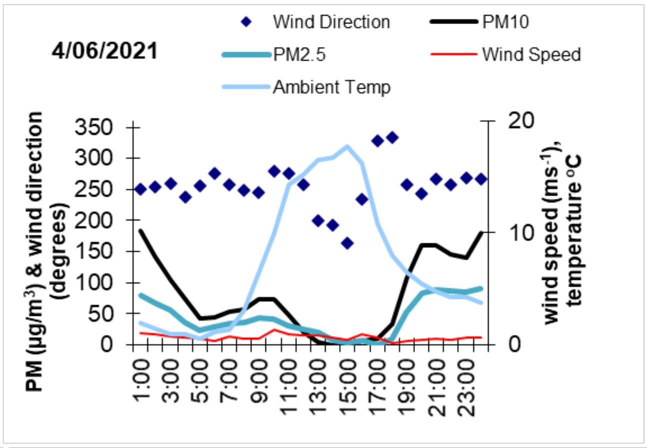


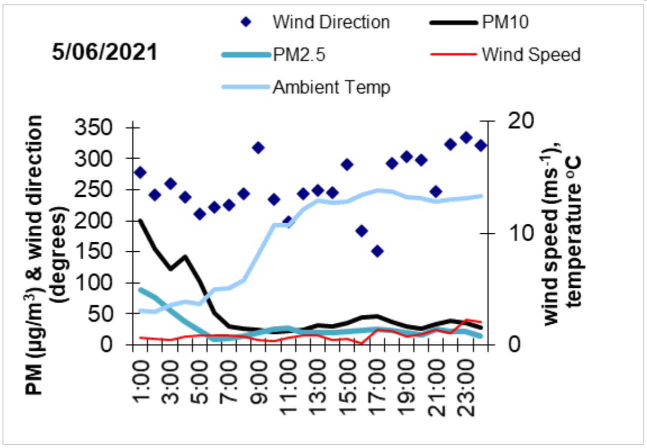
Figure 3.6: Summary $PM_{2.5}$ concentrations from 2017 to 2021.

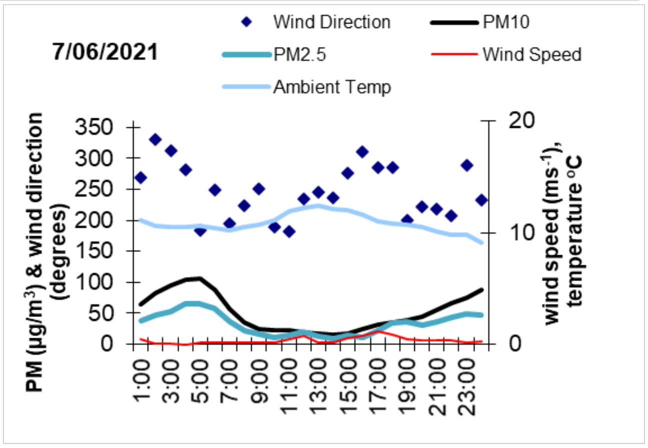
3.3. Particulate concentrations and meteorology in Blenheim

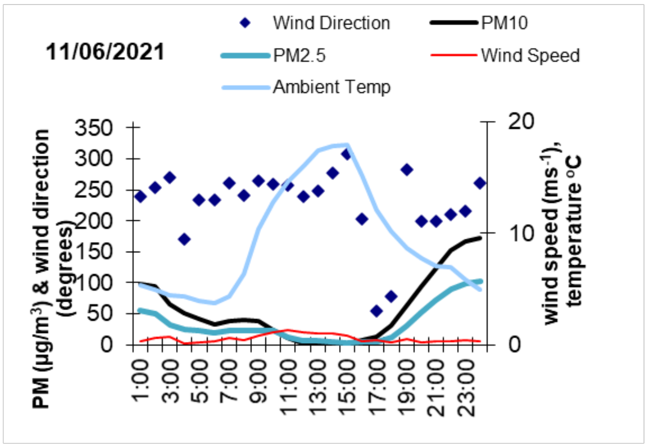
Daily variations in PM_{10} and $PM_{2.5}$ concentrations and meteorological conditions on days when PM_{10} concentrations exceeded 50 µg m^{-3} at the monitoring site are shown in Figure 3.7. Data are consistent with historical high pollution days with peak PM_{10} concentrations occurring during the evening and typically a smaller peak occurring mid-morning. A key difference to previous years is the extent to which elevated PM_{10} concentrations exceed the $PM_{2.5}$ concentrations. On a number of days the exceedance occurs because of elevated concentrations from the preceding evening. Examples of these days are 5 June, 7 June, 17 June and 5 July. The key meteorological conditions associated with the elevated concentrations on high pollution days are low wind speeds and south-westerly wind direction.

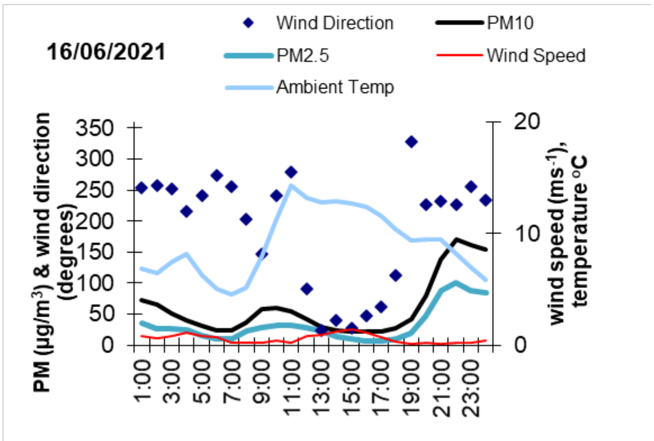

3/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C

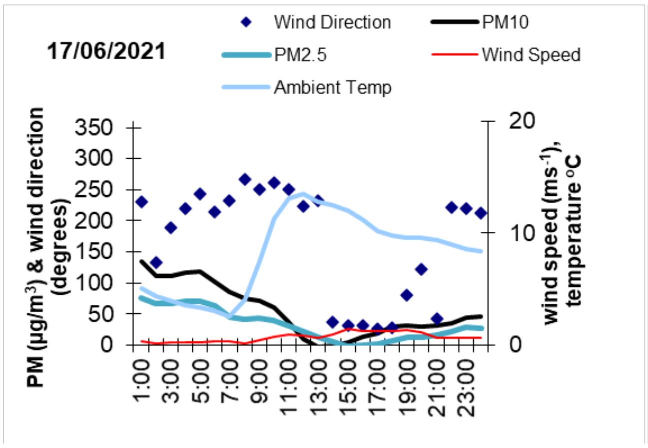

4/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C

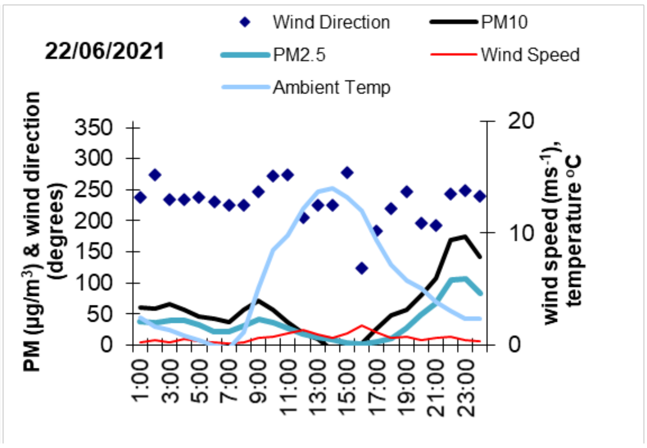

5/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C


7/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C


11/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C


16/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C


17/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C


22/06/2021
Wind Direction
PM10
PM2.5
Wind Speed
Ambient Temp
PM (µg/m3) & wind direction (degrees)
wind speed (ms-1), temperature °C

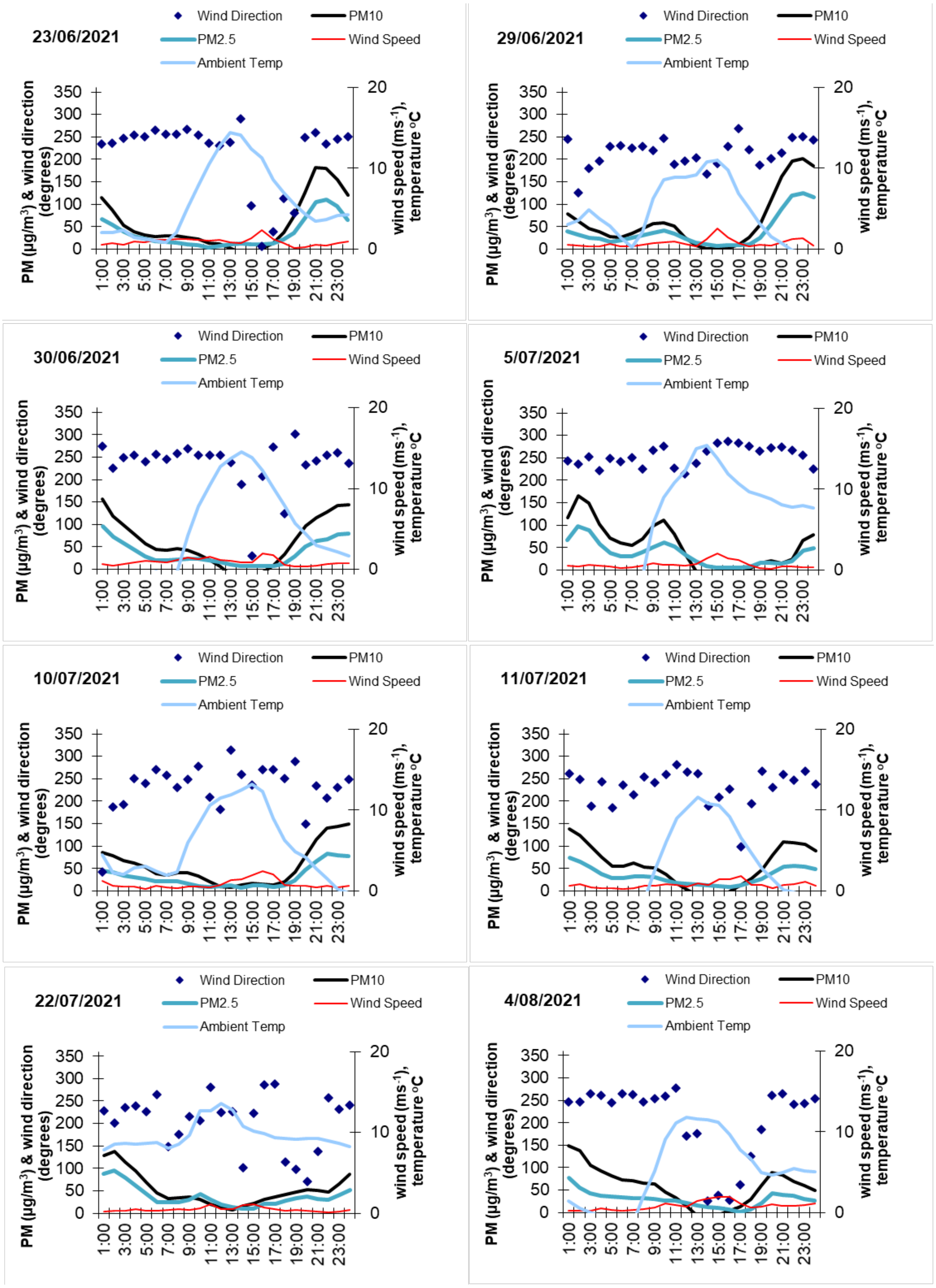


Figure 3.7: Hourly average PM_{10}, $PM_{2.5}$, wind speed, direction and temperature on days when PM_{10} concentrations exceeded 50 µg m^{-3} (24 hour average).

4. Trends in PM_{10} concentrations in Blenheim

To quantify the impact of meteorological conditions and therefore further assess the likelihood of changes in PM_{10} concentrations since 2005, a trends assessment was updated in 2012 (Wilton, 2012). The objective of that work was to identify meteorological conditions giving rise to concentrations of PM_{10} in excess of the NES and to provide a tool for comparing year to year PM_{10} concentrations whilst minimising the impact of variability in meteorological conditions. The trends assessment provided a tool for updating the trends analysis with time. Figure 4.1 shows trends in PM_{10} concentrations updated with the 2021 PM_{10} data adjusted for the impact of meteorological conditions.

Results for 2021 are slightly higher than the values of 2018 which were highest for average and 75th percentile values since 2006. Previous assessments had concluded that the data are not indicative of overall improvement or degradation in PM_{10} concentrations in Blenheim and that no trend is evident. The 2021 data are consistent with no improvement in PM_{10} concentrations in Blenheim.

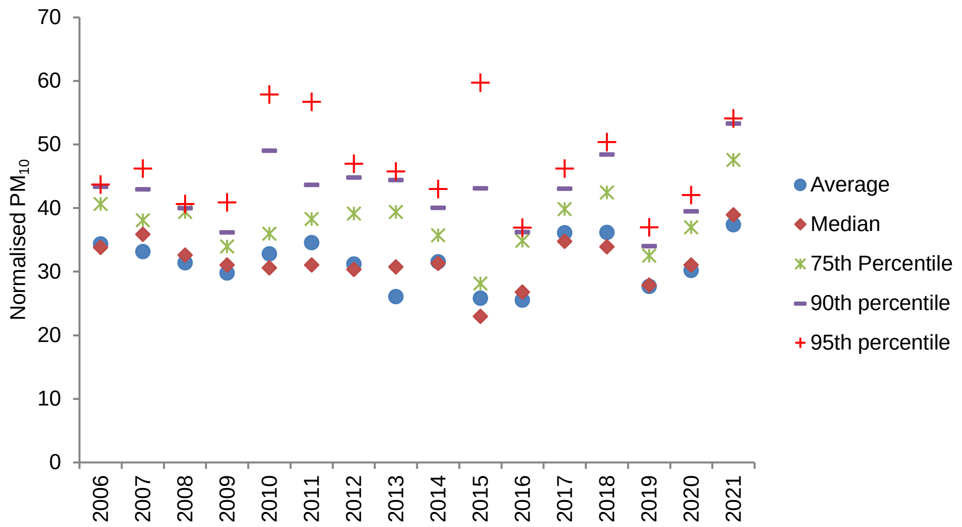


Figure 4.1: Trends in PM_{10} concentrations after adjusting for meteorological conditions

To examine the potential for trends further, an evaluation was done of the number of high pollution potential days during 2021 compared with previous years as well as the number of exceedances that occurred on those days (Figure 4.2). It was noted previously that for 2017 that eight exceedances occurred on days that did not qualify as high pollution potential because they did not meet the minimum hours of temperature less than five degrees. These days had very low wind speeds and otherwise would have been classed as high pollution potential days. A similar pattern occurred in 2021 whereby on seven occasions exceedances occurred where the minimum temperature threshold was not met.

Figure 4.2 shows that while 2021 had a similar number of high pollution potential days to the 2015-2020 period, the proportion of these that experienced PM_{10} concentrations in excess of 50 $\mu g/m^3$ was higher at 47%. If the high pollution criteria for 2021 were extended to include the seven days when the NES was exceeded the number of pollution potential days would have increased to 26 and the proportion that resulted in exceedances would have increased to 62%.

This evaluation suggests that the increase in high pollution potential days resulting in breaches of the NES is of concern as it may be indicative of an increase in particulate. A key parameter of note is the lack of increase in $PM_{2.5}$ concentrations from 2020 to 2021. This suggests the increase relates to a source other than domestic heating, which is predominantly in the $PM_{2.5}$ size fraction. Figure 4.3 compares 24-hour average $PM_{2.5}$ and PM_{10} concentrations for the period May to August 2021. This suggests significant variability in the coarse mode (PM_{10}-$PM_{2.5}$) size fraction particularly at higher PM_{10} concentrations. For example, for PM_{10} concentrations around 50 $\mu g/m^3$ the coarse mode contribution can vary by as much as 11 $\mu g/m^3$ (23%).

In contrast the relationship between the two variables in 2020 was much closer with minimal variability in the coarse mode size fraction at higher concentrations (Figure 4.4). The slope in the relationship in the preceding years is such that a $PM_{2.5}$ concentration needed to be higher than around 42 µg/m^3 for a PM_{10} exceedance of 50 µg/m^3 to occur, excluding anomalies. In 2021 there was only one occasion when $PM_{2.5}$ concentrations were higher than 42 µg/m^3.

An evaluation of the relationship between $PM_{2.5}$ and PM_{10} and exceedances of 50 µg/m^3 for the years 2017-2019 indicates the occasional presence of a coarse mode source resulting in a breach when otherwise it would be unlikely based on $PM_{2.5}$ concentrations. Both 2018 and 2019 include an exceedance day which occurs when there is a large coarse mode contribution.

Possible sources were discussed with Council staff who identified significant earthworks for land development commencing in February 20021 about one kilometre to the east of Redwoodtown. Given the location of the development site, the size fraction of particulate (coarse mode) and the timing of the increase in exceedances this is considered a potential source of the additional PM_{10}. An alternative explanation is an anomaly with the PM_{10} sampler.

Based on the relationships observed in Figures 4.3 and 4.4 it is likely that only one exceedance of 50 µg/m^3 for PM_{10} would have occurred in 2021 in the absence of the elevated coarse mode particulate.

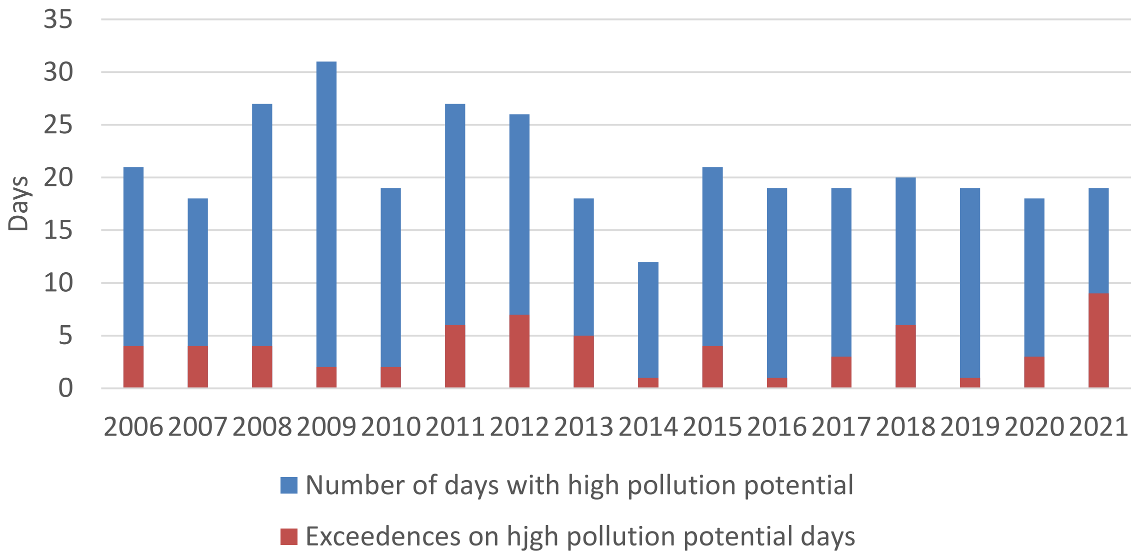


Figure 4.2: Prevalence of high pollution potential days and the number resulting in exceedances of 50 µg/m^3 (24-hour average) PM_{10}.

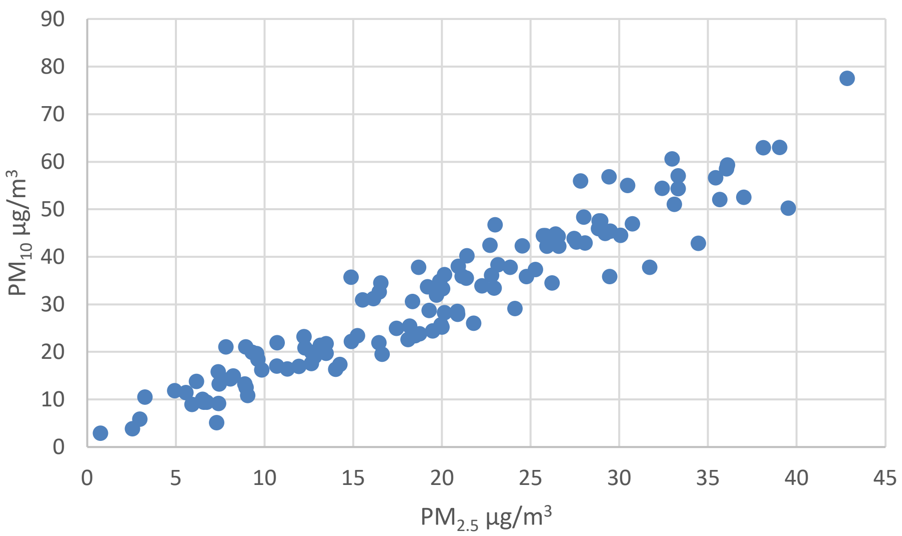


Figure 4.3: Relationship between PM_{10} and $PM_{2.5}$ concentrations at Redwoodtown[1] (24-hour average) PM_{10}.

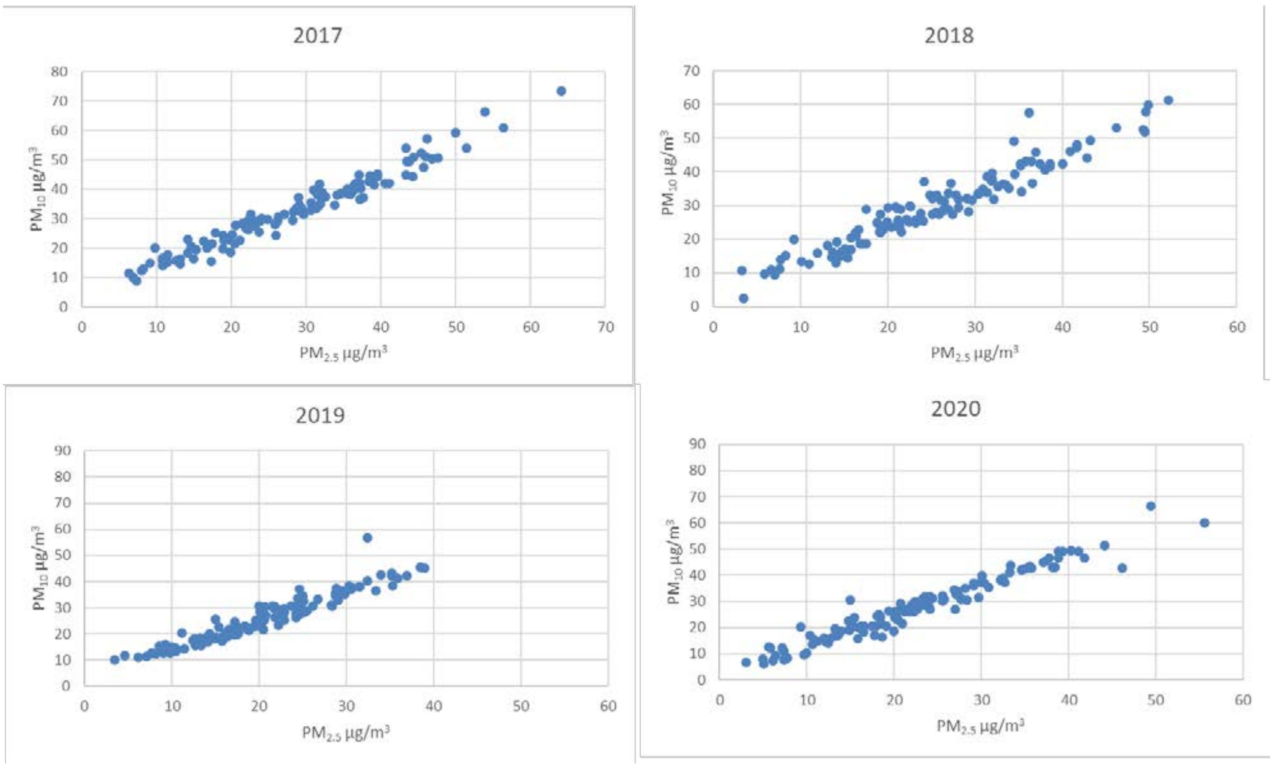


Figure 4.4: Relationship between PM_{10} and $PM_{2.5}$ concentrations at Redwoodtown[1] for 2019 and 2020 (24-hour average).

[1] Noting that the PM_{10} concentrations have been adjusted (increased) for gravimetric equivalency and the $PM_{2.5}$ data have not.

5. Summary

During 2021 there were 15 breaches of the NES for PM_{10} in Blenheim. This is the highest number since continuous monitoring commenced in 2006. The maximum PM_{10} concentration was 78 µg/m³ (24-hour average) and compares with a 2020 value of 66 µg/m³. The 2021 PM_{10} concentrations appear to differ from earlier years in that coarse mode particulate is contributing significantly to the exceedances. Earthworks associated with land development around one kilometre from the monitoring site was identified as a potential - cause of the additional PM_{10} although this remains uncertain. Monitoring of PM_{10} and $PM_{2.5}$ concentrations during 2022, when this source should have ceased, will assist understanding. If relationships between $PM_{2.5}$ and PM_{10} observed in earlier years were maintained, it is likely that Blenheim would have experienced only one exceedance of the NES in 2021. The annual average concentrations for 2021 was 19 µg/m³. No trend in the data is evident.

Monitoring of $PM_{2.5}$ in Blenheim suggests that both annual and 24-hour average concentrations exceed the proposed NES for $PM_{2.5}$. The maximum and fourth highest $PM_{2.5}$ concentrations were 43µg/m³ and 36 µg/m³ respectively and compare with a proposed NES of 25 µg/m³ and the WHO guideline of 15 µg/m³. Significant reductions would be required should a daily $PM_{2.5}$ NES be introduced as a standard. Data are indicative of a downward trend, but further monitoring is required to confirm this.

Management measures to reduce PM_{10} concentrations to meet the NES have been included in the in the Proposed Marlborough Environment Plan (notified June 2016). Measures are based on a 2012 assessment which predicted concentrations would reduce from 2012 – 2018 in the absence of regulation. Potential reasons for the reductions not occurring include higher than anticipated emissions from newer burners and underestimated population increase in the airshed area from 2006-2013. Further evaluation of the effectiveness of the management options given the downward trend did not occur suggests that additional measures would likely be required to achieve the NES for PM_{10}. These may include a behaviour change programme targeting household's operation of wood burners. It is unlikely that these measures will target all factors contributing to 2021 exceedances as data are indicative of a significant source with particles in the PM_{10}-$PM_{2.5}$ size fraction.

A key air quality management scenario would arise if the proposed short term (24-hour average) NES for $PM_{2.5}$ of 25 µg/m³ or lower (e.g., WHO guideline) were introduced. Data indicates both high $PM_{2.5}$ concentrations and a high frequency of exceedances. The reductions in particulate concentrations and consequent air quality management required to meet this target would be likely be significant.

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