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PREPARED FOR
West Coast Regional Council

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Air Quality - monitoring strategy for Westport

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1 INTRODUCTION

Air quality monitoring in Westport was carried out during winter 2022 for concentrations of $PM_{2.5}$ using SDS011 light scattering air quality monitoring instrument (Baynham, 2022). The monitoring was investigative to examine spatial variability and potential magnitude of concentrations.

Particles in the air are typically measured as either the $PM_{2.5}$ or the PM_{10} size fraction. The finer $PM_{2.5}$ size fraction comprises all particles less than 2.5 microns in diameter and is a component of the PM_{10} size fraction. The finer $PM_{2.5}$ size fraction is the most relevant in terms of health impacts as these particles penetrate deep into the lungs resulting in a range of adverse health impacts.

In 2021 the WHO released new air quality guidelines including an annual and daily guidelines for $PM_{2.5.}$ (World Health Organization, 2021) Both the annual guideline of 5 $\mu g/m^3$ and the daily guideline of 15 $\mu g/m^3$ are significantly lower than previous WHO guidelines for $PM_{2.5}$ (15 $\mu g/m^3$ and 25 $\mu g/m^3$ respectively (WHO, 2006)).

Monitoring data for Westport suggests $PM_{2.5}$ concentrations in excess of the proposed daily NES for $PM_{2.5}$ and the WHO (2021) $PM_{2.5}$ guideline. Although deriving meaningful compliance information from the data is limited, because of the non-standard method, the data does provide insight into spatial variability in $PM_{2.5}$ concentrations in Westport. An additional long term monitoring is required to assist with the effective management of air quality in Westport.

This report assesses emissions from key sources of particles in Westport and evaluates these spatially to identify hot spot areas where concentrations might be highest. These data are considered in conjunction with existing spatial monitoring data and meteorology to identify priority areas for the establishment of a long term monitoring site for $PM_{2.5}$ in Westport.

2 $PM_{2.5}$ MONITORING IN WESTPORT

2.1 Monitoring data summary

The Mote 2022 air quality monitoring investigation included a total of fifteen air quality samplers measuring concentrations of $PM_{2.5}$ using a light scattering approach. The objective of the study was to measure $PM_{2.5}$ concentrations and the spatial variability across Westport.

The monitoring period covers the majority of the 2022 winter commencing on 31 May and concluding on 8 September. The maximum $PM_{2.5}$ concentrations measured over the period was 55 µg/m^3 (24-hour average) and the majority of the samplers recorded breaches of the Ministry for the Environments 2020 proposed NES for $PM_{2.5}$ of 25 µg/m^3 (Ministry for the Environment, 2020). The report suggests that the proposed NES for $PM_{2.5}$ (daily average of 25 µg/m^3) was exceeded in Westport on three days during 2022. It is noted however that the 2021 WHO guidelines (World Health Organization, 2021) set a much lower daily $PM_{2.5}$ concentration (15 µg/m^3) which could be adopted in the revised NES. The WHO (2021) value of 15 µg/m^3 was exceeded on 21 days from 31 May to 8 September 2022.

Concentrations were found to be highest near the centre of town and lowest on the town boundaries. Highest concentrations occur at the northern end of the township and on the west side adjacent to the river.

The report evaluates spatial variability in $PM_{2.5}$ concentrations and suggests that the driving mechanism behind elevated concentrations is emission density as opposed to drainage flow wind patterns. A wind rose shows the main wind direction when the conditions are calm is southerly.

2.2 Limitations of the monitoring

Whilst providing and initial insight into concentrations of $PM_{2.5}$ in Westport and data on the spatial variability in concentrations the monitoring approach used is a preliminary or survey type method that can not be relied on or used for reporting compliance with guidelines or standards, and in particular National Environmental Standards.

Additionally, the sites used for the investigative monitoring are generally unlikely to be suitable for long term monitoring owing to the different siting requirements.

It is therefore proposed that an air quality monitoring strategy for Westport include the establishment of a long term NES compliant $PM_{2.5}$ monitoring method.

2.3 Long term $PM_{2.5}$ monitoring in Westport

Given the indications of the initial monitoring for $PM_{2.5}$ it is recommended that the West Coast Regional Council establish a long-term monitoring site for $PM_{2.5}$ in Westport. The monitoring method should be consistent with methods authorised by the current NES.

Given the existing WCRC monitoring network we would recommend either a BAM or a T640. It is also recommended that allowance be made for the purchase of meteorological equipment to supplement the $PM_{2.5}$ data.

3 EMISSION DENSITY ASSESSMENT

An emission density assessment is a useful tool to assist in evaluation air quality monitoring locations. In the case of Westport, the preliminary air quality monitoring analysis (Baynham, 2022) suggests that emission density is a key variable influencing spatial variability in concentrations in Westport.

1.1 Methodology

An SA1 level evaluation of emissions from domestic heating, outdoor burning, motor vehicles and industrial and commercial activities was conducted for Westport using a combination of census data (home heating emissions), household data, resource consent information and local NZTA vehicle kilometer travelled data.

The Statistical Area Two (SA2) areas of Westport North and Westport South were used to define the emission assessment area. The SA2 areas are further broken down spatially into 33 SA1 level areas. Emissions are estimated at the SA1 level for domestic heating, motor vehicles, outdoor burning and industrial and commercial activities.

1.1.1 Domestic heating

Domestic heating methods were obtained from the 2018 census data SA1 estimates of households using different fuels and appliance types. Home heating methods were classified as; electricity, open fires, wood burners, pellet fires, multi fuel burners, gas burners and oil burners.

Emission factors were applied to these data to provide an estimate of emissions for each study area. The emission factors used to estimate emissions from domestic heating are shown in Table 3.2. The average fuel quantity (18 kilograms of wood per night) and age distribution of older wood burners (48% pre NES burners) was taken from the average of a range of 2022 air emission inventory surveys.

Table 3.1: Emission factors for domestic heating methods.

	PM_{10} g/kg	$PM_{2.5}$ g/kg	CO g/kg	NOx g/kg	SO_2 g/kg
Open fire - wood	7.5	7.5	55	1.2	0.2
Open fire - coal	21	18	70	4	8
Pre 2006 burners	10	10	140	0.5	0.2
Post 2006 burners	4.5	4.5	45	0.5	0.2
Pellet burners	2	2	20	0.5	0.2
Multi-fuel[1] - wood	10	10	140	0.5	0.2
Multi-fuel[1] – coal	19	17	110	1.6	8
Oil	0.3	0.22	0.6	2.2	3.8
Gas	0.03	0.03	0.18	1.3	7.56E-09

[1] - includes potbelly, incinerator, coal range and any enclosed burner that is used to burn coal

Emissions for each contaminant were calculated based on the following equation:

Equation 3.1 CE (g/day) = EF (g/kg) * FB (kg/day)

CE = contaminant emission

EF = emission factor

FB = fuel burnt

1.1.2 Motor vehicles

Motor vehicle emissions to air include tailpipe emissions of a range of contaminants and particulate emissions occurring as a result of the wear of brakes and tyres. Assessing emissions from motor vehicles involves collecting data on vehicle kilometres travelled (VKT) and the application of emission factors to these data.

Emission factors for motor vehicles are determined using the Vehicle Emission Prediction Model (VEPM 6.0) developed by Auckland Council. Emission factors for PM_{10}, $PM_{2.5}$, CO and NOx for this study have been based on VEPM 6.0. Default settings were used for all variables. Resulting emission factors are shown in Table 4.2.

Emission factors for SOx were estimated for diesel vehicles based on the sulphur content of the fuel (10ppm) and the assumption of 100% conversion to SOx. The g/km emission factor was estimated using VEPM 6.0 using the fuel consumption per VKT for the parameters described above.

The number of vehicle kilometres travelled (VKT) was estimated using the New Zealand Transport Authority VKT data (Table 4.3) for Buller District disaggregated to SA1 level based on the proportion of households within each SA1 area.

In addition to estimates of tailpipe emissions and brake and tyre emissions using VEPM an estimate of the non-tailpipe emissions (including brake and tyre wear and re-suspended road dusts) was made using the EMEP/EEA air pollutant emission inventory guidebook (2016). The emission factors from this method are shown in Table 4.4. It is noted that emission factors for fugitive sources such as resuspended dusts can have a high level of uncertainty.

Table 3.2: Emission factors (2023).

2023	CO g/VKT	PM_{10} g/VKT	PM brake & tyre g/VKT	NOx g/VKT	NO_2 g/VKT	$PM_{2.5}$ g/VKT	$PM_{2.5}$ brake & tyre g/VKT
Fleet profile	1.4	0.02	0.02	0.65	0.13	0.02	0.01

Table 3.3: VKT daily and annual (NZTA, 2021).

		Annual VKT
Westport	461094	168299182

1.1.3 Industrial and commercial activities

Industrial and commercial activities to be included in the inventory were identified by searching the Council's resource consent database.

Information on activities with resource consents for discharges to air in Westport were provided by the West Coast Regional Council. These included a range of surface coating activities, combustion activities, and odourous discharges. Additionally local schools were contacted to ascertain heating methods and where combustion of solid fuels was undertaken these were included in the assessment.

The main discharge from surface coatings is volatile organic compounds (VOC) which is a contaminant not included in most air emission inventories for New Zealand. Particle emissions may occur if coatings are applied using spray guns in an uncontrolled environment. However, they are not typically included in emission inventory assessments as they are comparatively small in relation to those from other sources (Environment Australia, 1999). Odourous activities also discharge VOCs and were not included in the emissions assessment.

The general approach was to identify activities discharging to air and collect site specific information relevant to the discharge type (activity data) as well as information on seasonal variability and hours of operation where relevant.

Emissions were estimated using activity data and emission factor information, as indicated in Equation 5.2. Activity data from industry includes information such as the quantities of fuel used, or in the case of non-combustion activities, materials used or produced. Activity data was collected by direct contact with industry, using data from the resource consents or compliance monitoring or a combination of these methods.

Equation 5.2 Emissions (kg) = Emission factor (kg/tonne) x Fuel/Material use (tonnes)

1.1.4 Outdoor burning emissions

Outdoor burning emissions were estimated using 2022 emission inventory data averaged to an emissions per household basis, for areas where outdoor burning is not prohibited during the winter months. These were estimated at the SA1 level using 2018 household data from the census.

Table 3.4: Outdoor burning emissions per household basis

Garden waste kg/hh/year PM_{10}	Garden waste kg/hh/year CO	Garden waste kg/hh/year Nox	Garden waste kg/hh/year Sox	Garden waste kg/hh/year $PM_{2.5}$
2.0	6.8	0.5	0.1	1.9

1.2 Results

Figure 3.1 shows and estimate of the relative contribution of sources to daily and annual $PM_{2.5}$ emission in Westport. It is noted that the methodology is less robust than a site specific inventory with surveying but provides a strong indication that domestic heating is the main contributor to $PM_{2.5}$ emissions.

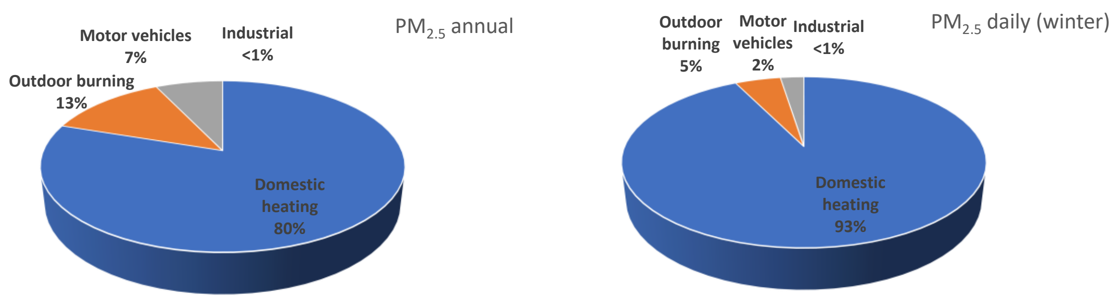

Figure 3-1: Relative contribution of sources to daily and annual $PM_{2.5}$ in Westport

The spatial distribution in $PM_{2.5}$ emissions in Westport will depend largely on domestic heating emissions in conjunction with meteorological conditions, noting the conclusion of Baynham (2022) as to the latter having minimal impact. Figure 3.2 shows the spatial distribution in daily $PM_{2.5}$ emissions from domestic heating, outdoor burning and motor vehicles in Westport. Industrial emissions are point source discharges and have different dispersion characteristics and therefore have not been included in Figure 3.2. The location of the main industrial discharge is on the northern end of Westport.

Annual variations are also illustrated in Figure 3.3. This suggests areas of highest emission density in the northern Westport area between Queen and Derby Streets, with Gladstone Street on the north and Cobden Street on the southern side. Further high emission density areas are located to the south between Wakefield

Street and Fonblanque Street. Implications for the establishment of an air quality monitoring site are discussed in section 4.

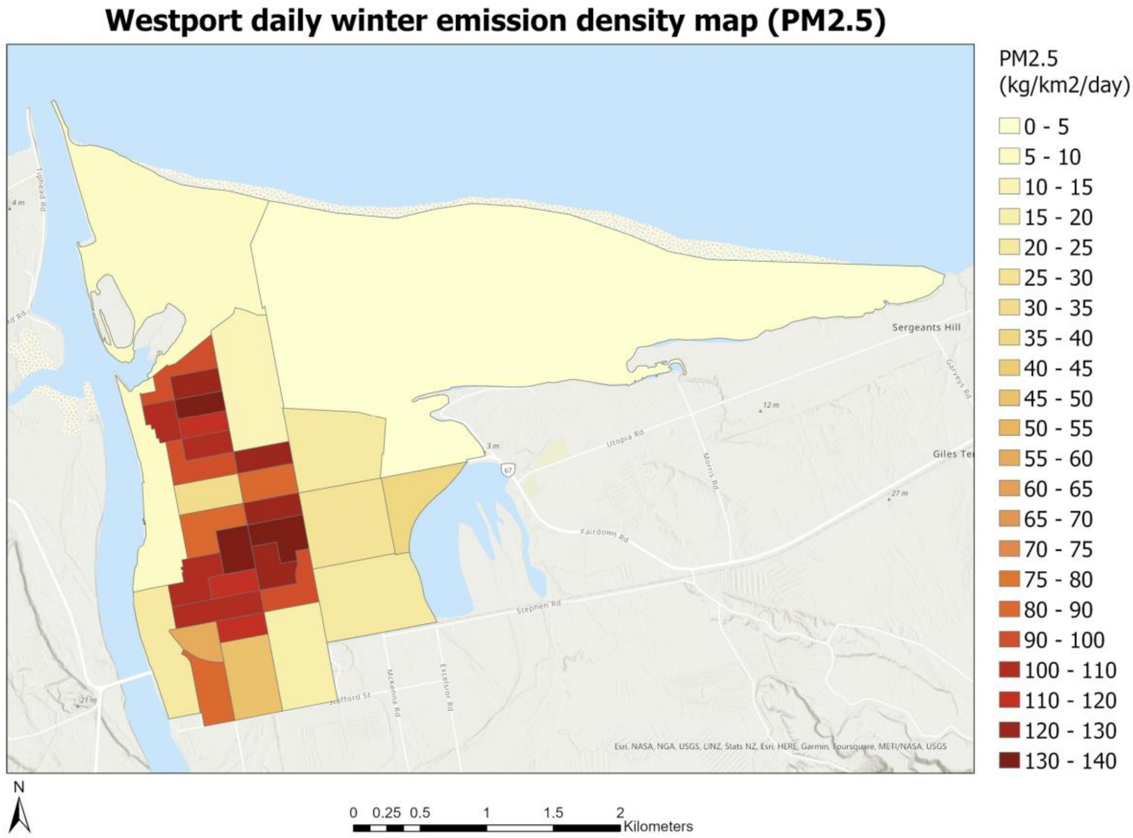

Figure 3-2: Emission density for daily $PM_{2.5}$ in Westport ($kg/km^2/day$)

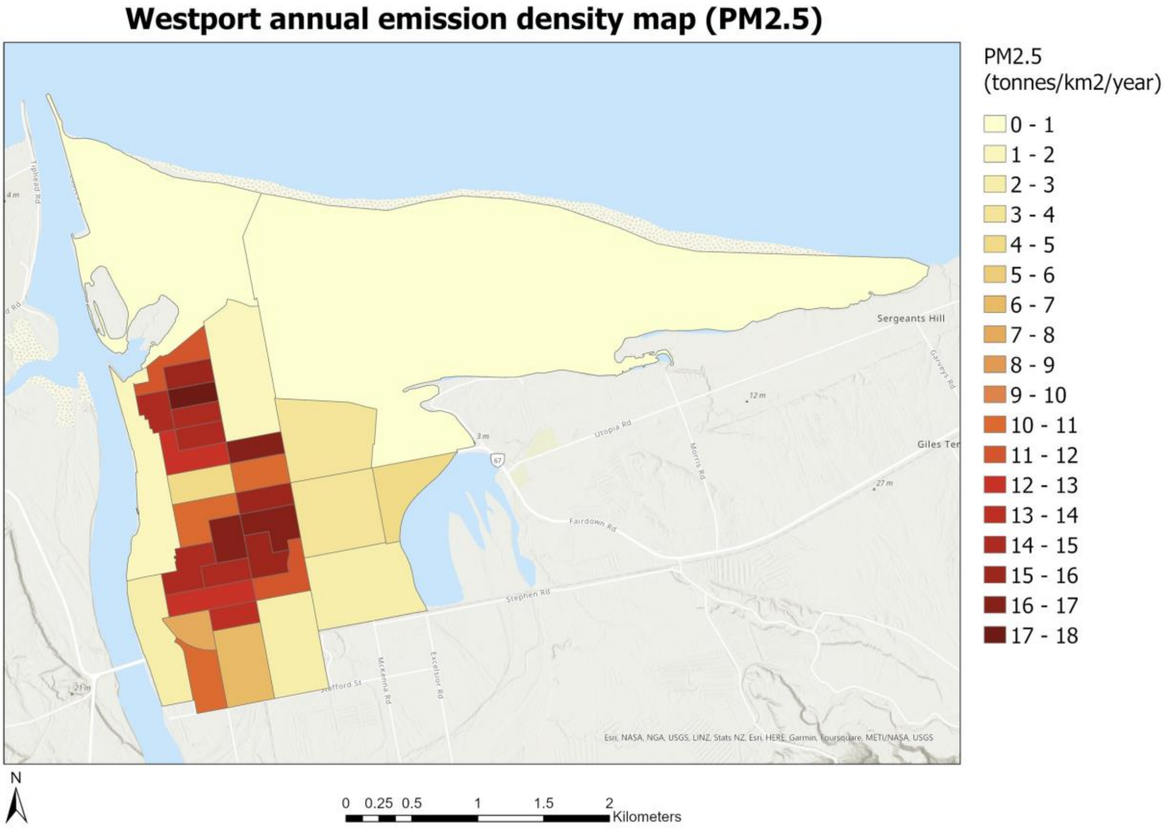

Figure 3-3: Emission density for annual $PM_{2.5}$ in Westport (tonnes/km^2/year)

4 MONITORING SITE

A key limitation in establishing a long-term air quality monitoring site is finding a location with adequate open space with sufficient distance from localised sources that may impact directly on the monitoring equipment. In urban areas monitoring sites tend to be located in parks, schools or similar areas. Location of a monitoring site in a backyard, for example, is rarely suitable in areas of high density wood or coal use. Additionally, site security is a concern as publicly accessible locations can be subject to vandalism if adequate measures are not taken.

The areas identified by Baynham (2022) as likely having the highest $PM_{2.5}$ concentrations are predominantly residential areas to the northern end of Westport. The emission density analysis also identifies an area of high emission density to the north around the M8 monitor from Baynham (2022) and reasonably high emission densities around the M2 sampler. An evaluation of open spaces in these areas shows no obvious locations close to these sites suitable for long term air quality monitoring. Additionally, the area around M9 from Baynham (2022) which appears close to the Derby Street side of the Rugby Club and Trotting Club areas gave rise to regular high concentrations. This is on the eastern side of the high-density emissions area to the north of Westport. Similarly, the Buller High School is located near to the area of the M8 sampler and to the east of one of the very high emission density areas in the northern end of Westport. It is noted that the school has a boiler system with flue located on its western boundary and any monitoring site established in that area would need to distance itself from this point source.

Wind rose data from Baynham (2022) shows the prevalence of a southerly wind on days when the meteorological conditions will likely be conducive to elevated $PM_{2.5}$. This wind direction will direct emissions from higher density areas to the south and impact on the monitoring area.

Based on these data it is recommended that Council aim to locate the long-term monitoring equipment in the vicinity of the rugby grounds or trotting club on Derby Street in the first instance and if a site is unable to be secured that an area around the Buller High School be targeted for the establishment of a monitoring site.

5 CONCLUSIONS AND RECOMMENDATIONS

An evaluation was carried out into sources of $PM_{2.5}$ in Westport and consequently the most appropriate location to measure worst case $PM_{2.5}$ concentrations. Domestic heating was found to the primary source of daily winter time $PM_{2.5}$ contributing over 95% of the emissions.

An evaluation of the emission densities within Westport identified an area to the north of the township and a further area to the south as having the greatest $PM_{2.5}$ emission densities. Establishing a monitoring site in the vicinity of the northern high emission density area was recommended as this coincided with information from a spatial air quality monitoring programme and was consistent with meteorological data which suggests a gradual flow from south to north on days of low wind speed.

An evaluation of potential monitoring site locations near the recommended area highlighted the potential for a monitoring site in the vicinity of the rugby club grounds or trotting club grounds on Derby Street. A second location at the Buller High School was also identified should it not be possible to secure either of the first options.

Monitoring for $PM_{2.5}$ with an NES compliant method is recommended as is inclusion of meteorological equipment at the monitoring site.

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